Introduction: Local or Universal Principles of Reasoning?

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INNATE PRINCIPLES OF REASONING

In the past, philosophers used to put infants and children on the opposite side from science in the spectrum of cognitive rationality. Their supposed cognitive immaturity did not allow them to approach the ideal image of rational beings. Two psychologists, Gopnik and Meltzoff (1997), declared, at the end of the introduction to their book: "Ultimately, our reason for watching and talking to children is the same as Socrates'. The most central questions in cognitive science are questions that only they can answer" (p. 9).

One of the questions that children seem to answer in their book is about the analogy of the child as a little scientist. The central idea of the book is that "the processes of cognitive development in children are similar to, indeed perhaps even identical with, the processes of cognitive development in scientists" (Gopnik & Meltzoff, 1997, p. 3).

Infants are endowed with an innate set of principles that allows them to begin to interact with the world. Among these principles, one of the most important allows a causal attribution to relations between physical events. At around the age of 6 months, the infant is able to apply the principles of *cohesion*—a moving object maintains its connectedness and boundaries—*continuity*—a moving object traces exactly one connected path over space and time—and *contact*—objects move together if and only if they touch (Spelke, Phillips, & Woodward, 1995). A child has an

intuition of what characterizes a living being from an artifact or an object. Between the ages of 2 and 5, the child assumes that external states of affairs may cause mental states and that there is a causal chain from perception to beliefs to intentions and to actions (see Sperber, Premack, & Premack, 1995). According to Viale (1999), these results on causal cognition in infants seem to justify the anti-Humean thesis of causal inferences based on synthetic a priori principles.

What are the features of these principles? Data from developmental studies and a certain universality of causal perception in cross-cultural studies seem to support the hypothesis that we are endowed with early developed cognitive structures corresponding to maturational properties of the mind-brain. They orient the subject's attention toward certain types of clues, but they also constitute definite presumptions about the existence of various ontological categories, as well as what can be expected from objects belonging to those different categories. Moreover, they provide subjects with "modes of construal" (Keil, 1995)—different ways of recognizing similarities in the environment and making inferences from them. Moreover and more surprisingly, contrary to the Piagetian theory, according to which the notion of causality is domain-general and gradually modified by experience,

> different conceptual domains are structured by different principles which 1) carry information about the types of stimuli that are likely to correspond to particular ontological categories, 2) convey expectations about non-obvious properties of objects in different domains, 3) constrain the manner in which spontaneous inductive inferences are made about objects from different domains. (Boyer, 1995, p. 623)

The previous Piagetian notion of formally defined stages, characterized by principles that apply across conceptual domains, has been replaced by a series of domain-specific developmental schedules, constrained by corresponding domain-specific principles. These principles constitute a core of probably innate "intuitive theories," which are implicit and constrain the later development of the explicit representations of the various domains. As Gelman (1990) highlighted, "different sets of principles guide the generation of different plans of action as well as the assimilation and structuring of experiences" (p. 80). They establish the boundaries for each domain, which single out stimuli that are relevant to the conceptual development of the domain.

The three main intuitive theories individuated by cognitive science are the theory of physical objects, the theory of biology, and the theory of psychology. These theories allow infants to individuate some theory-specific

causal mechanisms to explain interactions among the entities in a domain. A child has an intuition of what characterizes a living being from an artifact or object. Between the ages of 2 and 5, the child assumes that external states of affairs may cause mental states and that there is a causal chain from perception to beliefs to intentions to actions.

The intuitive theory of physical causality is the least controversial and very rich in empirical data. Intuitive physical principles orient the child's understanding of the physical environment from infancy. Principles specifying that solid objects are cohesive, continuous, and not susceptible to action at a distance seem to emerge before 4 months (Baillargeon & Hanko-Summers, 1990; Leslie, 1988; Spelke, 1990). At around 6 months, the infant is able to apply the principle of support (i.e., that objects fall if they are not supported; Spelke, 1990). The specific patterns of movements allow him to make ontological distinctions between self-generated and non-self-generated movement (Massey & Gelman, 1988). This distinction gives an initial skeleton to the differentiation between animate and inanimate kinds of objects, which has important consequences for causal reasoning in the biological and psychological domains.

Research on causal cognition has shown that there are perceptions of causality that are not affected by previous experiences, whether of the same specific kind of relations or of an analogous kind. Besides, there is a great amount of empirical data showing that there is, in many cases, a strong cognitive tendency to infer a priori the effect of observing a cause without any dependence on previous experienced regularity. These empirical data seem to meet Hume's challenge (i.e., to show examples of perception and of a priori inference of a nonexperienced causal relation; Viale, 1999).

Starting from these data, Gopnik and Meltzoff (1997) introduced "The Little Scientist Thesis":

> There is strong empirical evidence that starting from their innate endowed principles, children propose abstract entities, coherently organised with causal relations among them. They make ontological commitments and hold counterfactuals. These entities serve to provide characteristic explanations, predictions and interpretations. Children initially ignore certain kinds of counter-evidence, then account for such evidence with auxiliary hypotheses, then use the new theoretical idea in limited contexts, and only finally reorganise their knowledge so that the new theoretical entities play a central role. When the new theory is under construction, they engage in extensive experiments relevant to the theory and collect empirical generalisations.

The innate theories function as a start-up of the conceptual development—but while innate, they would be defeasible. They are later modi-

fied and revised by new evidence: "Innate theories are like the Neurath boat that pushes off from the pier. The boat you start out in may have considerable effect on the boat you end up with, even if no trace of the original remains" (Gopnik & Meltzoff, 1997, p. 51).

Children resemble scientists in their method of theory change. One theory can substitute another when it fits the empirical evidence better and allows one to make better predictions. Counterevidence to a theory is ignored unless it manifests itself persistently. The methodological criteria of theory change in little scientists are not the guarantee of truth and representational success. Many false hypotheses are generated using these criteria. Nonetheless they seem to be a guarantee of conceptual learning from errors to generate theories that fit the world better.

ARE CHILDREN RATIONAL?

Norms and criteria of theory change and conceptual development in children give a positive representation of the rational attitude of humans. On the contrary, there is a dark side of the coin. Little scientists seem not to satisfy elementary canons of correct reasoning. For example, one candidate principle of inductive reasoning concerns the diversity of evidence in support of a general hypothesis. It is widely claimed that greater diversity entails greater support (e.g., Franklin & Howson, 1984; Hempel, 1966). Why did Newton's theory end up commanding so much assent? One reason is that in the presence of various background assumptions, the theory accurately predicts heterogeneous phenomena, such as the trajectories of balls thrown into the air, the behavior of gyroscopes, and the orbit of celestial bodies. At the end of the 17th century, these phenomena appeared very diverse, which forced respect for the theory despite reservations about the reliance on occult, nonmechanical entities like gravity.

The diversity principle has been the object of psychological investigation. Osherson, Smith, Wilkie, López, and Shafir (1990) discovered that it is one of the phenomena present in category-based induction tasks.

A general inductive argument is one in which the category in the conclusion properly includes the categories in the premises. For example, the conclusion category MAMMAL in Argument 1 includes the premise category HIPPO and HAMSTER:

(1) *Hippos have ulnar arteries.*
Hamsters have ulnar arteries.

All mammals have ulnar arteries.

An argument is strong if belief in the premises causes people to believe the conclusion.

American adults seem to support a general or specific conclusion more when the premises are more different than when they are more similar. On the contrary, studies by López, Gelman, Gutheil, and Smith (1992) and Gutheil and Gelman (1997) among 6- and 9-year-olds show an opposite attitude. For example, 6-year-olds prefer Argument 2:

(2) *Cows have ulnar arteries.*
Buffalos have ulnar arteries.

All animals have ulnar arteries.

to the alternative Argument 3:

(3) *Cows have ulnar arteries.*
Cats have ulnar arteries.

All animals have ulnar arteries.

Moreover, both 6- and 9-year-olds prefer more homogeneous premises to more diverse premises in arguments with specific conclusions like Argument 4:

(4) _____
Kangaroos have ulnar arteries

Children seem not to apply a fundamental norm of inductive reasoning. Therefore, the little scientist hypothesis might be weakened.

The diversity principle is a genuine feature of rational inquiry, hence part of the meaning of the "little scientist" hypothesis. Viale and Osherson (chap. 1, this volume) argue against the use of the diversity principle as a normative standard of inductive reasoning. The diversity variable is not related in such a simple fashion to argument strength, even at the prescriptive level. This is because so-called *blank* predicates (i.e., predicates that are indefinite in their application to given categories, but clear enough to communicate the kind of property in question) often retain enough meaning to open the door to legitimate reasoning that violates the diversity principle. An example is provided by the predicate *often carry the parasite Floxum.* It counts as blank because the parasite *Floxum* is unfamiliar, so nothing can be divined about which mammals are more or less likely to suffer from it. Now consider Arguments 5 and 6:

(5) *Housecats often carry the parasite Floxum.*
Fieldmice often carry the parasite Floxum.

All mammals often carry the parasite Floxum.

(6) *Housecats often carry the parasite Floxum.*
Tigers often carry the parasite Floxum.

All mammals often carry the parasite Floxum.

It seems undeniable that housecats resemble tigers more than they resemble fieldmice. Yet it appears perfectly defensible to judge Argument 6 to be stronger than Argument 5 on the grounds that housecats might catch Floxum from fieldmice (their prey), whereas they have little contact with tigers. In this case, reasonable judgments about strength run counter to the advice offered by the diversity principle. Hence, the latter is discredited as a basis for evaluating inductive intuition. Of course the example does not show that diversity always gives the wrong advice, only that it sometimes does. But this is enough to undermine its claim to normative status.

If we accept the Bayesian probability theory as a normative account of scientific inference, as most contemporary philosophy of science is doing (Howson & Urbach, 1993), we may propose that it is the probability of premises prior to accepting the conclusion that governs its strength (Horwich, 1982). Under these conditions, argument strength stands in a simple relation to premise probability.

Premise Probability Principle (PPP)

Suppose that Arguments A,B/C and A,B'/C are given where C logically implies A,B and B'. Then the strength of the first argument is greater than the strength of the second if and only if $P(A \& B) < P(A \& B')$.

The less probable the premises, the stronger the argument. Diversity of premises is often (but not systematically) associated with low premise probability. For example, it seems less likely that cows and cats have ulnar arteries than that cows and buffalos do. Based on this assumption, PPP accounts for the greater strength of Argument 3 compared with Argument 2. Likewise, given their unrelated habitats, housecats and tigers seem less likely to carry common parasites than do housecats and mice. For anyone sharing the latter judgment, PPP rules Argument 6 to be stronger than Argument 5.

From the proof of PPP, it can be seen that the principle applies to arguments with any predicate, blank or not. Its normative status is thereby en-

hanced because inductive reasoning almost invariably involves meaningful predicates. Observe also that PPP is a consequence of no more than the axioms of probability along with our definition of argument strength.

The experiments on PPP, summarized in Viale and Osherson (chap. 1, this volume), come from Lo, Sides, Rozelle, and Osherson (2002). All experiments were designed to collect judgments about argument strength versus premise probability in two-premise general arguments with blank predicates. The crucial items were arguments evaluated at separate times for strength and premise probability.

In Experiment 1, American preschoolers showed reliable (albeit imperfect) conformity to PPP. Indeed, they showed more conformity to PPP than to the diversity principle. In Experiment 3, it was seen that Taiwanese children showed as much conformity to PPP as their American counterparts.

The PPP has better credentials because it follows from the axioms of probability and a plausible definition of argument strength. The experiments reveal tenuous but detectable conformity to PPP on the part of young children in different cultures. If these findings are supported and extended by further experimentation, they provide one clear sense in which young children's inductive methodology can be interpreted as properly scientific.

Furthermore, these studies show how, prior to environmental conditioning resulting from different latitudes and longitudes, there is cognitive uniformity that appears to be based on a common genetic endowment of the same principles of reasoning.

REASONING BIASES OR EXPERIMENTAL ERRORS?

If the studies on biases and errors during developmental age do not generate great concern about the image of human rationality, on the contrary, the enormous amount of empirical evidence collected over the past 40 years on suboptimal ways of human reasoning and decision making has provoked great bewilderment. "How can we go to the Moon with so many constant errors of judgement?" was the question asked by a colleague to Nisbett and Ross after having read the proofs of the first eight chapters of their book *Human Inference: Strategies and Shortcomings of Social Judgement* (1980). The image of man that is portrayed in the book is of a person unable to use formal criteria of reasoning and decision making like those that scientists use in their activity. Man chooses samples that are biased by systematic tendencies; he is not able to assess the covariation between events; he is biased in the causal attribution; he makes predictions

ignoring base rate and regression toward the mean; he tends to confirm the theory instead of falsifying it.

Nevertheless, man goes to the Moon—that is, he is quite able to adapt to his social and natural environments. He is able to understand, predict, and control many aspects of his life and environment. He is able to plan his career, make diagnoses from his symptoms, and discuss rationally many problems.

There are two important aspects of human irrationality that can find a moderate interpretation. The first concerns suboptimality in assessing covariation among events, which is a crucial ability for generating hypotheses. Outside the laboratory, in real life, there are many circumstances that allow good performance in covariation:

1. Because sometimes the stimuli are well perceived, evident, close, and motivationally relevant.
2. Because when covariation is very strong, a single prototypical case can offer a reliable representation of the general relation.
3. Because most of our theories are founded on covariations made by experts (scientists, advisers, consultants) in particular fields.

The second and most important concern about human rationality is the "perseverance bias." People tend to persevere in their beliefs even when faced with data that falsify them. This phenomenon seems to undermine the dynamic image of theory change of the little scientists thesis. Actually, the dynamics of theory change of the child compared with the adult is much stronger. In fact, the *little scientist* metaphor finds its justification in the greater analogy between child and scientist than child and adult. Adults, for many acceptable and unacceptable reasons, are more conservative in maintaining their theories of the world. They prefer stability of their system of thought and find it difficult to integrate, in the quick flow of contemporary life, empirical counterevidence into new alternative theories. Nevertheless:

a) The maintenance of a theory in front of anomalies, until we are sure that it is systematic, seems a sound methodological rule also in the scientific community.

b) The adult seems more close to the model of the technologist rather than the scientist. He needs to apply theories in everyday problem-solving. He has no time to worry about the truth of the theory. What is important is that it functions in solving practical problems. He fears more a casual error in applying the theory in a given pragmatic context than a systematic error that would need the generation of an alternative theory. Nevertheless, as in technology, the solution works if the embodied theory is

> valid. Therefore, sooner or later, even the adult is obliged to change ill-functioning theories. (Viale, 2001, p. 225)

However, not all people accept a picture of man as being naturally inclined to systematic errors and bias. Following the tradition of studies on probabilistic judgment, the mainstream, represented by Kahneman, Slovic, and Tversky (1982), sees in natural heuristics the "strategies of simplification that reduce the complexity of judgement tasks, to make them tractable for the kind of mind that people happen to have" (p. XII). Availability heuristic and representativeness heuristics are an example of these inferential tools used by the human mind and based on the limits of memory. Their activation appears to be responsible for probability judgments that do not comply with the canons of Bayesian theory. These results have been criticized by Gigerenzer (1991, 1994) and Cosmides and Tooby (1996), who, following evolutionist psychology, regard probabilistic reasoning as based on observed frequencies, sequences of events, and limited samples. Contrary to the frequentist approach, the Bayesian method adopted by Kahneman et al. uses probability expressed in percentages that are a highly processed cultural product and consequently do not seem to be a natural representation to study probabilistic reasoning. As a result, many errors and biases identified in the experiments undertaken in the past few years appear not to be an expression of irrationality in human cognition, but rather the effect of an unnatural method of studying probabilistic reasoning. This offers contrast between two opinions on the natural dimension of probabilistic reasoning: The first focuses on the limitations of the mind and the use of heuristics, whereas the second stresses the categorization of events through sequences and frequencies. According to Macchi and Bagassi (chap. 9, this volume), this characterization is inadequate. In fact, both approaches fail to take account of an important explanatory element for the formation of errors and biases: the pragmatic effect of context-dependent variables activated by the formulation of a problem. As the studies described in the chapter show, the difficulties and suboptimal features of many tests on probabilistic reasoning are related more to the structure of the text than to the heuristic factors or the statistical format in which the probabilities are expressed. This consideration is true irrespective of the use of cultural percentages or natural frequencies.

CULTURAL DIFFERENCES IN THE STYLES OF REASONING

When we analyze the cognitive rationality stemming from the cognitive tests on everyday reasoning, one important question concerns the cultural variability of the styles of reasoning. Are cognitive abilities universal or

context-dependent? Can we discover common patterns of thinking among different cultures or does each sociocultural environment shape its system of thought?

An answer to this question comes from Nisbett and Masuda (chap. 2, this volume); Nisbett, Peng, Choi, and Norenzayan (2001); and Nisbett (2003) on the differences between Asian and American thinking. They rely on an impressive number of cognitive tests that try to compare the way of reasoning of North Americans, mainly university students, and East Asians (Korean, Chinese, and Japanese), mainly university students. The East Asians and Americans respond in qualitatively different ways to the same stimulus situation in many different tests.

For example, American participants showed large primacy effects in judgments about covariation, whereas Chinese participants showed none. Control illusion increased the degree of covariation seen and the reported accuracy of Americans, but tended to have the opposite effects on Chinese. Koreans were greatly influenced in their causal attribution by the sort of situational information that has no effect for Americans. Koreans showed great hindsight bias effects under conditions where Americans showed none. Finally, Americans responded to contradiction by polarizing their beliefs, whereas Chinese responded by moderating their beliefs. I can summarize the results as follows.

The *American* versus *East Asian style of thinking* (Nisbett et al., 2001):

1. *Explanation*: East Asians tend to explain events, both social and physical, more with respect to the field, whereas Americans tend to explain events more with respect to a target object and its properties.

2. *Prediction* and *postdiction*: East Asians tend to make predictions with reference to a wider variety of factors than Americans do. Consequently, they are less surprised by any given outcome, and they are more prone to "hindsight bias" or the tendency to regard events as having been inevitable in retrospect.

3. *Attention*: Because East Asians locate causality in the field instead of the object, they tend to be more accurate at "covariation detection"—that is, the perception of relationship within the field.

4. *Control*: Americans are more subject to the "illusion of control"—that is, a greater expectation of success when the individual is involved in interaction with the object—even when that interaction could not logically have an effect on the outcome.

5. *Relationships and similarities* versus *rules and categories*: East Asians tend to group objects and events on the basis of their relationships to one another (e.g., "A is a part of B"). Americans would be expected to group them more on the basis of category membership (e.g., "A and B are both Xs"). Americans are inclined to learn rule-based categories more readily

than East Asians and rely on categories more for purposes of inductive and deductive inference.

6. *Logic* versus *experiential knowledge*: East Asians are more influenced by prior beliefs in judging the soundness of a formal argument. Americans are more able to set aside prior beliefs in favor of reasoning based on logical rules.

7. *Dialectics* versus *the law of noncontradiction*: East Asians are inclined to seek compromise solutions to problems ("middle way") and reconcile contradictory propositions. Americans tend to seek solutions to problems in which a given principle drives out all but one competing solution, to prefer arguments based on logic, and to reject one or both of two propositions that could be construed as contradicting one another.

These differences are reflected in the different kinds of errors and biases that affect East Asians and Americans. We cannot say that one culture is normatively better than another. East Asians are better at causal covariation and less prone to illusion of control. Americans are better at deductive reasoning in category-based induction and less prone to hindsight bias. Obviously, better does not mean that they satisfy, absolutely, the normative canons of rational reasoning. It is well known that the tradition of investigation into deductive and probabilistic errors and biases started in American colleges.

Therefore, we can say that we are faced with two different mixes of rational and irrational reasoning. But the crucial thesis of Nisbett et al. (2001) and Nisbett and Masuda (chap. 2, this volume) is that the different ways of reasoning are not a contingent and superficial feature, but are rooted in two completely different systems of thinking—that is, in different metaphysical and epistemological principles that shape the American and East Asian cognition differently. These two different systems of thinking originated causally from two different sociocultural environments: the old Greek trading society and classical philosophy, on the one hand, and the old Chinese agricultural society and Confucian philosophy, on the other hand.

Different socioeconomic variables gave birth to different styles of thought that we can summarize under the headings of *holistic* and *analytic* thought. Nowadays, these different styles of thought continue to be effective in differentiating the reasoning processes of contemporary Americans and East Asians.

Norenzayan (chap. 3, this volume) also confirms the results of Nisbett and Masuda (chap. 2, this volume), Nisbett (2003), and Nisbett et al. (2001). The cultural differences between Western and Asiatic populations are examined in a variety of cognitive tasks that involve formal and intuitive reasoning.

> Formal reasoning is rule-based, emphasizes logical inference, represents concepts by necessary and sufficient features, and overlooks sense experience when it conflicts with rules of logic. Intuitive reasoning is experience-based, resists decontextualizing or separating form from content, relies on sense experience and concrete instances, and overlooks rules and logic when they are at odds with intuition. The reasoning of Euro-American, Asian American, and East Asian university students was compared under conditions where a cognitive conflict was activated between formal and intuitive strategies of thinking. The central hypothesis was that Euro-Americans would be more willing to set aside intuition and follow rules than East Asians. (Norenzayan, chap. 3, this volume)

The chapter contains the results of four experiments. In the first experiment, participants are asked to apply complex rules to classify imaginary animals correctly. Then, to test the inductive category learning, a conflict is stimulated between the complex rule and the memory of animals seen previously. The second experiment explores judgments of similarity and drawing classification. These judgments use either a solution based on rules or a family-resemblance-based solution. The last two experiments attempt to examine the conceptual processes. In the third experiment, participants are asked how convincing deductive reasoning is when logic comes into conflict with the typicality of the conclusion. In the fourth experiment, Norenzayan examines deductive reasoning when the logical structure opposes the credibility of the conclusion.

The results confirm the starting hypothesis that Euro-American students have a much stronger tendency to ignore intuition and follow the rules of reasoning when the latter conflict with the former.

THE APPARENT DIVERSITY OF TRIBAL AND CIVILIZED STYLES OF REASONING

The first consideration about this anti-universal conception of cognition comes from the supporters of the universal endowment of cognitive abilities. If the innate theories of physics, biology, and mind are true, then these theories form a common universal cognitive basis for the thought of every human in the world. Other investigators are even more radical. There are even common essential beliefs about the nature of the social world (Hirschfeld, 1996; see also chap. 5, this volume), and even religious conceptions, such as spirits and superhuman agents, are remarkably similar from one culture to another (Boyer, 1993).

In my opinion, this position may be consistent with the anti-universal thesis of Nisbett et al. The little scientist hypothesis can explain why. We know that conceptual and theory change in the developmental age does

not start from nothing, but from an innate endowment of theory about causality, the physical world, and so on. The change toward new theories is triggered by empirical evidence and informative inputs that come from the environment. These evidential and informative inputs obviously are variable in relation to the particular developmental contexts. Therefore, they drive the generation of different theories on how to interpret and understand the world. They are the metaphysical and epistemological theories representing the implicit premises of our reasoning and thinking. In conclusion, it is likely that such different sociocultural contexts as the East Asian and American ones are able to lead, in the developmental age, to the generation of different metaphysical and epistemological theories that have a different effect on ways of reasoning.

Norenzayan (chap. 3, this volume) agrees with the previous consideration. The human mind is equipped with basic cognitive primitives and possesses cognitive processes that carry out many tasks, such as exemplar-based categorization, deductive reasoning, causal attribution, and so on. However, this basic endowment does not rule out differentiated development in response to cultural and environmental stimuli. These differences are manifested in various ways. First, different cultural practices can make a given cognitive process, which is universally available in principle, accessible in a differentiated way. Asians appear to have a greater propensity than Westerners for exemplar-based categorization and a lesser propensity to decontextualize deductive arguments and more to explain behavior by referring to the situational context. Second, through discoveries and inventions, societies often introduce artificial and complex new ways of thinking that differentiate one culture from another. One needs only think of the statistic and probabilistic revolution in the 17th century and its impact on Western rationality and decision-making models—or the development and influence of the ancient Taoist notion of yin and yang in the contemporary Chinese way of reasoning in relation to modal concepts like change, moderation, and relativism.

The second consideration about the thesis proposed by Nisbett et al. relates to the implicit support of a kind of cognitive relativism. This is the natural consequence of the socioeconomic determinism present in their thesis. In fact, according to them, social organization and economic structure are the major determinants of the causal chain metaphysics–epistemology–cognition. Different socioeconomic configurations generate fixed, irreversible, different causal chains. The world seems shaped with different and incommensurable causal chains related to the different socioeconomic structures.

One of the results that Nisbett et al. bring to support their thesis seems to go in the opposite direction. It deals with the difference principle mentioned in a previous paragraph. According to them: "Koreans make less

use of categories for purposes of inductive inference than do Americans and therefore are not able to follow the difference principle in an argument with a specific conclusion" (Nisbett et al., 2001).

Faced with Arguments 7 and 8, Koreans prefer Argument 7 because they are less able than Americans to generate the inclusive category MAMMALS from the category in the conclusion RABBIT, and therefore to estimate that LIONS and TIGERS have a lesser coverage of the category MAMMAL than LIONS and GIRAFFES (Choi, Nisbett, & Smith, 1997).

(7) *Lions have ulnar arteries.*
Tigers have ulnar arteries.

Rabbits have ulnar arteries.

(8) *Lions have ulnar arteries.*
Giraffes have ulnar arteries.

Rabbits have ulnar arteries.

On the contrary, if the category MAMMAL is made salient by changing the conclusion to:

(9) _____
Mammals have ulnar arteries.

the principle of difference is satisfied.

Data that seem more severe about the ability to use categories come from a study that has been carried out in Vietnam at the University of Ho Chi Min City (Viale & Osherson, 2000). The sample seems to show that even using arguments with a general conclusion, and not only with a specific conclusion, the East Asian students are unable to apply the difference principle. Does this mean that there are fixed wired-in limitations in the cognitive processing of categories in some people (e.g., East Asians), but not in others (e.g., Americans)? I don't think so.

The answer comes from the studies carried out among traditional Itza' Mayans from the Peten region of Guatemala (López, Atran, Coley, Medin, & Smith, 1997; see Atran, Medin, & Ross, chap. 4, this volume) to identify the universal cultural features of folk-biological inductions on mammal categories. They discovered that, as in the previous case of Vietnam, Itza' did not follow the diversity principle with general and specific conclusions. These data were very different from those found in many American colleges, where the diversity principle was always followed. They tried to explain, through a number of follow-up studies, what the reasons were

for this difference. The conclusion was not one of radical cognitive differences, but rather an ecology-based reasoning stemming from the particular pragmatic context where they were living.

> Itzaj participants had extensive knowledge of the habits, characteristics, and ecological proclivities of Peten mammals; this ecological knowledge appears to have blocked diversity-based reasoning by rendering the premises implausible on the basis of what the Itzaj know to be true. Cultural knowledge available to the Itzaj may have rendered the diversity strategy irrelevant. (López et al., 1997, p. 288)

In fact, they tried to control the hypothesis of ecology-based reasoning in two following studies. One was made on Itza', using arguments stemming from real-world scenarios and not from natural taxonomy. The tests were about saving money, inspecting farmland, and buying corn. It showed that they were able to follow the diversity principle when reasoning about everyday life and pragmatic problem solving. One of the tests was the following:

> Imagine you want to buy several bags of corn from a given person. Before buying them, this person will show you only two cobs of corn to check whether all the corn is good. Do you prefer him to show you two cobs from one and the same bag (non-diversification response), or do you prefer him to show you one cob from one bag and another cob from another bag (diversification response)? (López et al., 1997, p. 284)

The majority of Itza' chose the diversification response because, according to their theory based on real-life experience, they had good reasons to widen the sample.

The other study was made on American tree experts. They discovered that the less expert the individuals were (e.g., maintenance personnel), the more subject they were to ecology-based reasoning and the less they followed the diversity principle. On the contrary, expert taxonomists were able to extrapolate the inclusive categories more easily and to follow the diversity principle. Scientific knowledge enables the taxonomists to generate more salient categories at a rank higher than genus and family. When an individual, as in the case of the maintenance personnel, has knowledge based on concrete examples of trees at the genus level, he is not able to reason using categories at a higher rank and, consequently, cannot follow the diversity principle. On the contrary, the taxonomist can generate more generalized theories about the same object of everyday experience (e.g., the trees), therefore he is able to categorize at a more abstract level. These more abstract theories enable him to generate and use inclusive categories, and therefore to satisfy the diversity principle.

LAY FOLKS' REASONING

These tests appear capable of demonstrating that cognitive styles from other cultures (e.g., like those used by the Indios, which seem so different, in terms of performance, from Western ones) in fact present similar cognitive skills. The data presented earlier are reported by Atran, Medin, and Ross (chap. 4, this volume), who tackle various topics linked to folk biology. The first set of experiments was carried out with Yukatek Maya and urban American children and showed how the former, but not the latter, were able to reason on the members of the biological world without using analogies with humans. American children, in contrast, show an anthropocentric bias that can be explained by their different experience and interaction with animals and plants compared with the Indios children, who have lived in the rain forest since birth. Therefore, it would seem that "humans are not the prototype that organizes the domain of animals."

The second set of experiments was carried out with 4- and 5-year-old children belonging to the Maya Indios tribe and on Brazilian and American children living in cities. Both appear to use "concepts of innate species potential, or underlying essence, as an inferential framework for projecting known and unknown biological properties to organisms in the face of uncertainty." Together with the first set of experiments, these studies confirm the hypothesis that folk biology does not come from folk psychology. Children from different cultures relied on the concept of underlying essence, not on the properties of human beings, to reason on the properties of animals and plants.

The third set of experiments was carried out with adult Maya Indians and Americans living in the Midwest. Both sample populations showed a common tendency to prefer the generic-species level—the level of robin and oak—as the taxonomic rank to reason and make inductive inferences. This result appears to be counterintuitive among American adults owing to their scant knowledge and culture of individual animal and plant species. One would have expected that, for reasons of experience and similarity reasoning, the preferred level would be that of life forms—the level of tree and bird. Instead, also among the Americans, the level of generic species is preferred to make inductions on the distribution of biological properties and for "predicting patterns in the face of uncertainty." This result is a further confirmation of the presence of concept of underlying essences, the "generic-species level as a partitioning of the ontological domains of plant and animal into mutually exclusive essences."

The fourth set of experiments was carried out with adult Mayas, American college students, and various groups of biological experts (landscapers, park workers, birdwatchers, professional taxonomists). It showed that all groups tend to categorize generic species spontaneously into taxono-

mies with higher and lower levels. "People from diverse societies build topologically-similar biological taxonomies that guide inferences about the distribution of biological and ecological properties." As we have seen before, only the students and, for the great part, the taxonomists use diversity-based reasoning. Instead the other groups use ecology-based reasoning and the "taxonomy constrains the likely operational range of ecological agents and causes."

We saw earlier that Atran, Medin, and Ross (chap. 4, this volume) present data that appear to falsify the thesis that folk biology is parasitic on folk psychology. On the contrary, according to other authors, the propensity to attribute human psychological properties to nonhuman agents appears much more pervasive than that to animals alone. Because the concept of *person* seems to be a primitive concept that is applied to all nonhuman intentional agents, like animals (Carey, 1985), but also to ghosts (Boyer, 1990) and gods (Barrett & Keil, 1996), these nonhuman intentional agents are represented with human psychological properties, including intentional, emotional, and affective forms. There even appears to be a tendency to treat the computer as a conversational partner, attributing it with human psychological properties and regarding it as a much more real intentional agent than we might otherwise imagine (Moon & Nass, 1996). There appears to be a fundamental level, that of personhood, on which all the other levels depends. When intentional agency appears in other domains—animal, ghost, or inanimate object—it is a result of conceptual inheritance from person.

However, how does this mind-reading function occur? There are two main conflicting theories on the subject. According to the first theory, also known as "Theory Theory," people have folk-psychological knowledge of what goes on in other people's minds and how that makes them act in particular situations. This kind of knowledge can be defined as a *theory* of other people's mental activity (Churchland, 1981; Fodor, 1987). According to the second theory, also known as "Simulation Theory," individuals try to identify with other people's mental activities, beliefs, and aims, and therefore they can infer their consequent actions and behavior (Gordon, 1986; Heal, 1986). Perner and Kühberger (chap. 6, this volume) ask how we can decide which of these two mind-reading models is genuinely active. One possibility is the different result produced by the simulation model compared with the Theory Theory when elaborating prediction. If we examine the predicted behavior of an individual faced with two options, the simulation model only allows one option to be analyzed at once, whereas the Theory Theory, in principle, also allows both conditions to be placed alongside. Empathic simulation literally means getting into the other person's mind and elaborating the choice by examining the options one at a time and then comparing them, whereas the theory regarding the

behavior of the other person can blend and juxtapose the two conditions. Perner and Kühberger (chap. 6, this volume) present an experimental method, together with two experiments, that looks promising as a way of understanding in the future how the Theory of Mind (ToM) works.

In any case, understanding the behavior of other humans through the attribution of desires, beliefs, and intentions appears essential to the constitution of human society. Reading other people's minds to interpret their behavior is a crucial aspect of man's adaptation to evolutionary challenges (Tomasello, 1999). As is seen later with regard to the role of testimony and argumentation (see Sperber, chap. 7, this volume), the complexity of networks and social ties in human communities makes the possibility of mind reading, getting inside other people's minds, an essential tool to detect and track failures to cooperate and avoid the costs of cheating. This human capacity, termed by some authors the Theory of Mind (ToM), appears to emerge very early on and can already be found at the age of 9 months when the movement of a human hand is interpreted as intentional, but not that of an artifact (Woodward, 1998). As the child learns language, he tends to follow the mother's gaze to understand what is the referent for the word, therefore attributing it the intention to refer to the denotate of the term (Baldwin, 1991). Last, as Hirschfeld affirms (chap. 5, this volume), a ToM milestone in the developmental age "is the capacity to grasp that other people hold beliefs that one knows to be false."

The importance of ToM to our understanding of the social world appears to be demonstrated by the social maladjustment found in autistic children who appear to lack the ability to represent others as having beliefs and desires independent of one's own (Baron-Cohen, 1996). The fundamental level of folk psychology is also manifested in a form of folk-ontological holism that is found when we attribute intentionality to social aggregates. As Hirschfeld writes (chap. 5, this volume), "traffic jams, stampedes, riots, folie a deux (trois ou beaucoup), and other forms of 'groupthink' are aggregate phenomena that are best understood without appeal to individual persons' mental states," but ascribing to them intentions as if they had a mind of their own. According to most authors, this attribution of intentions is parasitic on folk psychology and does not constitute an independent folk sociology. Hirschfeld (chap. 5, this volume) disputes both the thesis that social understanding is largely concerned with the interactions of individual persons and their mind and the thesis that only individual persons (and other complex living organisms) are genuine intentional agents.

The understanding of the social dimension may also occur without understanding other persons' minds as postulated by ToM. We can understand another's behavior by identifying the social category to which he be-

longs and by foreseeing the standard and stereotypical forms of behavior resulting from this categorization. For example, if we meet an old retired general who is queuing to buy a ticket with us, we would expect him to show a low tolerance threshold to anyone failing to respect the order of precedence. If we meet a priest in the street, we would expect him to show verbal or nonverbal irritability with dissolute or shameless behavior. But, as exemplified by the case of Temple Grandin, mentioned by Hirschfeld (chap. 5, this volume), even definite cases of autism can understand the collective behavior of groups of agents (Sacks, 1995). Grandin was an autistic scientist who specialized in understanding animal psychology and raising and treating herds of domestic animals under stress. However, she was incapable of penetrating the human mind, and therefore did not possess a ToM with which to transfer intentional and affective activities to nonhuman agents like pets; her "extraordinary ability comes from her capacity to 'see' the nature of animal social experience without anthropomorphizing it." Some studies on autistic children presented by Hirschfeld (chap. 5, this volume) appear to show that, even "with significant impairment in their ability to interpret the behavior of others with respect to mental states, [they] were virtually unimpaired in their ability to interpret the behavior of others in terms of the groups of which they were members." They were able to do this by utilizing the social stereotypes, and in this way their capacity of group reasoning was independent of the capacity for person-based reasoning about behavior. This capacity for group-based reasoning independent of ToM person-based reasoning seems to emerge very early in human development. It is based on a number of cognitive and perceptive characteristics. Studies of geometric figures (Berry & Springer, 1993; Springer, Meier, & Berry, 1996) show that perceptual figures are crucial to intentional attributions. Specific patterns of motion invite people to attribute intentions to geometric figures without making any use of ToM. "Coordinated movement plus a version of spatial contiguity would thus seem an important determinant of perception of corporate individuality," namely, the attribution of intentional individuality to groups, sets, and aggregates of persons without any anthropomorphization process. To these aspects, we can add others concerning the common characteristics that supervise the social categorization of a group of individuals compared with others (e.g., physical characteristics, like skin color, hair color, or stature, or behavioral traits, like a subcultural type of dress and aesthetic identity). Therefore, the attribution of intentional individuality to groups and social aggregates is unrelated to the attribution of human psychological characteristics, such as desires, beliefs, and emotions.

In summary, for Hirschfeld, it is a question of recognizing that, together with ToM and the person as a primitive cognitive, there is another

primitive cognitive represented by the social entity. Therefore, alongside folk psychology and folk biology, we must introduce a new level of lay folks' reasoning—that of folk sociology.

EVOLUTION OF SOCIAL PRACTICES TO AVOID FALSITY

As we have seen earlier, one of the evolutionary explanations of folk psychology and the capacity for mind reading represented by ToM is the possibility of foreseeing and intercepting untruthful behavior that pretends to cooperate. The creation of social networks, organizations, and even institutions appears to be fostered by the ability to avoid the social costs of cheating behavior.

Goldman's (1999) Social Epistemology supports this veritistic aim. It identifies two goals: first, to criticize the Cartesian image of the knowledge generated by isolated thinkers with no connections; second, to launch a critical attack on those epistemological concepts of a relativistic and constructivist type that reject any truthful criterion of knowledge generation and evaluation.

On the contrary, according to Goldman (1999), social practices like communication, testimony, and argumentation are developed to help the individual pursue the goal of truth in the furthering of knowledge. Obviously, this truthful function of social procedures is not univocal, but, as Sperber (chap. 7, this volume) affirms, Goldman fails to point out that a "significant proportion of socially acquired beliefs are likely to be false beliefs and this not just as a result of the malfunctioning, but also of the proper functioning of social communication." If we analyze two means of communication—testimony and argumentation—we find that truth was not the evolutionary factor that led to the stabilization of communications. It is the causing of desirable effects on the audience that makes communication advantageous to the communicator. From this point of view, "Communication produces a certain amount of misinformation in the performance of its function, more specifically, in the performance of those aspects of its function that are beneficial to the communicator." Also when analyzed using game theory, there is no stable solution to the game between a true or false communicator and the listener who has or does not have faith in what the communicator says. Even if, in theory, the condition of the truthfulness of the communicator and the faithfulness of the listener is convenient to both, there is no stable solution to the game. Rather, it is through argumentation that evolution has developed ways of defending itself against the risk of falsehood. Contrary to animals, humans do not

just communicate information, they also argue it. According to Sperber (chap. 7, this volume), argumentation has neither the general function of providing the reasons for accepting a given argument nor that, affirmed by evolutionary psychology, of "domain- and task-specific inferential mechanisms corresponding to problems and opportunities met in the environment in which a species has evolved."

Instead, in Sperber's (chap. 7, this volume) view, "there are evolutionary reasons to expect a kind of seemingly general reasoning mechanism in humans, but one that is in fact, specialized for processing communicated or to be communicated information." This mechanism does not seem to be linked to individual cognitive activity, but instead is functional to communicative activity. Communicating does not just mean testimony, as in the case of animals, but trying to cite reasons and arguments to support your own thesis. In this sense, the listener has developed various instruments to gauge the trust of the speaker. As Sperber (chap. 7, this volume) points out, the two instruments—the capacity to distinguish between behavioral signs of sincerity or insincerity and trust in relation to benevolence to the speaker—are not specifically applicable to an assessment of the argument. Above all, "coherence checking," namely focusing on the internal and external coherence of the message and what you believe in, serves as a marker for possible lies passed on by the communicator.

To be more persuasive, in their cultural evolution, humans have developed a form of argument that uses various logical terms like *if, and, or, therefore, but,* and so on. This explains, for example, as Nisbett and Masuda (chap. 2, this volume) affirm, the development of rhetoric and logic in ancient Greeks compared with the lack of this development in China. This development stemmed from the need of the Greeks, a society of merchants and individuals, to persuade their partners through the discussions and confrontations that occurred for commercial, political, religious, and later philosophical reasons. The contemporary inhabitants of China, as part of an organic society whose purpose was above all harmony and social balance, did not feel the need to affirm their reasons and tended to prefer the middle way in discussions and comparisons.

The communicator develops the argumentative capacity to persuade even if he does not always succeed; the listener develops coherence checking to assess the reliability of the communicator's arguments even if he is often wrong. The communicator develops the capacity to be considered honest and reliable in testimony even if he is not; the listener develops fallible psychological instruments to identify whether the communicator is lying. In evolution, truth and rationality, falsehood and irrationality blend, and the evolution of the social practice of communication is less univocally marked by the truthful ideal of what Goldman thinks.

UNIVERSAL AND LOCAL COGNITIVE STYLES AND THEIR NORMATIVE CONSEQUENCES

From the experiment described by Atran, Medin, and Ross (chap. 4, this volume), it emerges that genetically inherited cognitive universals, represented by "universal taxonomic structures, centered on essence-based generic species," are likely to be present. These innate concepts could have been selected at an evolutionary level to represent important and recurrent aspects of nature.

These data seem to support the image of a human being genetically endowed with concepts and universal principles of inference. It is likely that there are not fixed irreversible cultural differences in cognition that stem from relative culturally different and fixed metaphysical and epistemological theories about the world. On the contrary, the cognitive abilities develop from universal type inferential principles that are genetically inherited. They can follow different paths of development depending on different cultural contexts. However, their diversity is reversible, and the cognitive styles are dependent on knowledge, expertise, and pragmatic needs. These factors are able to reduce and, in some cases, neutralize the cultural diversity of the cognitive abilities.

This conclusion is well known in cognitive anthropology. Education can quite easily shape cognitive attitudes, making them transculturally similar. The problem-solving ability is much stronger in real-world scenarios linked to particular pragmatic contexts and practical needs than it is in abstract tasks. The need for practical problem solving can trigger cognitive abilities that were hidden in abstract and uninteresting tasks (Boudon & Viale, 2000). Moreover, as we have seen before in summarizing the chapter by Macchi and Bagassi (chap. 9, this volume), the pragmatic dimension of the discourse involved in solving the problems of the experiments seem to strongly influence the answers. For example, many biases seem to be caused by the structure of the text than by a natural or cultural propensity to errors.

Also the analysis reported earlier on the normative aspects of probabilistic reasoning in children (Viale & Osherson, chap. 1, this volume) appears consistent with these remarks. By adopting a different normative principle of inductive judgment as the Probability Premise Principle, which seems to fit with the Bayesian theory of probability, it was seen that children from two different cultures (American and Chinese-Taiwanese) do not show any significant differences in their replies that conform to the normative standards of PPP. Before environmental differences start to influence cognitive styles, children appear to show the same inductive style irrespective of latitude and longitude.

Even Nisbett (2003) acknowledged that reversibility exists in the cognitive style of East Asians and Americans. Chinese people who have lived for a few years in America tend to adopt American cognitive styles and vice versa. In the experiments, adequate priming can significantly reduce cultural inclinations in cognitive styles. In tests of causal attribution carried out by the developmental psychologist Miller (1984; quoted in Nisbett, 2003), similar behavior can be seen between Hindu East Indian children and American children. Not until adolescence did Indians and Americans begin to diverge in causal attribution. Instead, when adults, Indians tend to explain behavior in terms of contextual factors, whereas Americans reason in terms of individual dispositions.

If, as seems to be shown by Viale and Osherson (chap. 1, this volume); Lo, Sides, Rozelle, and Osherson (2002); López et al. (1997); and Atran, Medin, and Ross (chap. 4, this volume), there do not appear to be differences in the cognitive style concerning some forms of inductive reasoning among people from different cultures, this has an important consequence for the normative justification of belief formation and revision.

The presence or otherwise of cultural differences in the cognitive style of reasoning and decision making is, according to Weinberg, Nichols, and Stich (chap. 8, this volume), a fundamental epistemological fact when understanding which epistemological strategy to adopt in justifying knowledge. Why? One of the epistemological theories most in vogue over the past few years is the internalist theory. It affirms that the sole source of normative legitimation for our beliefs is internal—inside us. With a proper process of self-exploration, we can discover the correct epistemic norms for belief formation and revision. By analogy with Romanticism in literature, Weinberg, Nichols, and Stich (chap. 8, this volume) call this approach Epistemic Romanticism. In fact, as in the case of Romanticism, only by exploring within ourselves can we make the real essence of ourselves emerge, and also in Epistemic Romanticism we are the normative source of the epistemic principles. But in what way? One of the most debated solutions is that which identifies epistemic intuitions as the main cause—namely, the spontaneous judgment about the epistemic properties of some cases. There are various examples of Intuition Driven Romanticism (IDR). The best known is the reflective equilibrium strategy of Goodman (1965), in which "a [normative] rule is amended if it yields an inference we are [intuitively] unwilling to accept [and] an inference is rejected if it violates a [normative] rule we are [intuitively] unwilling to amend" (p. 66).

The balance may occur in various forms. It may be "narrow" if we restrict the rules and inferences, for example, only to those of philosophical interest. It may be "expert" if we restrict the creation of a reflexive balance

to the category of professionals of knowledge—the epistemologists, for example. Many researchers, including Laudan (1984) and Goldman (1986), support Intuition-Driven Romanticism (IDR). Rules of justification are required to justify one's own beliefs. These rules will specify permissible ways in which cognitive agents may go about the business of forming and revising their beliefs. How can we decide that a rule is correct? By appealing to a higher level, "a criterion of rightness." But how can we decide what this criterion is? Goldman (1986) affirms that the correct criterion of rightness is the one that comports with the conception that is "embraced by everyday thought and language" (p. 58). "A criterion is supported to the extent that implied judgements accord with such intuitions and weakened to the extent that they do not" (Goldman, 1986, p. 66).

Now, the validity of IDR, in its various versions, is based on a condition: Universal intuitions can be used to determine universal norms for the formation and revision of beliefs. If, on the contrary, for the same type of events and cases the intuitions were different in relation to cultural, ethnic, and social contexts, then it would not be possible to admit some form of epistemic relativism. This would reveal the impossibility of IDR strategies to generate a normative theory of knowledge.

We saw earlier that Nisbett and Masuda (chap. 2, this volume) appear to show that a difference exists between the cognitive styles of Westerners and Far Easterners. However, Viale and Osherson (chap. 1, this volume) and Atran, Medin, and Ross (chap. 4, this volume) put forward data and arguments that seem to weaken the cognitive relativism outlined by Nisbett and Masuda. Weinberg, Nichols, and Stich (chap. 8, this volume) start from Nisbett's results, and from what might be termed the moral relativism of Haidt, Koller, and Dias (1993), to verify empirically whether IDR is false and whether we are faced with a situation of epistemic relativism. To do this, they undertook a series of tests involving persons from different cultural, ethnic, and social extractions. They wanted their intuition probes—the cases that they ask subjects to judge—to be similar to cases that have actually been used in the recent literature in epistemology.

For example, a category of examples that was widely used in epistemology was the "Gettier cases" (Gettier, 1963), "in which a person has good (though, as it happens, false, or only accidentally true, or in some other way warrant-deprived) evidence for a belief which is true."

As appears to emerge from Nisbett and Masuda (chap. 2, this volume) and Norenzayan (chap. 3, this volume), the East Asians have a tendency to make categorical judgments on the basis of similarity. Instead, Westerners are more inclined to focus on causes when they have to classify things. The intuition probe that was used to explore cultural differences on Gettier cases was the following:

> Bob has a friend, Jill, who has driven a Buick for many years. Bob therefore thinks that Jill drives an American car. He is not aware, however, that her Buick has recently been stolen, and he is also not aware that Jill has replaced it with a Pontiac, which is a different kind of American car. Does Bob really know that Jill drives an American car, or does he only believe it?
>
> REALLY KNOWS ONLY BELIEVES
>
> The striking finding in this case is that a large majority of Ws give the standard answer in the philosophical literature, viz. 'Only Believes'. But amongst EAs this pattern is actually *reversed*! A majority of EAs say that Bob really knows.

The results from this and the other intuition probes seem to prove that East Asians and Westerners are sensitive to different features of the situation—different *epistemic vectors* as Weinberg, Nichols, and Stich call them (chap. 8, this volume). East Asians are much sensitive to communitarian, contextual factors, whereas Westerners respond to more individualistic, dispositional ones. The conclusion is that, because IDR relies on epistemic intuitions that are not universal, but local to one's own cultural and socioeconomic group, it is not able to lead to genuine normative conclusion.

CONCLUSION: OUTSIDE THE RELATIVIST CAGES

The conclusion put forward by Weinberg, Nichols, and Stich (chap. 8, this volume) appears to reinforce the thesis of epistemological relativism. If it is not possible to find an inner and universal foundation for normative principles and if we are prisoners within our local contexts, how can we not give in to relativism? However, are we really certain that no universal principle exists on which we can base the justification for our knowledge of the world?

Earlier we saw that although cultural differences do exist in cognitive styles, these are not irreversible and tend to narrow when they involve pragmatic and existential problems rather than abstract and artificial ones. The greater the adaptive meaning of a problem is, the greater the uniformity of the reply adopted. It seems likely that our conceptual cages, used in cultural learning and socialization processes, can be questioned in relation to different social and adaptive contexts.

Irrespective of the culture to which we belong, at birth we all receive the same innate endowment of principles of reasoning. The cultural differences that subsequently emerge in individuals are mainly in response to metaphysical and ontological theories and schemes for representing

and interpreting the world (Gopnik & Meltzoff, 1997; Nisbett & Masuda, chap. 2, this volume). Both the metaphysical theories that dominate our cognitive styles and the physical theories on the empirical nature of the world can be altered in the light of new cultural contexts and new empirical evidence. The relative plasticity of cognitive abilities in different cultures reflects the dynamics of theory change in the little scientist hypothesis. Human cognitive abilities depend on a person's theories about the world. But these theories are not fixed, irreversibly, by his or her local sociocultural condition. They can be changed in relation to pragmatic feedback, empirical evidence, and new information derived from the environment. The relative theory change is driven by methodological norms that are effective during childhood (and we meet it again, in a similar fashion, inside the scientific community). The methodological norms of theory change appear, to a large extent, universal.

It is true that humans often fall into errors of deduction, statistical assessment, causal attribution, inductive support, and so on. These errors, both in scientific enterprise and everyday life, seem not to have a great effect on the growth of knowledge and on economic and social development. The reason for the scarce effect of biases, errors, and irrational reasoning might rely solely on the meta-inferential norms of theory change. Children, scientists, and adults make mistakes and generate false theories or empirical generalizations about the world; they produce beliefs that do not correspond to reality. However, at the same time, they are able to accept information, empirical evidence, or pragmatic feedback from the world about the reliability, legitimacy, and pragmatic utility of their hypotheses. If the theory does not work, sooner or later it will be changed and another theory will be generated. Therefore, the synchronic consequences of errors stemming from irrational reasoning are diachronically neutralized by the application of the norms of theory change.

Weinberg, Nichols, and Stich (chap. 8, this volume) are correct when they write that any epistemological internalist justification of knowledge has to cope with the cultural diversity of thinking. Boudon (1995) tackled the same problem in a different manner. If we wish to avoid the dangers of both cultural relativism and ethnocentrism, we should be able to find transcultural and transcontextual reasons for beliefs and actions. If every reason that justifies a belief or an action is relative to a given local sociocultural context and cannot be judged by others living in different contexts, then rationality will shatter into a dispersed multitude of different and incommensurable reasons. If the reasons are relative to local sociocultural contexts, but they can be judged by the inhabitants of other ethnic niches, then we can speak of transcultural reasons. An example taken from Boudon (1995) may help to explain this point. The Papago

Indios of Arizona explain any social and natural events by the will of a god living on the top of Boboquivari mountain. The place is visible to anyone in the tribe. Why does nobody see the god of the mountain? The reason is because the ants inform him when humans are coming and he hides himself. Can we accept their reasons? Obviously, according to our beliefs, knowledge, and theories of the world, their reasons seem to us completely unacceptable. But if we try to represent the theories and beliefs of the Indios, which function as the premises of their reasons, perhaps we can justify their reasons according to their theories of the world. It might be thought reasonable that they propose the ant hypothesis to justify the impossibility of seeing the god of the mountain. If this is the interpretation of the Indios' reasons, then what are the differences between this position and the relativistic one? The same exercise used in relation to the Indios' reasons can be replicated for a multitude of other ethnic niches.

The crucial point that distinguishes a normative position from a relativistic one relies, in my opinion, on using the methodology of theory change (Viale, 2001). As a thought experiment, think of a variation of the previous story. The same person who told us the story of the god of the mountain informs us that the Indios believing in the ant story are professional scientists and engineers working at the nearby nuclear power station. At this point, it is likely that our chances of justifying the believers' reasoning would greatly decrease. The justification would become almost null if, talking with them, we discovered that they share with us all our metaphysical and epistemological principles about the world. In this case, their reasons for believing the ant theory would become very unsound. A likely hypothesis is that the reason for our judgment of their irrationality relies on the following principle (i.e., an application of the methodology of theory change characteristic of the little scientist hypothesis): A given theory is maintained if a better alternative theory is not available. A theory is better when it has more empirical content and is able to solve the problems of the old one plus some others. When one has a better theory, one should use it instead of the previous one.

Faced with a new and better theory, its negative utilization can present different situations (Viale, 2001). (a) The subject may not accept the new theory that increases his ability to explain the empirical phenomena. The maintenance of the old theory may rely on traditional habits, emotional factors, theoretical support, and so on. (b) He can accept the new theory and put it in his knowledge base. But at the same time, he can continue to use the old one to generate his beliefs about the world. If the two theories are inconsistent, his cognitive behavior relies on an inconsistent set of beliefs. If the two theories are consistent, but the old one is implied by the

new one, his cognitive behavior relies on a theory that has less empirical content or problem-solving ability. (c) He acquires the new theory and puts it into his knowledge base, but his previous beliefs continue to be triggered in an automatic and reflex way. They are not based on conscious reasons. They are a kind of traces of the old theory, and they do not stem from any intentional act of reasoning.

When the traditional Indios had only beliefs and knowledge stemming from their tradition, their belief in the ant theory might be judged to be reasonable because no better alternative theories were available. But when "nuclear" Indios have at their disposal alternative hypotheses to explain the social and natural events and these hypotheses are able to explain other aspects of the world, we can suppose that their belief in the ant theory might be judged as rationally unjustified.

As in the case of the Arizona Indios, also in relation to the diversity principle analyzed by Atran, Medin, and Ross (chap. 4, this volume), we can say that the knowledge and beliefs of the taxonomists would not justify their preference for an argument with more homogeneous premises that does not satisfy the diversity principle. Using the same argument, we might say that, hypothetically, the Itza', with an education on abstract taxonomy about mammals, *ceteris paribus*, would not be justified in still relying on ecology-based reasoning and not satisfying the diversity principle.

On the basis of the previous arguments, we can hold the following procedural normative principle:

> *There is reason to justify a belief of a subject that is the effect of given theories on the world when the subject has no knowledge of alternative theories that are better for their empirical content and problem-solving ability.*

It might be objected that there is no reason to try to establish normative criteria for the rational justification of beliefs. The world will go on without the need for any general normative constraint. In reality, there are many fields of human life where implicit normative criteria are applied. Education and science are important examples. Often the criteria are ad hoc and lack transparency. Other times they rely on a priori canons of rationality that find their justification in some kind of narrow social consensus by some elite set of experts. Consequently, it may be worthwhile trying to develop some general norms of epistemological justification that stem from our best real procedures of knowledge acquisition (i.e., science and developmental age). The positive features of the proposed epistemological procedural principle may be the fulfillment of the following two conditions (Viale, 2001):

It seems to meet our intuition about the reasons for accepting a belief given the actual knowledge of the subject.

It seems to be coherent with the "internalist epistemology" program: extrapolating the norms of justification from the internal cognitive procedures of theory generation and application.

In conclusion, the cultural variability of inferential styles and the errors and biases of human reasoning and decision making appear to outline an epistemological picture characterized by relativism and irrationality. This picture is countered by a number of normative factors following the internalist theory and linked to the little scientist hypothesis: the universal endowment of inferential principles that are both innate and adaptive in the sense of evolutionary psychology; the presence from birth of a method of theory and concept change based on empirical falsification, pragmatic consequences, and problem solving, which also appears to be explained, in evolutionary terms, by its capacity to promote successful environmental adaptation.

These innate principles of reasoning and the method of theory change are universal and characterize man's shared capacity, irrespective of any cultural context, to create hypotheses involving the physical, biological, psychological, and social worlds; to learn from mistakes; and to correct his theories to make them empirically and pragmatically successful.

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