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Resistance to certain scientific ideas derives in large part from assumptions and biases that can be demonstrated experimentally in young children and that may persist into adulthood. In particular, both adults and children resist acquiring scientific information that clashes with common-sense intuitions about the physical and psychological domains. Additionally, when learning information from other people, both adults and children are sensitive to the trustworthiness of the source of that information. Resistance to science, then, is particularly exaggerated in societies where nonscientific ideologies have the advantages of being both grounded in common sense and transmitted by trustworthy sources.

Scientists, educators, and policy-makers have long been concerned about American adults' resistance to certain scientific ideas (*1*). In a 2005 Pew Trust poll, 42% of respondents said that they believed that humans and other animals have existed in their present form since the beginning of time, a view that denies the very existence of evolution (*2*). Even among the minority who claim to accept natural selection, most misunderstand it, seeing evolution as a mysterious process causing animals to have offspring that are better adapted to their environments (*3*). This is not the only domain where people reject science: Many believe in the efficacy of unproven medical interventions; the mystical nature of out-of-body experiences; the existence of supernatural entities such as ghosts and fairies; and the legitimacy of astrology, ESP, and divination (*4*). This resistance to science has important social implications, because a scientifically ignorant public is unprepared to evaluate policies about global warming, vaccination, genetically modified organisms, stem cell research, and cloning (*1*).

Here we review evidence from developmental psychology suggesting that some resistance to scientific ideas is a human universal. This resistance stems from two general facts about children, one having to do with what they know and the other having to do with how they learn.

The main source of resistance concerns what children know before their exposure to science. Recent psychological research makes it clear that babies are not "blank slates"; even 1-year-olds possess a rich understanding of both the physical world (a "naïve physics") and the social world (a "naïve psychology") (*5*). Babies know that objects are solid, persist over time (even when out of sight), fall to the ground if unsupported, and do not move unless acted upon (*6*). They also understand that people move autonomously in response to social and physical events, act and react in accord with their goals, and respond with appropriate emotions to different situations (*5*, *7*, *8*).

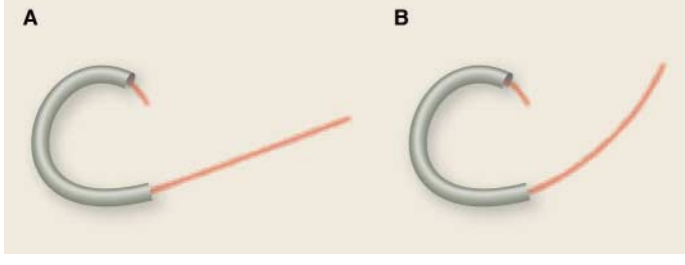

Fig. 1. (**A** and **B**) Alternative intuitions about the movement of a ball out of a curved tube [from (*13*)].

These intuitions give children a head start when it comes to understanding and learning about objects and people. However, they also sometimes clash with scientific discoveries about the nature of the world, making certain scientific facts difficult to learn. The problem with teaching science to children is thus "not what the student lacks, but what the student *has*, namely alternative conceptual frameworks for understanding the phenomena covered by the theories we are trying to teach" (*9*).

Children's belief that unsupported objects fall downward, for instance, makes it difficult for them to see the world as a sphere—if it were a sphere, the people and things on the other side should fall off. It is not until about 8 or 9 years of age that children demonstrate a coherent understanding of a spherical Earth (*10*), and younger children often distort the scientific understanding in systematic ways. Some deny that people can live all over Earth's surface (*10*), and when asked to draw Earth (*11*) or model it with clay (*12*), some children depict it as a sphere with a flattened top or as a hollow sphere that people live inside.

In some cases, there is such resistance to science education that it never entirely sticks, and foundational biases persist into adulthood. One study tested college undergraduates' intuitions about basic physical motions, such as the path that a ball will take when released from a curved tube (*13*). Many of the undergraduates retained a common-sense Aristotelian theory of object motion; they predicted that the ball would continue to move in a curved motion, choosing B over A in Fig. 1. An interesting addendum is that although education does not shake this bias, real-world experience can suffice. In another study, undergraduates were asked about the path that water would take out of a curved hose. This corresponded to an event that the participants had seen, and few believed that the water would take a curved path (*14*).

The examples so far concern people's common-sense understanding of the physical world, but their intuitive psychology also contributes to their resistance to science. One important bias is that children naturally see the world in terms of design and purpose. For instance, 4-year-olds insist that everything has a purpose, including lions ("to go in the zoo") and clouds ("for raining"), a propensity called "promiscuous teleology" (*15*). Additionally, when asked about the origin of animals and people, children spontaneously tend to provide and prefer creationist explanations (*16*). Just as children's intuitions about the physical world make it difficult for them to accept that Earth is a sphere, their psychological intuitions about agency and design make it difficult for them to accept the processes of evolution.

Another consequence of people's common-sense psychology is dualism, the belief that the mind is fundamentally different from the brain (*5*). This belief comes naturally to children. Preschool children will claim that the brain is responsible for some aspects of mental life, typically those involving deliberative mental work, such as solving math problems. But preschoolers will also claim that the brain is not involved in a host of other activities, such as pretending to be a kangaroo, loving one's brother, or brushing one's teeth (*5*, *17*). Similarly, when told about a brain transplant from a boy to a pig, they believed that you would get a very smart pig, but one with pig beliefs and pig desires (*18*). For young children, then, much of mental life is not linked to the brain.

The strong intuitive pull of dualism makes it difficult for people to accept what Francis Crick

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called "the astonishing hypothesis" (*19*): Dualism is mistaken—mental life emerges from physical processes. People resist the astonishing hypothesis in ways that can have considerable social implications. For one thing, debates about the moral status of embryos, fetuses, stem cells, and nonhuman animals are sometimes framed in terms of whether or not these entities possess immaterial souls (*20*, *21*). What's more, certain proposals about the role of evidence from functional magnetic resonance imaging in criminal trials assume a strong form of dualism (*22*). It has been argued, for instance, that if one could show that a person's brain is involved in an act, then the person himself or herself is not responsible, an excuse dubbed "my brain made me do it" (*23*). These assumptions about moral status and personal responsibility reflect a profound resistance to findings from psychology and neuroscience.

The main reason why people resist certain scientific findings, then, is that many of these findings are unnatural and unintuitive. But this does not explain cultural differences in resistance to science. There are substantial differences, for example, in how quickly children from different countries come to learn that Earth is a sphere (*10*). There is also variation across countries in the extent of adult resistance to science, including the finding that Americans are more resistant to evolutionary theory than are citizens of most other countries (*24*).

Part of the explanation for such cultural differences lies in how children and adults process different types of information. Some culture-specific information is not associated with any particular source; it is "common knowledge." As such, learning of this type of information generally bypasses critical analysis. A prototypical example is that of word meanings. Everyone uses the word "dog" to refer to dogs, so children easily learn that this is what they are called (*25*). Other examples include belief in germs and electricity. Their existence is generally assumed in day-to-day conversation and is not marked as uncertain; nobody says that they "believe in electricity." Hence, even children and adults with little scientific background believe that these invisible entities really exist (*26*).

Other information, however, is explicitly asserted, not tacitly assumed. Such asserted information is associated with certain sources. A child might note that science teachers make surprising claims about the origin of human beings, for instance, whereas their parents do not. Furthermore, the tentative status of this information is sometimes explicitly marked; people will assert that they "believe in evolution."

When faced with this kind of asserted information, one can occasionally evaluate its truth directly. But in some domains, including much of science, direct evaluation is difficult or impossible. Few of us are qualified to assess claims about the merits of string theory, the role of mercury in the etiology of autism, or the existence of repressed memories. So rather than evaluating the asserted claim itself, we instead evaluate the claim's source. If the source is deemed trustworthy, people will believe the claim, often without really understanding it. Consider, for example, that many Americans who claim to believe in natural selection are unable to accurately describe how natural selection works (*3*). This suggests that their belief is not necessarily rooted in an appreciation of the evidence and arguments. Rather, this scientifically credulous subpopulation accepts this information because they trust the people who say it is true.

Science is not special here; the same process of deference holds for certain religious, moral, and political beliefs as well. In an illustrative recent study, participants were asked their opinion about a social welfare policy that was described as being endorsed by either Democrats or Republicans. Although the participants sincerely believed that their responses were based on the objective merits of the policy, the major determinant of what they thought of the policy was, in fact, whether or not their favored political party was said to endorse it (*27*). Additionally, many of the specific moral intuitions held by members of a society appear to be the consequence, not of personal moral contemplation, but of deference to the views of the community (*28*).

Adults thus rely on the trustworthiness of the source when deciding which asserted claims to believe. Do children do the same? Recent studies suggest that they do; children, like adults, have at least some capacity to assess the trustworthiness of their information sources. Four- and five-year-olds, for instance, know that adults know things that other children do not (like the meaning of the word "hypochondriac") (*29*), and when given conflicting information from a child and from an adult, they prefer to learn from the adult (*30*). They know that adults have different areas of expertise: Doctors know how to fix broken arms, and mechanics know how to fix flat tires (*31*, *32*). They prefer to learn from a knowledgeable speaker than from an ignorant one (*29*, *33*), and they prefer a confident source to a tentative one (*34*). Finally, when 5-year-olds hear about a competition whose outcome was unclear, they are more likely to believe a person who claimed that he had lost the race (a statement that goes against his self-interest) than a person who claimed that he had won the race (a statement that goes with his self-interest). In a limited sense, then, they are capable of cynicism (*35*).

These developmental data suggest that resistance to science will arise in children when scientific claims clash with early emerging, intuitive expectations. This resistance will persist through adulthood if the scientific claims are contested within a society, and it will be especially strong if there is a nonscientific alternative that is rooted in common sense and championed by people who are thought of as reliable and trustworthy. This is the current situation in the United States, with regard to the central tenets of neuroscience and evolutionary biology. These concepts clash with intuitive beliefs about the immaterial nature of the soul and the purposeful design of humans and other animals, and (in the United States) these beliefs are particularly likely to be endorsed and transmitted by trusted religious and political authorities (*24*). Hence, these fields are among the domains where Americans' resistance to science is the strongest.

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