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Getting to the Truth: Grounding Incomplete Knowledge

Frank C. Keil

Getting to the Truth

GROUNDING INCOMPLETE KNOWLEDGE

Frank C. Keil[†]

One aspect of truth concerns knowing when to trust others when one's own knowledge is inadequate. This is an ever more common problem in societies where technological and scientific change seems to be constantly accelerating. There is an increasing need to rely on the expertise of others and consequently to know when others are more likely to be offering an objective opinion as opposed to a biased one. Here, I argue that there are systematic and early emerging cognitive heuristics and biases that profoundly influence our patterns of deference, our ways of assessing expertise, and our sense of when testimony is to be trusted. For the most part, the power and pervasiveness of these biases are ignored or greatly under-appreciated. These biases and heuristics can both mislead and inform our understanding and use of others' expertise; it is therefore critical that we acknowledge their presence and know how to work with them.

As will be seen shortly, people tend to make serious mistakes in their evaluations of both their own knowledge and the complexity of systems. Even worse, when people do recognize that their understanding is inadequate, they can make surprising mistakes in guessing who the right expert is to fill out the details. In other cases, however, adults and even young children can accurately figure out where appropriate expertise lies. The details of this story, as described later in this paper, are central to any full account of how we know when to trust others. We have many tools that can be used to help decide when it is appropriate to defer to another's area of expertise and when it is better to have serious doubts; unfortunately, we often do not use these tools effectively.

[†] Professor of Psychology and Linguistics and Master of Morse College at Yale University. Much of the research described in this paper was funded by NIH grant- R37- HD023922 to Frank Keil.

The issue of establishing trust will be considered in a series of five sections. Part I will explore the problem of unbounded causal complexity, namely, the need for ways to construct explanatory gists of causal systems that are far too complex for any one person to fully understand. Part II will ask about the ability to assess the quality of one's own knowledge and will argue that there is a strong tendency for people to overestimate the depth and quality of their explanatory understanding of a wide range of devices and natural phenomena. Part III will consider a related phenomenon in which people are shown to have misleading illusions of insight when explanations are supplemented with certain kinds of irrelevant, but nonetheless compelling, support. Part IV will suggest that illusions of explanatory depth and illusions of insight may be related to errors in underestimating just how complicated various phenomena are, especially those related to the social sciences. Part V will consider how people manage to get by with incomplete knowledge, suggesting that there are several cognitive tools and heuristics that are used to help fill in the gaps in one's own knowledge. Finally, Part VI will discuss how all these factors converge to explain how people are able to establish trust and what errors are likely to occur.

I. THE PROBLEM OF UNBOUNDED CAUSAL COMPLEXITY

Virtually any phenomenon in the natural or artificial world has seemingly unbounded levels of causal complexity. Ask a simple question, such as what stem cells are and how they work, and the answer can be expanded on in ever deeper and more complex ways. Stem cells may initially be described as cells that have the potential to become any one of the many cell types within an organism. A request for more detail may reveal broad classes of cell types that can be created (for example, ectodermal, mesodermal, or endodermal). Deeper answers can reveal ever more fine-grained descriptions of the different cell types. Still deeper answers reveal how all these cell types are related in a hierarchical structure. All of this information can then be elaborated on in enormous detail with respect to the signaling mechanisms that cause cells to differentiate in one manner as opposed to another, mechanisms that can involve intricate accounts of molecular pathways that regulate various sets of genes. If one is driven to gain the deepest explanation possible, one gradually gets exposed to much of developmental biology and molecular biology, as well

as areas of chemistry, physics, and even other more distant fields.

The same holds for questions about the world of human inventions, such as how helicopters fly, how drugs influence the body, or how a resolution of patent dispute might influence the economies of several nations. In all such cases it is quickly apparent that no one person can possibly know the full answer to each question. One must know how to seek out legitimate experts and how to avoid illegitimate ones. One must also know when experts are making a statement within their range of competence as opposed to outside that range. All of us have huge gaps in our explanatory understandings that we tolerate because we think they are firmly grounded in legitimate understandings in other minds, understandings on which we can rely when necessary.

These issues are highly salient in the law. The courts, for example, frequently allow the testimony of expert witnesses, assuming that there are reliable ways to identify such experts and use them to improve the quality of legal proceedings and decisions. The complexity and distributed nature of knowledge requires that we have well-worked-out and reliable mechanisms for grasping the division of cognitive labor and that we know how to identify appropriate areas of expertise and appropriate experts within those areas. In addition, we need to know when experts are likely to be more or less trustworthy. The cognitive science of such processes is critically relevant to evaluating how well such patterns of deference, consultation, and trust work; yet it has been largely neglected in the law.

II. HOW WELL DO WE KNOW THAT WE DON'T UNDERSTAND?

To assess how well people deal with causal complexity and the need to consult others, one must first know when one is in over one's head. One must have a way of sensing when there are gaps in one's knowledge that make one's understanding so flawed that it is inadequate for use in a task. This problem of knowing how little one knows occurs in every facet of life. A student may not realize that she does not really understand an explanation offered by a teacher; a businessman may not know that he has misunderstood a critical clause in a contract; and members of a jury may think they understand the details of a

complex patent dispute when in fact they have overlooked a critical underlying principle.

Most people are quite inept at estimating how well they understand various everyday phenomena, showing a strong tendency to assume they understand how the world works in far more detail than they really do. We have called this effect an "illusion of explanatory depth" ("IOED").[1] The IOED can be quickly revealed in tasks where people are taught how to rate causal understanding on a scale that ranges from one (virtually no understanding beyond a vague sense of what a phenomenon appears like) to seven (a full mechanistic understanding of exactly how a device works or how a natural phenomenon occurs). Even though people can be shown to clearly understand the scale and use it correctly when rating sample texts of explanations, they give much higher scores than they should when asked to estimate their own explanatory understandings.

The effect is the strongest for estimates of one's causal understanding. For example, when people are asked to rate how well they think they understand how a helicopter flies, they might give a rating of five or six. Yet we can show that this rating is far too high by simply asking them to actually write out, or verbally report, everything they know about how a helicopter flies. After giving the fullest explanation they can, people are again asked to rate their knowledge in light of that explanation. Their ratings on this second occasion show a sharp drop relative to their first ratings, with people routinely evincing great surprise at how little they actually knew. Matters get worse if they are asked a simple diagnostic question (for example, how does a helicopter go from hovering to moving forward?) and are then asked to re-rate their knowledge in light of their ability, or inability, to answer that question. People again show a considerable drop relative to their initial rating and even to their second rating. Their ratings stay low if they are shown a concise but detailed explanation and asked to compare it to their own initial understanding and then use that comparison as a basis for assigning a score to their initial rating. In other words, people consistently rate their initial guesses of how well they

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[1] Frank. C. Keil. *Folkscience: Coarse Interpretations of a Complex Reality*, 7 TRENDS IN COGNITIVE SCI. 368, 368 (2003); Leonid Rozenblit & Frank Keil, *The Misunderstood Limits of Folk Science: An Illusion of Explanatory Depth*, 26 COGNITIVE SCI. 521, 522 (2002).

understood various phenomena as being far too high when their real knowledge is put to the test.

These effects are substantial and happen for ratings of understandings of both artifacts, such as helicopters, and natural phenomena and systems, such as the workings of the heart. In contrast, when asked to rate self-knowledge of facts (for example, the capitals of relatively obscure countries) or of procedures (such as how to make an international phone call) or even of narratives (such as the plot of a well-known movie), people tend to be much better calibrated, either being fully accurate or overestimating the depth of their knowledge to a much lesser extent.[2]

The selectivity of the IOED has strong implications for drawing conclusions about when a person is likely to be accurate or inaccurate with respect to claims about the quality of their own knowledge. In some domains that do not require much underlying causal structure, assuming that people are acting in good faith, they are likely to be quite accurate. In others, however, such as ratings of causal explanatory understanding, even the most sincere and trustworthy people are likely to systematically overestimate what they really know. The extent of the IOED can be quite remarkable even for extremely common everyday objects. In one series of recent studies people were shown sets of simple drawings of bicycles. One drawing was correct while others had the chain connected to sprockets on both wheels in a manner that would make steering impossible or had the chain disconnected from the drive wheel. Adults had great difficulty picking out the correct drawing from among three incorrect ones, even though they all said they were familiar with bicycles and often rode them. They showed the same patterns of major errors when shown bicycle frames of which only one could functionally work. Even members of an active bicycle club made substantial numbers of errors.[3] The commonplace nature of some devices does not assure that people will know how well they understand them. Indeed, in at least some cases, high familiarity may breed an especially high overconfidence. It may be that when someone can easily use something, he or she confuses that sense of ease with a sense of causal understanding.

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[2] Rozenblit & Keil, *supra* note 1, at 533.

[3] Rebecca Lawson, *The Science of Cycology: Failures to Understand How Everyday Objects Work*, 34 MEMORY & COGNITION 1667, 1671 (2006).

Experts may also fall prey to the IOED in their highly refined areas of expertise. They may be somewhat better calibrated,[4] but, especially in areas that are at the boundaries or "leading edge" of their own understanding, they may sincerely believe that their understanding is deeper than it is. This seems to be particularly true in cases where experts are assessing how well they understand something, as opposed to assessing how well they know how to do a procedure. In such rarified areas, novices who rely on these experts may have an especially difficult time evaluating an expert's sincere, but misguided, claims to having deep explanatory understanding. As will be shown, however, even when a layperson is at such a disadvantage in the relative size of the knowledge base, there still are ways to adjust confidence in an expert's testimony.

The IOED holds not only for assessments of one's knowledge, but also for assessments of knowledge in other minds. Thus, recent work in our laboratory indicates that ratings of how well others understand various phenomena or devices are equally likely to be inflated. This has important implications for knowing when and to whom one should defer. Thus, even if one comes to a realization that one does not understand, such a person may systematically overrate the likelihood that another person does. The IOED also tends to get stronger the less one knows or the younger one is.[5] Thus, if a person has a very high level of ignorance in an area, that person is especially liable to not know when intellectual outsourcing, namely, the reliance on others to provide complex explanations, is needed.[6] The greater extent of the phenomenon in children raises questions about how to evaluate their claims that they understand the reason for an action or event. Similarly, children may be especially vulnerable to knowing how well they have understood instructions or explanations that are provided to them in a courtroom.

Across numerous studies, we see several converging cognitive mechanisms that seem to set up and maintain an

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[4] Rozenblit & Keil, *supra* note 1, at 554-55.

[5] Candice M. Mills & Frank C. Keil, *Knowing the Limits of One's Understanding: The Development of an Awareness of an Illusion of Explanatory Depth*, 87 J. EXPERIMENTAL CHILD PSYCHOL. 1, 23-24 (2004); Candice M. Mills & Frank C. Keil, *The Development of Cynicism*, 16 PSYCHOL. SCI. 385, 389-90(2005).

[6] *See* Justin Krueger & David Dunning, *Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments*, 77 J. PERSONALITY & SOC. PSYCHOL. 1121, 1126-30 (1999).

especially strong IOED for explanatory understanding.[7] People tend to confuse higher-level functional glosses on a system (such as knowing that turning a key starts a car) with lower-level mechanistic understanding (such as understanding the complex starting circuitry in modern vehicles). They also tend to confuse explanations that they are able to piece together in an ad hoc manner with pre-stored explanations that they bring to a situation, underestimating the degree to which they generate explanations "on the fly" as opposed to bringing them preformed to a situation. In addition, because people rarely give exhaustive explanations, they have little practice in evaluating explanations for completeness. These and other factors help make the IOED robust and difficult to attenuate.

III. FALSE EXPLANATORY INSIGHTS

There is a related cognitive bias to the IOED that documents ways in which people can have a false rush of explanatory insight when in fact none was actually achieved. Certain kinds of information can be associated with explanations that make them much more appealing than is appropriate. One example with increasing relevance for the law is the use of functional magnetic resonance imaging ("fMRI") data to make claims about neural functions, or about disruptions in neural function that might arise from various forms of brain damage. Many court cases have allowed extensive testimony in which fMRI findings are alleged to explain why a person behaved as he or she did or why an individual clearly has suffered brain damage arising from the negligence of others.[8] In many cases, fMRI findings might well provide useful additional information in legal procedures, but in many others they can have a powerful and often unrecognized ability to mislead.

In particular, fMRI results can create a false sense of insight when they are in fact completely irrelevant to the

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[7] *See* Frank C. Keil, *Explanation and Understanding*, 57 ANN. REV. PSYCHOL 227 (2006); Frank C. Keil, *Doubt, Deference and Deliberation: Understanding the Division of Cognitive Labor*, *in* 1 OXFORD STUDIES IN EPISTEMOLOGY 143, 163-64 (Tamar Szabo Gendler & John Hawthorne eds., 2006); Rozenblit & Keil, *supra* note 1, at 552-56.

[8] *See* Jennifer Kulynych, Note, *Psychiatric Neuroimaging Evidence: A High-Tech Crystal Ball?*, 49 STAN. L. REV. 1249, 1251; Lewine et al., *Objective Documentation of Traumatic Brain Injury Subsequent to Mild Head Trauma: Multimodal Brain Imaging with MEG, SPECT, and MRI*, 22 J. HEAD TRAUMA REHABILITATION 141 (2007).

quality of an explanation in which they are embedded. Thus, it can be more difficult to detect weak or flawed research when it is accompanied by uninformative fMRI results than it is to detect equally weak or flawed research without such results. To demonstrate such an effect experimentally, one can present adult experimental participants with one of four explanations, which are created by varying the explanations along two dimensions: whether the explanation is good or empty and circular, and whether or not it contains irrelevant fMRI results. Student participants clearly preferred the good explanations to the empty/circular ones when there were no fMRI results accompanying those explanations. In contrast, they found it much more difficult to tell the good from the bad explanations when they also contained the fMRI results, even though the fMRI results were completely noninformative.[9] Only highly trained experts in cognitive neuroscience showed the same abilities to discriminate good from bad explanations when they were accompanied by neuroimaging results.[10] The neuroimaging results were not particularly complicated; however, it appeared that phrases such as "brain scans showed that" made it much harder for most people to then evaluate that the brain scans added no new information. Because the experts were easily able to see the good from the bad experiments with the neuroimaging results, we know that the neuroimaging really did not add any new information of value.

It seems that we can gain misleading senses of insight when studies are made more concrete through such means as brain imaging, even when the imaging is irrelevant. In deciding whether fMRI results should be admitted into evidence, it is critical to carefully look at what additional insights they really offer, as opposed to relying on simple intuitions that the fMRI supplemented explanations seem more "solid." More broadly, neuroimaging certainly has an important role to play in understanding behavior, but the potential for abuse needs to recognized.[11] When people try to understand the many invisible factors leading to behaviors,

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[9] Deena Skolnick-Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, J. COGNITIVE NEUROSCI. (in press).

[10] *Id.*

[11] *See generally* Neal Feigenson, *Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI*, 2 INT'L J.L. CONTEXT 233 (2006); Jennifer Kulynych, *Legal and Ethical Issues in Neuroimaging Research: Human Subjects Protection, Medical Privacy, and the Public Communication of Research Results*, 50 BRAIN & COGNITION 345 (2002).

such as a criminal act, there is a tendency to seize on any claims about how the basis for such behaviors might be physically instantiated. It seems likely that comparable effects may be found for other alleged physical bases for behavior, such as claims that there is "a gene" causing a certain behavior.

In short, people can have rushes of insight as they learn more about a phenomenon, but sometimes these rushes do not correspond to real increases in understanding. In particular, when people are offered information that is phrased in terms of a lower, more concrete, level of analysis, they often will take that information quite uncritically and think that it adds value because it is lower level and not because it actually provides any new explanatory information. Laypeople should be especially vigilant when provided with explanations that shift down levels in some kind of reductionist hierarchy, keeping in mind that things often sound better than they really are when such a shift occurs.

IV. DO WE KNOW WHERE COMPLEXITY LIES BENEATH?

Another problem related to assessing truth concerns estimating the complexity of various systems and phenomena. Even if people were fairly accurate at sensing the degree of comprehensiveness of their own knowledge, they might get into considerable trouble because they do not understand the level of complexity of a phenomenon; they assume that their relatively simple understanding is all that is needed because they underestimate the actual complexity of the phenomenon. Difficulties here lead directly to problems of trust and deference.

Knowing when we need to defer to another's expertise is intimately related to how complex we think the phenomenon being explained is. If the phenomenon seems trivial and relatively self-evident to any reasonably observant and thoughtful person, then it may be inappropriate to bring in an expert who might only muddy the waters rather than shed insight. We can all envision such trivial cases. Suppose, for example, a defendant drove through a school zone at 100 mph and asked for clemency on the grounds that he didn't know that such a high speed posed a risk for school children. It is reasonable to argue that there is no need for traffic experts to be brought into such a case to testify that the risk level was increased. Moreover, it certainly makes sense for the courts to

exercise discretion in allowing people to testify as expert witnesses. Without such discretion, it is easy to see how the introduction of experts could lead to delaying tactics and obfuscation in a courtroom.

Other cases, however, may seem far simpler than they really are. In particular, experts on psychological mechanisms have often been disallowed in the courts on the grounds the expertise is simply "common knowledge" and that the alleged expert has nothing to offer that a reasonable layperson does not already know. For several decades psychological experts have been excluded in cases abroad[12] and in the United States. One especially prominent recent case concerned the perjury accusations against I. "Scooter" Libby. Libby's defense team wanted to bring in experts on memory to testify that it was quite plausible that Libby could have misremembered past events, rather than deliberately committing perjury.[13] Judge Reggie B. Walton, however, disallowed such experts partly on the grounds that laypeople had accurate and detailed understandings of the fallibility of memory; it was not clear what additional insights could be added by "experts."[14]

It is beyond the scope of this paper to document the many complex features of the human memory system and how they can cause behaviors that may surprise the layperson and even be quite counterintuitive to lay theories of how memory works. To use just one example, many people think that memory is laid down almost like a videotape recording that may become buried but is always present.[15] Such a view grossly underestimates the extent to which memories are constantly being revised and reconstructed in ways that can completely overwrite the earlier version. The public fascination with "recovered memories" is one example of this bias. Although

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[12] *See* Andrew M. Colman & R.D. Mackay, *Legal Issues Surrounding the Admissibility of Expert Psychological and Psychiatric Testimony*, *in* CHILDREN, EVIDENCE AND PROCEDURE 46 (Noel K. Clark & Geoffrey Stephenson, eds., 1993); R.D. Mackay et al., *The Admissibility of Expert Psychological and Psychiatric Testimony*, *in* ANALYSING WITNESS TESTIMONY: A GUIDE FOR LEGAL PRACTITIONERS AND OTHER PROFESSIONALS 321 (Anthony Heaton-Armstrong et al. eds., 1999).

[13] *See* Elizabeth F. Loftus & Richard L. Steinberg, Op-Ed., *If Memory Serves*, WALL ST. J., Mar. 9, 2007, at A14.

[14] United States v. Libby, 461 F. Supp. 2d 3, 16 (D.D.C. 2006); *see also* Thomas Adcock, *'Psychology in the Practice of Justice' Conference Draws Together Legal, Science Scholars*, 237 N.Y. L.J. 20 (2007).

[15] Seema L. Clifasefi et al., *Setting the Record (or Video Camera) Straight on Memory: The Video Camera Model of Memory and Other Memory Myths*, *in* TALL TALES ABOUT THE MIND AND BRAIN 60, 60-61 (Sergio Della Sala ed., 2007).

laypeople often believe that there exist exact traces of memories of childhood experiences that can be brought to light with appropriate "excavations" by therapists, the experimental evidence for such recoveries is minimal. Putting aside the merits of Judge Walton's decision, the question arises as to whether judges might often be prejudiced against the possibility of psychological explanations having a complexity comparable to that which one might find in areas such as biology or physics.

In adults, it is very difficult to know how to measure the relative complexity of two domains, as complexity itself can vary in so many ways. For example, if asked whether a full explanation of superconductivity or face recognition is more complicated, one could easily pick either alternative by emphasizing different facets of the phenomena. Perhaps superconductivity is more complicated because it requires a particular kind of mathematics, or perhaps face recognition is more complicated because it requires integration across several different forms of mathematics as well as anatomy. Thus, it may seem impossible to distinguish between claims that people are biased to think of psychology as simpler than other sciences and claims that psychology really is simpler. Recently, however, studies have been conducted that suggest a cognitive bias is at work.[16]

These studies rely on the assumption that such biases might arise from very basic intuitions that emerge early in childhood, intuitions that might gradually become weaker with age by compensating knowledge. Thus, there might be a rough and ready intuition that psychological phenomena are simpler, an intuition that gets tempered with age through experience with the complexity of actual psychological situations. To examine this possibility, one study took a large number of everyday phenomena in domains such as physics, biology and psychology. The phenomena were pre-tested to find a subset that adults judged as all about equal in complexity. For example, the following "why" questions were judged to be equally complex: How does a top stay spinning upright? How does your skin heal after it has been cut? Why is it hard to understand two people talking at once? Children, ranging in age from five to fourteen years, were then asked to make

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[16] Frank C. Keil, Kristi L. Lockhart & Esther Schlegal *A Bump on a Bump?: Early Intuitions Concerning the Relative Difficulty of the Sciences* (forthcoming).

judgments about the complexity of these same selected phenomena.[17] As the age of children decreased, a stronger bias emerged in which psychological phenomena were judged as much simpler than those in the biological and physical sciences.[18] This pattern strongly suggests that the bias may persist in adults, but in a reduced form. Moreover, it may re-emerge in stronger terms in adults when they must also evaluate several other complex factors at the same time, such as in a legal case. Similarly, this pattern may emerge in time pressured situations, rapid verbal exchanges, or under pressing questions. Thus, even though the stimuli questions were judged by adults to be of equal complexity, the psychological ones may actually be more complex, with the difference being masked by a latent bias that still persists in a weaker form from childhood. It might be possible to show this remaining difference in complexity by contrasting detailed expert explanations of psychological and natural science phenomena that are judged to be of equal complexity by laypeople.

Children in these studies often attempted to explain their intuitions by referring to the immediacy of psychological states. They experienced them automatically and effortlessly, and that feeling may be confused with a sense that the phenomena are therefore simple. They also often said that everyone could understand such phenomena, suggesting something quite close to the "common knowledge" claims made by judges. Common knowledge may, in fact, not be well understood.

In short, it is not safe to assume that one's novice intuitions about the complexity of phenomena are always accurate. There may be systematic biases that heavily distort one's intuitions into thinking some classes of phenomena are much simpler than they really are. There is also the possibility that other biases may create intuitions of greater complexity than is warranted, although such patterns still remain to be experimentally demonstrated. One such example might involve a system that has a vast number of parts and seems hopelessly complex, but which is suddenly rendered very simple when a basic repeating pattern is pointed out. Some fractal patterns can take on great simplicity when seen in such a light.

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[17] Note that all the questions were phrased in very simple terms that would be readily understandable to young children.

[18] *Id.*

It would be extremely useful in legal cases to have a greater awareness of complexity biases and to factor them in when making decisions about whether to allow certain kinds of expert witnesses. It does not follow that all claims of expertise should be allowed, or even that all legitimate areas of expertise are relevant to the case at hand; but it is evident that we do not currently have in place sufficiently rigorous and systematic ways of evaluating whether a phenomenon requires testimony from experts in order for jurors and judges to act in a more informed manner.

V. GETTING BY WITH LESS

The story so far seems pretty discouraging. Normal adults, as well as attorneys and judges, labor under several cognitive biases that could powerfully influence trust and deference. They overestimate their own explanatory understanding, they get false surges of insight from irrelevant sources of seductive information, and they may have heavily distorted senses of what phenomena are truly complex and require expert assistance and deference to those experts. How might these problems be addressed? There are two answers, one arising from trying to instill a mindfulness about these biases in the legal system, and the other arising from ways in which complete novices do have tools at their disposal that enable them to evaluate expert claims, even when they understand very little about the details of those claims.

A. Mindfulness

In the case of mindfulness, legal cases might well be helped by a simple awareness not only of the fallibility of our knowledge related judgments, but also of the details of how those judgments are distorted. All parties in a legal proceeding should constantly be asking if they might be systematically overestimating not only their own understandings, but also those of others. This might entail techniques to carefully examine levels of understanding in ways that are thorough without being badgering or intimidating. There may be a set of heuristics that one could apply before making statements about the depth of one's own understanding or of that held by others. For example, one might be required to write out complete explanations of some facet of a phenomenon or to answer

certain critical diagnostic questions posed by top experts in the field.

Similarly, one should not assume that it is an easy matter to ascertain whether an area of expertise is legitimate or merely common knowledge. It would be a mistake to clutter the courts with an endless parade of experts on every possible topic, but it would be an equally large mistake to not try to develop explicit sets of procedures for evaluating alleged areas of expertise. If, for example, people have a tendency to succumb to reductionist explanations, even when they are empty, it might be possible to present them with examples of noninformative reductionist explanations to illustrate common pitfalls. Alternatively, one could suggest that people specifically ask what value is added when a new piece of information is introduced at a different level of analysis; for example, asking what predictions the new information now makes possible that were previously impossible or more difficult before receiving the new information. It is unclear what mindfulness strategies may be most effective simply because research in this area is relatively new. There is a great deal of cognitive science to be done in this area as well, but the knowledge gained so far can certainly suggest some guidelines.

B. Implicit Tools for Evaluating Expertise

Everyone shares certain heuristics that can be brought to bear to assess both the credibility and relevance of experts and the appropriateness of judgments, heuristics that have roots in early childhood. For example, young school children are more likely to doubt the testimony of people whose statements are self-serving. Thus, a person who claims to have won a close race is more likely to be doubted than one who claims to have lost the same race.[19] This may seem blindingly obvious, but it is not clear how often people are provided with adequate information about the potential links between a person's testimony and their own motivational states. For example, only recently have several major newspapers adopted the practice of disclosing the funding sources behind new discoveries in biomedical research. This practice undoubtedly was influenced by studies showing, for example, that scientists funded by pharmaceutical companies have quite different, and

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[19] Mills & Keil, *The Development of Cynicism*, *supra* note 5, at 389.

usually much more company-self-serving, results than scientists funded by government grants. Indeed, drugs have been reported as twenty times more effective in supposedly objective trials when the studies are funded by drug companies as opposed to when they are funded by federal agencies.[20] One cannot rely on the researchers conducting such studies to monitor themselves, as even the most ethical may unknowingly introduce bias. Whenever information that has been gathered by others is presented, it is important to know how that information relates to the motivational states of others.

A second form of implicit knowledge relative to the evaluation of expertise concerns having a sense that a domain of knowledge is appropriate for expertise even when one does not grasp most of the details of that domain. Here, we can consider some forms of implicit knowledge that are very early emerging in normal cognitive development and therefore should be considered available to virtually all adult jurors. There are, in fact, several distinct ways to enhance our judgments of the legitimacy of expertise: whether the properties being stressed are likely to co-occur in a domain, whether a coherent domain is being discussed, whether there are signs of deeper causal structure, and whether an appropriate gist has been constructed. Each of these ways is actively being pursued in research, but there are already indications that laypeople also use these to evaluate expertise in their everyday lives.

People will look at which property types are emphasized in an explanation to support hunches about whether an avowed expert is likely to be making sense. For example, all things equal, someone who explains how a novel machine works by stressing its color and the precise number of internal parts is less likely to be a legitimate expert than one who stresses the shape of the machine and the strength or fragility of specific parts. In contrast, someone who is trying to explain the nature of a novel plant might well focus on color and precise numbers of parts of its anatomy.[21] Even five-year-olds have some sense of this difference and can use it to choose between experts.[22]

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[20] *See* Lisa A. Bero et al., *Factors Associated with Findings of Published Trials of Drug-Drug Comparisons: Why Some Statins Appear More Efficacious than Others*, 4 PLOS MED. 1001, 1006 (2007).

[21] Frank C. Keil et al., *Two Dogmas of Conceptual Empiricism: Implications for Hybrid Models of the Structure of Knowledge.* 65 COGNITION 137 (1998).

[22] *Id.*

Similarly, even preschoolers have a sense that it is more sensible to talk about the overall function of novel artifacts (such as machines and tools) than it is to talk in the same manner about novel animals (for example, it makes more sense to say what a new tool "is for" than it does for a new mammal).

Even children may have a sense to doubt expertise that spans too diverse or broad areas of knowledge.[23] Thus, if one person claims to be an expert on ducks and swans, that person is more credible as an expert than one who claims to be an expert on ducks and lasers. All laypeople, as well as young children, share a sense that it is more likely that one will be an expert on areas of knowledge that are closer together in some taxonomy of knowledge.[24] Similarly, even children are sensitive to the fact that it is more plausible for someone to be an expert on a smaller class of entities at a lower level in a taxonomy (for example, all ducks) than it is to be an expert on a larger class at a higher level of a taxonomy (for example, all animals).[25] These intuitions require some sense of the division of cognitive labor in a person's community and the idea that knowledge clusters can be understood to form a kind of hierarchical structure similar to that found in the academic organizational charts of universities. Quite surprisingly, children as young as five do have some sense of such a structure, which they extract by looking at meaningful causal clusters in the world.

In addition, people can also sense when there are signs of deeper causal structure and use those to guess whether one is discussing a legitimate area of expertise. It is, for example, quite obvious to young children that it makes much more sense for there to be an expert on hunting dogs than on dogs with red collars. Even though a child may know virtually nothing about hunting dogs, he or she seems to engage in causal conjectures that reveal a likely causal structure. For example, a child might speculate that dogs that hunt would have better vision and smell and that an expert might know all about how that happened. For dogs with red collars, however, the child would see that there were no comparable plausible speculations about

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[23] Keil et al., *supra* note 16.

[24] Other work shows that children do have some sense of such taxonomies. Frank C. Keil et al., *Discerning the Division of Cognitive Labor: An Emerging Understanding of How Knowledge Is Clustered in Other Minds*, COGNITIVE SCI. (forthcoming); Judith Danovitch & Frank C. Keil. *Should You Ask a Fisherman Or a Biologist?: Developmental Shifts in Ways of Clustering Knowledge*, 75 CHILD DEVELOPMENT 918, 919 (2004).

[25] Keil et al., *supra* note 24; Danovitch & Keil, *supra* note 24, at 927-28.

causal generalizations that would follow from having a red collar. Thus, even when one does not really understand a domain, one can often use simple heuristics, such as causal counterfactuals, to get a sense of whether there is likely to be causal depth present worthy of expertise. These heuristics are not perfect however and can fail when rating the relative complexity of physical and psychological phenomena. A better understanding is needed of when they can work and when their usefulness is more limited.

Finally, there are indications that people understand the difference between reasonable and unreasonable gists of complex explanations and can use the difference to evaluate experts as well as an area of expertise. They may be able to do so without having much understanding at all of the details of the explanation. For example, ongoing research in our laboratory suggests that people can look at very general structural principles of an explanation, such as how some details are elaborated on by others, to guess at which is a good gist. A good expert should be focusing on core concepts and not on peripheral elaborations of a specific point. Someone who does not really grasp a domain well may not know enough to say much about the core concepts and may try to feign expertise by going on about subdetails of one facet of a phenomenon. Even laypeople, however, can sense or can be trained to sense when this sort of excessive detail is occurring and to start questioning expertise. There are some relatively simple clues as to when someone is going into irrelevant details as a way of trying to cover up ignorance of a central issue, and these clues may be available to a wide range of observers with quite modest knowledge of the area of alleged expertise.

VI. CONCLUSIONS

Human cognition can cause both pitfalls and opportunities in our efforts to get at the truth in a causally complex world in which deference and trust are essential. The pitfalls revolve around the ways in which individuals can be quite poor at recognizing their own areas of weak understanding. We live under illusions of explanatory depth and we have the same illusions about explanatory understanding in others. We are further hindered by a tendency to be seduced by a sense of false insight when we are presented with certain ways of making phenomena more concrete, even when such concreteness is nothing more than uninformative fMRI results.

We may also introduce systematic distortions into our sense of where the deepest causal complexities in the world arise, with the result that we tend to underestimate the complexity of psychological phenomena relative to most physical ones.

The opportunities to overcome these predispositions arise from the surprisingly sophisticated ways in which all of us, even young children, can use our intuitive senses of real world causal structure and of the nature and purpose of explanations to assess experts even when we have very modest knowledge of an area of expertise. We can evaluate experts (and judges) in terms of their self-interest. We can also evaluate experts in terms of the reasonableness of the avowed area of expertise, using such factors as the breadth and depth of what they talk about and the ways in which they summarize complex bits of information. All of these are quite recent areas of research, but every sign is that cognitive science will soon tell us a great deal more about both the illusions we labor under and should be mindful of and about the ways in which we use heuristics and implicit knowledge to have a good sense of when and where to place our trust.

These new developments create a burden for cognitive scientists to communicate the current state of this research more clearly with those in the law, as well as a burden on those in the law to recognize both our cognitive biases and our surprising evaluative abilities. At present, we both over-estimate and underestimate different aspects of people's cognitive capacities, and we do so in ways that may well impair the manner in which trust should optimally function in the courtroom.