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Dual-Processing Models of Admissibility:

How Legal Tests for the Admissibility of Scientific Evidence Resemble Cognitive Science's System 1 and System 2

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ABSTRACT

This Essay explicates the correspondence between the law's two most prominent rules for the admission of scientific expert testimony (the *Frye* general acceptance test and the *Daubert* test of evidentiary validity) and the most prominent dual-processing model in cognitive science: System 1 (fast, intuitive) and System 2 (slow, reasoned).

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TABLE OF CONTENTS

I. INTRODUCTION

Why are the rules of evidence that govern the admissibility of expert testimony what they are instead of something else? Among other reasons, one factor surely is the evolved features of the human mind—the tendency to approach problems in certain ways rather than others.

The judge's obligation to filter expert testimony is itself partly rooted in a psychological assumption: that there is a high risk that laypersons will be over-awed by the testimony of experts, give their opinions more weight than they deserve, and be misled into erroneous beliefs about the trial's evidence.[1] The law's strategy for limiting this risk has been to require judges to screen expert evidence in an effort to ensure its soundness.

[1] *See* 1 DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 4:21 (2011–2012 ed. 2012) ("A frequently expressed belief is that jurors will uncritically accept expert testimony. This fear is expressed in a number of appellate opinions.").

But such filtering introduces a great paradox. How can judges distinguish the sound from the unsound when they themselves are non-experts on the subject, and the proffered evidence is "beyond the ken" of non-experts? Determining the admissibility of evidence under such circumstances presents a challenge to judges who are obligated to make a decision about something about which they lack knowledge and understanding.

The law's solution to that puzzle has been to invent evidentiary tests, the most prominent of which have pointed judges in one of two dramatically different directions. The earlier tests allowed or required judges to defer to evidence evaluators outside of the court, and the court was to piggyback on their judgments. The best-known test of that kind is the "general acceptance test," announced in 1923 in *Frye v. United States*.[2] At the other end of the spectrum is a test that obligates the judge to thoughtfully evaluate the proffered testimony in order to ensure that it will be reliable and relevant to the case at hand. This is the test that, in 1993, the Supreme Court held is required by the Federal Rules of Evidence.[3]

In this Article we suggest that these two tests represent—and perhaps are compelled into being by—the two major kinds of cognitive processing that the human mind has evolved to perform. These two major cognitive modalities can be referred to as *Thinking, Fast and Slow*.[4]

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[2] 293 F. 1013, 1014 (D.C. Cir. 1923).
[3] Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 589 (1993).
[4] We borrow this shorthand from a popular book by that title, published by a Nobel Prize-winning psychologist. *See* DANIEL KAHNEMAN, THINKING, FAST AND SLOW 13 (2011).

II. DUAL-PROCESSING MODELS OF COGNITION

For centuries, philosophers discussed the existence of seemingly automatic, emotion-driven responses and controlled reasoning processes, debating the relative dominance of these ostensibly distinct structures on cognition and behavior.[5] Sometimes we instantly perceive a conclusion and act on it.[6] Other times we ponder a problem deeply. More recently, psychologists have proposed that such duality has been installed in the mind by two evolutionarily distinct and sometimes competing cognitive systems.[7] This broad concept, termed "dual-processing theory," has been applied to research on persuasion,[8] prejudice and stereotyping,[9] impression formation,[10] and moral judgment,[11] among others.

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[5] *See, e.g.*, ARISTOTLE, NICOMACHEAN ETHICS 16–26 (Lindsay Judson ed., C.C.W. Taylor trans., Oxford Univ. Press 1st ed. 2006) (c. 350 B.C.E.); DAVID HUME, THE PHILOSOPHICAL WORKS OF DAVID HUME 193–236 (T.H. Green & T.H. Grose eds., Longmans, Green, & Co. 1st ed. 1874) (1739).

[6] For example, if we see people fleeing a building, we don't stop to analyze the situation, we immediately follow them.

[7] *See generally* KAHNEMAN, *supra* note 4.

[8] *See, e.g.*, Richard E. Petty & John T. Cacioppo, *The Elaboration Likelihood Model of Persuasion*, *in* 19 ADVANCES IN EXPERIMENTAL SOCIAL PSYCHOLOGY 123, 125 (Leonard Berkowitz ed., 1986).

[9] *See, e.g.*, Patricia G. Devine, *Stereotypes and Prejudice: Their Automatic and Controlled Components*, 56 J. PERSONALITY & SOC. PSYCHOL. 5 (1989).

[10] *See, e.g.*, Susan T. Fiske & Steven L. Neuberg, *A Continuum of Impression Formation, from Category-Based to Individuating Processes: Influences of Information and Motivation on Attention and Interpretation*, *in* 23 ADVANCES IN EXPERIMENTAL SOCIAL PSYCHOLOGY 1, 1 (Mark P. Zanna ed., 1990).

[11] *See, e.g.*, Joshua Greene & Jonathan Haidt, *How (and Where) Does Moral Judgment Work?*, 6 TRENDS COGNITIVE SCI. 517, 517 (2002).

Each of these applications of dual-processing theory suggests two discrete systems, generically described as System 1 and System 2.[12] System 1 is considered evolutionarily old and includes instinctive behaviors that are quick, automatic, heuristic-based,[13] emotional, and effortless. In contrast, System 2 processes are slow, voluntary, analytic, and effortful. System 2 allows for abstract hypothetical thinking and requires working memory capacity, and as such is limiting and cognitively taxing. By contrast, only the end results of System 1 processes reach consciousness. System 1 processes are best suited to circumstances under which automatic, intuitive action is necessary or sufficient, whereas System 2 is best suited for situations requiring reasoning and abstraction.

Research has shown that both of these systems influence judgments and that they can operate simultaneously—but when in conflict, one system might override the other. Using a deductive-reasoning paradigm, Evans et al. designed syllogisms that contained arguments that either were or were not logically consistent with the conclusion, and conclusions that either were or were not

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[12] *See* Daniel Kahneman, *A Perspective on Judgment and Choice: Mapping Bounded Rationality*, 58 AM. PSYCHOLOGIST 697, 698-99 (2003); Keith Stanovich & Richard West, *Individual Differences in Reasoning: Implications for the Rationality Debate*, 23 BEHAV. & BRAIN SCI. 645, 658–59 (2000); Jonathan St. B.T. Evans, *In Two Minds: Dual-Process Accounts of Reasoning*, 7 TRENDS COGNITIVE SCI. 454, 454 (2003). The description immediately following in the text is drawn from these sources, especially Kahneman.

[13] A cognitive heuristic is "a mental shortcut used to make a judgment." DOUGLAS T. KENRICK ET AL., SOCIAL PSYCHOLOGY 82 (5th ed. 2010).

consistent with common knowledge and beliefs.[14] Syllogisms that paired coherent logic with an "unbelievable" conclusion,[15] or incorrect logic with a "believable" conclusion, created conflict between System 1 and System 2 processes. Participants untrained in formal logic were asked to judge the validity of the conclusion based only on the arguments in the syllogism. Evans et al. found that participants were more likely to judge as valid those conclusions that were consistent with their prior beliefs and to reject conclusions that were inconsistent with their prior beliefs, regardless of the logical coherence of the underlying arguments.[16] These findings showed that the two systems were competing for control and that participants were unable to suppress the influence of prior beliefs and heuristics when trying to make judgments based on logical reasoning.

Building on the work of Evans et al., later researchers found neurological support for dual processing. Goel et al. used fMRI methodology to show that different types of cognitive tasks activated different regions of the cerebral cortex: associative processing typical of System 1 activated a left hemisphere temporal system, whereas reasoning with formal problems activated the parietal system.[17] These areas of activation have been shown by other neuropsychological studies to correspond to areas of the brain that are associated,

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[14] J. St. B.T. Evans et al., *On the Conflict Between Logic and Belief in Syllogistic Reasoning*, 11 MEMORY & COGNITION 295, 297, 299 (1983).

[15] *Id.* at 298–99. For example: No nutritional things are inexpensive. Some vitamin tablets are inexpensive. Therefore, some vitamin tablets are not nutritional.

[16] *Id.* at 297–303.

[17] Vinod Goel et al., *Dissociation of Mechanisms Underlying Syllogistic Reasoning*, 12 NEUROIMAGE 504, 511 (2000).

respectively, with heuristic responses and with areas critical to detecting and resolving conflict between neural systems.[18] Goel et al. also found fMRI evidence that different mental processes compete for control over responses to Evans's logic problems.[19]

Kahneman and Frederick have proposed that neither system in dual-processing theory consistently holds an advantage—instead, each has the potential to override the other, and which system takes control depends on the situation.[20] Stanovich and West have suggested that the efficacy of System 2 reasoning is also likely to vary among individuals due to its reliance on working memory capacity.[21] In a series of studies, these researchers showed that performance on several inferential and decision-making tasks was correlated with SAT scores, suggesting that System 2 might also be related to intelligence.[22] Thus, which processing system is used to make a particular judgment might vary from situation to situation and from person to person.

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[18] *See, e.g.*, Olivier Houdé et al., *Access to Deductive Logic Depends on a Right Ventromedial Prefrontal Area Devoted to Emotion and Feeling: Evidence from a Training Paradigm*, 14 NEUROIMAGE 1486, 1489–90 (2001).

[19] Goel et al., *supra* note 17, at 512.

[20] Daniel Kahneman & Shane Frederick, *Representativeness Revisited: Attribute Substitution in Intuitive Judgment*, *in* HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT 49, 51 (Thomas Gilovich et al. eds., 2002).

[21] Keith E. Stanovich & Richard F. West, *Cognitive Ability and Variation in Selection Task Performance*, 4 THINKING & REASONING 193, 196–97 (1998).

[22] *Id.* at 220–24.

An application of dual processing well suited to the concerns of legal trials comes from the elaboration-likelihood model (ELM) of persuasion, a theory that explains a wide range of empirical research findings on attitude change. The ELM defines a *peripheral route* to persuasion (which is analogous to System 1 thinking) and a *central route* (much like System 2).[23] The peripheral route involves responses to superficial features of a source, simple associations, and feelings about the message and messenger, but little consideration of the message content.[24] For example, jurors who accept the conclusions of an expert witness based on the witness's appearance, credentials, or style of testifying are engaged in peripheral processing. The central route to persuasion involves a recipient who engages in a high level of cognitive response: absorbing message content, thoughtfully parsing it, and assessing the merits of arguments.[25] Recipients of persuasive communications are more likely to engage in central-route processing when they are motivated to assess the message and are capable of doing so.[26]

III. *FRYE* AND *DAUBERT* TESTS AS MANIFESTATIONS OF DUAL PROCESSING

The law has invented two quite different ways of assessing the quality of expert evidence and, therefore, its admissibility at trial. Each, we suggest, is a manifestation of the two major ways that human minds assess information and make decisions.

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[23] Petty & Cacioppo, *supra* note 8, at 126.
[24] *Id.* at 125–26, 134.
[25] *Id.* at 125–26, 132–33.
[26] *Id.* at 131–32.

The test announced in *Frye v. United States*[27] (the "general acceptance" test) is best understood as a variation on an earlier pattern of screening expert evidence employed by American courts in the nineteenth century: a test that was not identified at the time as such and had no name, but that some scholars today refer to as the "marketplace" test.[28] We suggest that both the marketplace test and the general acceptance test are reflections of System 1 cognitive processing.

Courts originally asked only[29] whether a proffered expert was "qualified."[30] But what sense does it make to declare a person "qualified" to share the knowledge of a field at trial unless and until it has been established that the field itself is sufficiently sound that its knowledge can light the fact-finder's way to accurate conclusions?[31]

In the nineteenth century, courts appeared to add a requirement—or at least came to prefer—that the proffered expert be successful in the commercial marketplace outside of the court. The soundness of the expertise and the expert were simultaneously implied by the fact that people were spending their hard-earned money to purchase that expert's knowledge

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[27] 293 F. 1013, 1014 (D.C. Cir. 1923).

[28] *See* FAIGMAN ET AL., *supra* note 1, at § 1:2 ("If a person could make a living selling his knowledge in the marketplace, then presumably expertise existed.").

[29] We take as a given that courts would not consider proffered expert evidence unless they first determined that the testimony would be relevant to a disputed factual issue in the case and that the proffered knowledge was "beyond the ken" of the laypersons who were responsible for resolving the disputed facts of the case.

[30] *See* FAIGMAN ET AL., *supra* note 1, at § 1:2.

[31] For example, consider a thoroughly, masterfully, unimpeachably well qualified expert in astrology.

and skill. Thus, prosperity in the marketplace signaled both the validity of the field and the competence of the expert: knowledge that was valued in the marketplace could hardly be without value in a courtroom. That, at least, was the assumption. The test is relatively objective, fast, and easy for judges to apply. But is it a dependable test? The marketplace selects for many other things besides validity, accuracy, and effectiveness.[32] The marketplace test cannot, for instance, distinguish astrology from astronomy: consumers value both.

Another problem is that some fields have little or no life in commerce. Several fields have arisen in the past century that have no function outside of their possible value in the courtroom—and have, accordingly, been termed "forensic" sciences. The courtroom is their marketplace. How are the courts to assess those? That is the problem that gave rise to the *Frye* test.

Defendant Frye proffered an early type of polygraph test, the results of which supported his claim of innocence to a murder charge.[33] There was not then, unlike today, a robust market outside the courtroom for polygraph services. Thus, a novel scientific question presented itself, and the traditional test could not provide an answer.

The *Frye* court invented a solution that was, in essence, a minor variant of the marketplace test. For the axis of decision, the court substituted the field's intellectual

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[32] Today we can see many more failings of the marketplace than might have been apparent centuries ago. Hype, hope, and popularity also sell well. Many have grown rich selling horoscopes, phony cancer cures, worthless securities, and bracelets promising superior athletic prowess.

[33] *See* Frye v. United States, 293 F. 1013, 1013–14 (D.C. Cir. 1923).

marketplace for the commercial marketplace.[34] Like the marketplace test, the general acceptance test is relatively objective, fast, and easy for judges to apply. Also like the marketplace test, it has serious weaknesses: the *Frye* test is incapable of distinguishing astrology from astronomy. But in some ways the *Frye* test was even less sound than the test it replaced. As the pivotal evaluators of the quality of the knowledge being offered, *Frye* replaced buyers with sellers. Instead of consumers signaling to the courts what was to be considered worthwhile knowledge, that power now was passed to the people who produced the knowledge and offered it, and themselves, to the courts.[35]

Thus, the *Frye* test, much like the marketplace test, enables judges to make determinations about what are difficult scientific and technological questions, using a decision tool that is relatively fast, requires little thought about the heart of the matter (the scientific claims), focuses on a superficial proxy, and therefore is nearly effortless. In essence, the *Frye* test employs System 1 cognitive processing.

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[34] The *Frye* test was expressed in these words:

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while the courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

Id. at 1014.

[35] Think about astrologers. How likely are they to declare their enterprise to be without value? How likely are members of any field to do so?

After the adoption of the Federal Rules of Evidence in 1975—which made no mention of *Frye* or the concept of general acceptance either in the text of the rules or in the Advisory Committee's commentary—numerous federal courts continued to employ *Frye*, and others started using it.[36] In *Daubert v. Merrell Dow Pharmaceuticals*,[37] the Supreme Court was called upon to resolve the question of whether the *Frye* test had somehow become assimilated into the Federal Rules of Evidence. The Court unanimously held that the *Frye* test was superseded by FRE 702 and that the federal rules require judges to ensure that expert testimony rests on a reliable (i.e., scientifically valid) foundation.[38]

Thus, federal judges are now required to evaluate the knowledge of the field on which the expert's testimony would be based. The *Daubert* opinion offered suggestions to trial judges on how to evaluate the science underlying proffered testimony.[39] The suggestions included elements that echo the elements of a scientific article: Are the field's claims testable? Have they been tested? Is the methodology of that testing sound?[40] What are the results of the testing?[41]

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[36] Ironically, and perhaps paradoxically, the *Frye* test was more widely adopted after the advent of the Federal Rules than it had been before. *See* FAIGMAN ET AL., *supra* note 1, at § 1:3, n.8 and accompanying text.

[37] Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 579 (1993).

[38] For further refinement and expansion of *Daubert*, *see* Weisgram v. Marley Co., 528 U.S. 440, 457 (2000); Kumho Tire Co. v. Carmichael, 526 U.S. 137, 147 (1999); Gen. Electric v. Joiner, 522 U.S. 136, 142–43 (1997).

[39] *Daubert*, 509 U.S. at 593–94.

[40] The gravamen of the paragraph beginning "Another pertinent consideration," *id.* at 593, is that peer review and publication can provide assistance to judges in their efforts to evaluate the methodology of research. As a testament to the desire of lawyers and judges to simplify what is

With the Supreme Court's decision in *Daubert*, judges were at last to replace consumers and producers as the principal evaluators of the validity of expert evidence.[42] In effect, in thinking about the admissibility of expert evidence, judges were to stop employing System 1 and start using System 2.

IV. CONCLUSION

The kind of thinking that is called for by *Frye's* general acceptance test resembles System 1 cognition (fast, intuitive). The *Daubert* line of cases requires System 2 thinking (slow, reasoned). The two cognitive systems appear to have been crystallized into contrasting legal rules.

Perhaps System 1 and System 2 serve only as analogies to what is required by *Frye* and *Daubert*. The former test can be accomplished with a relatively simple look at what certain people think of the proffered expert evidence. *Daubert*, on the other hand, calls upon judges to learn new and difficult information and to think more deeply about the nature of the claims underlying the proffered expert testimony and how well the research supports those claims.

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probably most sensibly read as a guide to methodology assessment, this has come to be viewed as nothing more than an item on a checklist: Do peer reviewed studies exist? If so, there is no need to trouble oneself with the quality of the research design and the implications for what the studies purport to have found.

[41] The Court expressed this factor as "rates of error," which are but one kind of study results and not even the kind implicated by the toxic tort case before the Court. *Id.* at 594.

[42] Using the Court's terms, judges have a "gatekeeping role" in determining the "evidentiary reliability" of proffered expert testimony. *Id.* at 590, 597.

Even as metaphors, appreciation of the differences between these cognitive systems helps us see more clearly what is happening when the law moves from *Frye* to *Daubert*– from thinking about the nature of expert evidence in a System 1 mode to thinking in a System 2 mode.[43] The former does not engage the serious reasoning of the judge: the real decision is made by persons outside of the judicial process. The latter is more demanding: judges must try to understand both the field's claims and the empirical support for those claims, and they must decide even when the experts themselves cannot agree.[44]

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[43] The shift from *Frye* to *Daubert* has also been occurring in the states. *See* FAIGMAN ET AL., *supra* note 1, at § 1:7 (counting twenty-eight states adopting *Daubert*, six states and the District of Columbia following their home-grown equivalent of *Daubert*, nine rejecting *Daubert*, and other positions and permutations in the remaining states).

[44] Justices Rehnquist and Stevens wondered whether judges were up to such intellectual challenges. *See Daubert*, 509 U.S. at 600 (Rehnquist, J., concurring in part and dissenting in part). On remand, the Ninth Circuit expressed its own doubts:

> The task before us is more daunting still when the dispute concerns matters at the very cutting edge of scientific research, where fact meets theory and certainty dissolves into probability. As the record in this case illustrates, scientists often have vigorous and sincere disagreements as to what research methodology is proper, what should be accepted as sufficient proof for the existence of a "fact," and whether information derived by a particular method can tell us anything useful about the subject under study.
>
> Our responsibility, then, unless we badly misread the Supreme Court's opinion, is to resolve disputes among respected, well-credentialed scientists about matters squarely within their expertise, in areas where there is no scientific consensus as to what is and what is not "good science," and occasionally to reject such expert testimony because it was not "derived by the scientific method."

The former can seem to be an abdication of judicial responsibility, and the latter a command from above to do the impossible.

But judges do not necessarily actually engage System 1 when deciding admissibility under *Frye*, and System 2 when they decide under *Daubert*. Because judges are human beings, they inevitably employ the same cognitive processes as any other human being. Even when the governing rule is *Daubert*, they might incline away from hard thinking and toward less demanding shortcuts and superficial, peripheral analysis. Evaluating scientific and other expert claims, however, is not normally the occasion for intuitive, gut reactions.

Actual rulings by judges provide interesting illustrations of the difficulty judges sometimes have of abandoning System 1 thinking when thrust into a System 2 legal domain. One set of such examples is provided by challenges under *Daubert* to fingerprint expert testimony. Think of the *Daubert* analysis as a syllogism. The major premise is the legal rule: expert evidence is admissible only if empirical data establish the validity of the proponent's claims. The minor premise is the empirical research the proponent marshals in an effort to prove validity. The judge is to consider those arguments and reach a conclusion. After describing dozens of hearings in which virtually or literally no empirical evidence was put forward on behalf of the claimed expertise, yet the judges nevertheless found the proffered expert evidence

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> Mindful of our position in the hierarchy of the federal judiciary, we take a deep breath and proceed with this heady task.

Daubert v. Merrell Dow Pharm., Inc., 43 F.3d 1311, 1316 (9th Cir. 1995).

admissible, their judicial decision making was summed up in the following terms:

> The difficulty judges are having with challenges to fingerprint expert testimony is not unlike that of freshman philosophy students confronted by a syllogism to evaluate, the conclusion to which they somehow "know" to be valid before they undertake any analysis. Clear-headed evaluation of the logic of the syllogism is precluded by the compulsion the students feel to preserve the one thing they are "sure" about, namely, the conclusion. Given their deeply-held beliefs, they find it difficult to perform any analysis that might undermine the superhighway leading to the "obviously correct" conclusion.[45]

Just like the participants in Evans's study of syllogistic reasoning, district judges experience a tug-of-war between applying the reasoning commanded by *Daubert* and, on the other hand, prior beliefs, heuristics, and intuition.

In one appellate case, we can see the two systems at work in a conflict among the judges of a single court. In *United States v. Crisp*,[46] a defendant challenged the admissibility of handwriting and fingerprint expert testimony under *Daubert*. The two-judge (System 1) majority held, in essence, that since those fields had been coming in for a century, they must be valid and could continue to be admitted.[47] That was their

[45] FAIGMAN ET AL., *supra* note 1, at § 33:3.
[46] 324 F.3d 261, 266 (4th Cir. 2003).
[47] *Id.* at 269–71.

ruling, despite a wholly new rule (*Daubert*) requiring an entirely new analytic approach. The dissenting (System 2) judge, applying *Daubert*, found no supporting data and consequently argued for exclusion of the expert testimony.[48]

The law can evolve a System 2 rule faster and more easily than human judges can overcome the mental apparatus with which neuro-cognitive evolution has endowed them. As a result, judges sometimes or often employ System 1 cognition while trying to make decisions under a System 2 rule.

Perhaps the next work of cognitive science should be to develop ways to assist judges in employing the kind of thought processes best suited to the rules under which they are required to make their decisions.

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[48] *Id.* at 272 (Michael, J., dissenting) ("[T]he government did not prove that its expert identification evidence satisfied the *Daubert* factors or that it was otherwise reliable. I respectfully dissent for that reason. In dissenting, I am not suggesting that fingerprint and handwriting evidence cannot be shown to satisfy *Daubert*. I am only making the point that the government did not establish in Crisp's case that this evidence is reliable. The government has had ten years to comply with *Daubert*. It should not be given a pass in this case.").