Law & Neuroscience: The Case of Solitary Confinement

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Abstract: This essay discusses the interface between neuroscience and the law. It underscores the potential for neuroscience to break down the division that currently exists in law between physiological and psychological harm and between physical and mental injury. To show how scientific knowledge can illuminate a complex legal issue, we analyze the recent use of neuroscience in evaluating the harm caused by prolonged solitary confinement.

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Neuroscience is increasingly used in the courtroom, in a variety of circumstances.[1] Over the past decade or so, the distinct field of "law and neuroscience" has developed (sometimes termed "neurolaw"), a casebook on law and neuroscience has been published, courses on the subject are being taught in law schools and other departments, and the John D. and Catherine T. MacArthur Foundation has invested over $15 million in developing the Law and Neuroscience Project and Research Network.[2] Neuroscience testimony in the courtroom has, to date, largely focused on issues relating to criminal responsibility, with defense attorneys seeking to introduce brain scans of defendants to show that either they were not responsible for their actions or to argue that brain defects or problems justified mitigated penalties.[3]

Possible uses of neuroscience in the law go far beyond criminal cases, however. Neuroscience has the potential to bridge the divide in American law and culture between physical and mental injuries. For instance, it could enable judges to allow plaintiffs to recover damages in tort actions where mental harm may be uncompensable or disbelieved, but provable brain damage can be viewed as a physical injury.[4] Brain damage can be structural, such as a tumor or dimin-

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ished volume of a particular brain region, and/or it can be functional, such as a characteristic change in the activity of a brain circuit implicated in certain conditions, including severe chronic stress or depression, chronic pain, or loss of cognitive function. So, too, neuroscience might be useful in helping judges to understand the mental harms that government action can inflict and to determine whether the infliction of mental harm, intended or not, rises to the level of a constitutional violation.

This is already happening in one area: expert neuroscience evidence is being mustered to support claims of extreme and long-lasting, if not permanent, mental harm in constitutional challenges to prolonged solitary confinement, a disciplinary practice used in many state and federal prisons. Thus, in the class action case of *Ashker v. Governor*, challenging the solitary confinement of more than one thousand prisoners at Pelican Bay State Prison in California, the plaintiffs submitted expert neuroscience testimony in support of their Eighth Amendment claims that such prolonged confinement constitutes cruel and unusual punishment.[5] This essay reviews the current intersection between the law and neuroscience and then explores and analyzes neuroscience's use in evaluating the harm caused by prolonged solitary confinement.

At first, the connection between the law and neuroscience may seem surprising; the "Law and neuroscience seem strange bedfellows."[6] As legal scholar David Faigman has noted, there is a "fundamental divide between the fields of neuroscience and law," an observation that could also be made about the law and other fields in mainstream science.[7] Neuroscientists study the brain and are generally unconcerned with legal questions, while lawyers, as smart as they may be, usually know nothing about how the brain works and are not troubled by their ignorance. Yet the law and lawyers are ultimately concerned with regulating human behavior, and issues of intent are part of the grist in the legal mill. Understanding the brain is central to both the law and neuroscience; thus, the burgeoning interplay between the two fields should not be surprising.

Perhaps the most salient source of tension between the two fields has to do with the differing goals of the scientist and the lawyer. The scientist studying the brain is ideally a neutral analyst, an empiricist who pursues evidence to generate a better understanding of brain function regardless of preconceptions. The lawyer is ordinarily not neutral, but rather is an advocate for his or her client's interests. A scientist is only supposed to draw a definitive conclusion when findings are replicable to a very high degree. Yet lawyers and judges are seldom in a position to withhold judgment. They can, and often must, evaluate evidence bearing on a claim, even if it is not conclusive. Moreover, in civil cases, the usual standard of proof is not the scientific standard, which demands substantial certainty, but rather the preponderance of evidence, which translates into "more likely than not."

This difference leads to tensions that bear on both the potential uses and the need for caution when using neuroscience evidence in legal contexts. Lawyers would like to present favorable neuroscience evidence as dispositive, yet scientific norms specify that neuroscience claims should not be oversold. This does not mean that the neuroscientist cannot or should not advocate positions based on the science as we know it now, even if current science provides only strongly probable but not scientifically conclusive confirmation of a relationship. It does, however, mean that the neuroscience expert must admit, and indeed should proactively bring forth, the existence of scientifically sound conflicting evidence or underscore areas where current knowledge is

either lacking or too weak to support strong conclusions. In these circumstances, neuroscience advocacy is most likely to be relied upon by courts when its conclusions are consistent with common sense.[8]

Neuroscientific evidence has been used with significant success to mitigate punishment, particularly in capital cases.[9] In the juvenile death penalty case *Roper v. Simmons*, the Supreme Court seems to have utilized such evidence in support of its decision that it is unconstitutional to impose capital punishment on a minor.[10] Yet some of the more radical claims made by neuroscientists, like the claim that brain imaging undermines the whole basis of criminal responsibility, have been deeply controversial and have not gained much traction in the courts.[11] Moreover, outside of the criminal mitigation context, most efforts to introduce neuroscience evidence in courts have proven unsuccessful.[12] Nonetheless, neuroscience evidence continues to be introduced in civil cases.

There appear to be two broad ways in which neuroscience evidence has made its way into the legal system. The first is the use of case-specific evidence from brain imaging, such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scans, to demonstrate a particular criminal defendant's defective ability to make rational decisions or to show harm to the brain suffered by a plaintiff.[13] The second use, more important to this essay, is as what has been termed *framework* or *foundational scientific evidence*: scientific testimony bearing on how other evidence should be used based on general theories or hypotheses.[14]

These and other uses of neuroscientific evidence have the potential to break down the sharp dividing line the law has erected between mental injury and bodily harm. In diverse fields of law, from torts to constitutional law, the legal system treats mental harm differently from physical harm. Tort law traditionally makes a distinction between physical and emotional harm, "with emotional harm being treated as a second class citizen."[15] For example, to recover for the negligent infliction of emotional distress, a majority of states require the plaintiff to show not merely mental or emotional harm, but also physical injury.[16] The reasoning that the courts generally provide for this limitation is that mental harm, unlike physical injury, is essentially subjective and therefore the physical injury requirement will give "a sufficient basis for the trial courts to determine [that the claims of mental harm are] not . . . fraudulent claims."[17] Although often reaffirmed, this nexus requirement emerged many years ago, long before the capabilities that modern neuroscience gives us existed.

The American Law Institute's recent Third Restatement of Torts incorporates as a general rule this clear distinction between physical or bodily injury and mental or emotional injury.[18] It does, however, allow for claims of intentional or negligent infliction of pure, stand-alone emotional harm, but only in very circumscribed circumstances, citing, among other things, concerns that "emotional harm is less objectively verifiable than physical harm" and that "some degree of emotional harm is endemic to living in society."[19]

Neuroscience research at least muddies the distinction between bodily injury and mental harm, and, in the future, it might negate it entirely. One tool that neuroscience can deploy is brain imaging, which allows a window into the altered functioning of the brain under different conditions. This approach has been used to study chronic pain, considered the greatest source of disability worldwide. Neuroimaging has shown that chronic pain does indeed change brain function, altering specific neural pathways broadly, leading some to classify it as a neurodegenerative disorder. The brain changes resulting from chronic pain may not yet

reach the standard of being diagnostic on their own. Nevertheless, they are reliable enough to motivate recent reviews putting forward neuroimaging strategies as a potential basis of evidence for both clinical and legal purposes.[20] It is notable that emotional suffering, including chronic anxiety and depression, has an equally profound impact on brain structure and function. Indeed, some of the same brain regions are disrupted in both chronic pain and depression, providing clear biological evidence of the overlap between physical and mental distress.[21]

Other types of mental harm such as Post-Traumatic Stress Disorder (PTSD) can be shown objectively to affect the brain, thereby demonstrating that this emotional injury is also physical in nature. Indeed, one court has so ruled. In the Michigan case *Allen v. Bloomfield Hills School District*, the plaintiff was operating a train when he crashed into a bus that had negligently strayed onto the train tracks. The plaintiff developed PTSD because the crash resulted in the deaths of several schoolchildren. The lower court dismissed his tort claim because the applicable Michigan statute required a showing of "bodily injury," which the court ruled the plaintiff had not proved.[22]

The Court of Appeals reversed the ruling, relying on PET scans of the plaintiff, showing that he had suffered abnormalities in the brain due to the accident.[23] The court noted that "brain injury is a bodily injury."[24] The "plaintiff presented objective medical evidence that a mental or emotional trauma can indeed result in physical changes to the brain. . . . There should be no difference medically or legally between an objectively demonstrated brain injury, whether the medical diagnosis is a closed head injury, PTSD, [or] Alzheimer's Disease."[25] The brain is a part of the body, and hence an injury to the brain that is objectively verifiable should count as physical injury.

The neuroscientific insight that mental pain and harm are sometimes the result of or correlated with brain damage or abnormalities may also play an important role in constitutional jurisprudence addressing American prison systems' practices of prolonged solitary confinement.

At any given time, an estimated one hundred thousand prisoners in this country are held in solitary confinement. Such confinement varies slightly from state to state, but it generally involves a prisoner being kept for approximately twenty-three hours a day alone in a small cell, with minimal social contact and no physical contact with others.[26]

A draconian example of such solitary confinement existed for many years at the Pelican Bay State Prison Security Housing Unit (SHU). At that prison, built in 1989, approximately 1,300 prisoners were imprisoned in small, Spartan, eighty-square-foot cells with no windows for almost twenty-three hours a day. For years, they had no view of the outside world; they saw no birds, trees, cars, or grass.[27] For one-and-a-half hours per day, they went out to a recreation "yard" attached to their cell block. This was a facility about twice the size of their cell, with fifteen-foot-high walls and a grate over the top where they recreated, alone. If they went out to the yard at the right time during the day, it was possible to see a little sunlight, but, generally, most prisoners had only fleeting, if any, glimpses of direct sunlight during their stay at Pelican Bay. They were allowed no phone calls at all except in an "emergency," which was defined as a parent dying, in which case they were allowed a fifteen-minute call with next of kin. They were permitted visits with their family, but no contact visits, meaning they only could speak with their visitors through an intercom, viewing them through a glass window, unable to touch or hug their loved ones. While some had televisions and radi-

os, there was no educational, vocational, or religious programming or activities.[28]

One might think that only the most heinous, pathologically violent prisoners would be placed in these conditions. But, in fact, most of the 1,300 prisoners at the Pelican Bay SHU were not there because of any violent act they had committed in prison, but solely because they were either members or associates (a loose definition that included people who simply associated with members) of a prison gang. These prisoners were placed in the SHU for an indeterminate period of time, which in practice generally meant until the end of their prison terms, unless they were paroled, snitched, or died. In short, the only real way out of the SHU and into the general prison population was to become an informant against the gang, usually a dangerous proposition.

It is hard to imagine surviving in this environment for more than a few days or weeks without becoming suicidal or mentally ill. Some of the prisoners placed in the SHU did become mentally ill. But hundreds did not. It is a testament to the human being's ability to adapt to atrocious conditions that many prisoners were able to survive these conditions not only for weeks, but for decades. As of 2011, almost one hundred of the prisoners at Pelican Bay SHU had been held in solitary confinement for over two decades, and almost five hundred had been so confined for more than ten years. Survival does not, however, mean that they did not suffer serious mental harm: depression, paranoia, and loss of concentration and memory are just some of the symptoms associated with extended solitary confinement.

In 1990, within a year after the Pelican Bay SHU opened, a high-powered and skilled group of lawyers sued the California prison system on behalf of the class of prisoners incarcerated at the Pelican Bay SHU. They drew as the judge who would hear the case one of the most progressive, civil-rights oriented federal judges in the entire country, Thelton Henderson. The case went to trial in 1993, and in early 1995, Judge Henderson ruled that California officials had denied plaintiffs' constitutional rights by using excessive force and by not providing adequate medical care.[29] Yet on the fundamental issue of whether placing prisoners in such strict isolation for years by itself constituted cruel and unusual treatment prohibited by the Eighth Amendment, Henderson did not pull the trigger, even if he did find that the conditions were draconian, sterile, and isolating. For example, he opined that "the overall effect of the SHU is one of stark sterility and unremitting monotony."[30] He found that the conditions of social isolation were profound and noted that when he visited the prison, he observed prisoners pacing around in their cells as if they were animals in a zoo.[31]

The plaintiffs had submitted expert testimony from two internationally prominent psychological experts who had interviewed many prisoners and concluded that they suffered from varying degrees of psychological pain, including paranoia, lack of concentration, chronic depression, confused thought processes, hallucinations, irrational anger, emotional flatness, violent fantasies, and oversensitivity to stimuli.[32] Henderson acknowledged that mental pain, but held that it did not rise to the level of a constitutional violation, stating:

> the record demonstrates that the conditions of extreme social isolation and reduced environmental stimulation found in the Pelican Bay SHU will likely inflict some degree of psychological trauma upon most inmates confined there for more than brief periods. Clearly, this impact is not to be trivialized; however, for many inmates, it does not appear that the degree of mental injury suffered significantly exceeds the kind of generalized psychological pain that courts have found compatible with Eighth Amendment standards.[33]

Henderson did find that for the group of prisoners who were mentally ill or had a history of prior psychiatric problems, placement in the SHU did constitute an Eighth Amendment violation.

> For these inmates, placing them in the SHU is the mental equivalent of putting an asthmatic in a place with little air to breathe. The risk is high enough, and the consequences serious enough, that we have no hesitancy in finding that the risk is plainly "unreasonable." Such inmates are not required to endure the horrific suffering of a serious mental illness or major exacerbation of an existing mental illness before obtaining relief.[34]

Almost twenty years later, in 2011, thousands of prisoners in California went on a hunger strike protesting the conditions at the Pelican Bay SHU and other SHUs around the state. That hunger strike garnered national and international attention and eventually led to a class action lawsuit claiming that incarceration at Pelican Bay for more than ten years was cruel and unusual punishment in violation of the Eighth Amendment.[35] Some of the same prisoners who were at Pelican in the early 1990s were still there in 2011 and were named plaintiffs in the new class action lawsuit.[36]

California responded to the lawsuit by arguing that Judge Henderson had already ruled that the type of psychological pain and suffering that the ordinary, non–mentally ill prisoner suffered at Pelican Bay did not rise to the level of a constitutional violation, and that only harm that resulted in serious mental illness or attempted suicide would be actionable. None of the ten named plaintiffs in the new *Ashker v. Governor* were mentally ill, although they all claimed serious psychological harm. Moreover, they argued that Judge Henderson's ruling had been based on a record of prisoners who had spent two to three years at Pelican Bay, and that he had specifically left open the possibility that more prolonged stays in solitary confinement might violate the Constitution. Henderson could "not begin to speculate on the impact that Pelican Bay SHU conditions may have on inmates confined in the SHU for periods of 10 or 20 years or more; the inmates studied in connection with this action had generally been confined to the SHU for three years or less."[37] Judge Claudia Wilken, who was assigned to hear *Ashker*, rejected California's motion to dismiss the lawsuit, finding it was not precluded by Judge Henderson's decision in *Madrid v. Gomez*.[38]

While *Ashker* proceeded, the plaintiffs still faced the substantial hurdle set by Henderson and other cases that generalized psychological pain such as depression, paranoia, lack of concentration or memory, anger, and hallucinations was insufficient, at least if suffered for only several years, to constitute cruel and unusual punishment. The plaintiffs' team had included top notch psychological experts, one of whom, psychologist Craig Haney, had also testified in the *Madrid* case. Moreover, the plaintiffs' psychological harms seemed even more profound than those recognized in *Madrid* and, the team felt, ought to have been sufficient to establish an Eighth Amendment violation. Nevertheless, the law's general discounting of psychological harm and the Supreme Court's reluctance to recognize familiar modes of punishment as cruel and unusual precluded complacency.

The law concerning prisoners, like the torts jurisprudence discussed above, tends to discount psychological pain and suffering, as did Judge Henderson. While the courts have recognized that psychological harm inflicted by prison officials can constitute an Eighth Amendment violation, Congress enacted a statute, the Prison Litigation Reform Act, that precludes prisoners who suffer constitutional violations from being awarded damages unless they can show that they have suffered

"physical injury" and not purely mental harm.[39] Thus, for example, the Eleventh Circuit Court of Appeals dismissed a damages claim in which prison officials had "ordered prisoners to strip naked, and performed body cavity searches while members of the opposite sex were present; . . . made harassing comments to an inmate because of his perceived sexual orientation; and ordered one prisoner to 'tap dance' while naked."[40] So too, while some courts have held that rape or other sexual assaults constitute a physical injury within the meaning of the Prison Litigation Reform Act, several courts have held that "the bare allegation of sexual assault" does not constitute a physical injury under the statute.[41] Furthermore, when the Senate ratified the Convention on the Prevention of Torture, it added a reservation that mental harm would not count as torture unless it fell within certain narrowly circumscribed exceptions.[42] As it does with tort law, the United States treats mental pain as a second-class citizen for purposes of the international law of torture.

Given the reluctance of the courts and Congress to fully recognize that the mental pain wrought by solitary confinement rises to the level of an Eighth Amendment violation, plaintiffs' counsel sought ways of bringing other sciences and social sciences to demonstrate the harm caused by such conditions. In this case, the science was brought to bear in support of a conclusion that seemed obvious. To hold a person in a small cell with no windows for twenty-three hours a day under crushing conditions of isolation for ten, fifteen, or twenty years must cause serious harm to that individual in a manner that civilized society should not tolerate. As one prominent court of appeals judge has noted, it seems "pretty obvious, that isolating a human being from other human beings year after year or even month after month can cause substantial psychological damage, even if the isolation is not total."[43] Or as Justice Kennedy wrote in a concurring opinion in a case that did not directly challenge the use of solitary confinement, "the human toll wrought by extended terms of isolation has long been understood and questioned by writers and commentators. . . . [R]esearch still confirms what this Court suggested over a century ago. Years on end of near total isolation exact a terrible price."[44]

The plaintiffs' use of neuroscience in the solitary confinement challenge was thus similar to the role neuroscience played in the Eighth Amendment challenge to the execution of juveniles, wherein the Court viewed scientific evidence not as an independent basis for decision, but as evidence that would tend to confirm the conclusion that prolonged solitary confinement caused serious mental and physical harm to the brain to a degree prohibited by the Constitution. As the Court noted in the juvenile death penalty case *Roper v. Simmons*, in distinguishing between adults and juveniles, "as any parent knows, and as scientific and sociological studies respondent and his amici cite tend to confirm, 'a lack of maturity and underdeveloped sense of responsibility are found in youth more often than in adults, and are more understandable among the young.'"[45]

Using neuroscience in the prisoner context, however, faced substantial obstacles. The most important was that neuroscientists had never studied the brains of prisoners and, therefore, no studies directly on point existed. Moreover, the possibility that neuroscientists could do significant scientific studies of the Pelican Bay prisoners was remote. To demonstrate conclusively that solitary confinement alters the brain, a study would have to use one of two types of design. The optimal design would be longitudinal and would require gathering baseline brain imaging data on prisoners before they were placed in solitary confinement followed by periodic testing

to ascertain changes in brain structure and function. To be certain that such changes were associated with isolation and not with prison life in general, similar observations of well-matched control subjects (of similar age, sex, mental ability, and ideally criminal offense history) would have to be taken over the same period of time. An additional control group of subjects equally well-matched on crucial variables but not incarcerated would also be useful since this would enable the parsing of the effects of the general stress of prison life from the additional impact of social isolation, physical inactivity, and other distresses of solitary housing. Absent the basal data, a less optimal cross-sectional design could be used, but it would require a larger number of prisoners in order to enable either the two-way or three-way comparison.

Not only would the cost of doing such a study be massive and untenable for a public interest lawsuit, but even if the necessary funds could be raised, prison officials do not allow scientists into the prison to do studies, and, absent an unlikely court order, the plan would not be workable. Thus, using neuroscience to aid the Court in understanding how prolonged solitary confinement affected the brain required drawing on extant knowledge and theory and extrapolating from what scientists know generally about the brain to the situation in which these prisoners found themselves. This is a second-best solution, but the lawyers thought it would be nonetheless valuable to the Court, even though a more definitive study of the type sketched above was not possible for the purposes of *Ashker v. Brown*.

Despite these obstacles, the *Ashker* lawyers decided to make neuroscience evidence part of their core case for two reasons. First, the Supreme Court has held that to establish an Eighth Amendment violation, a prisoner must show that he or she has been deprived of some basic human need such as food, sleep, or exercise.[46] Court challenges to solitary confinement have sought to add social interaction to the list of basic human needs, and in some cases, have been successful.[47] Neuroscience could aid in establishing that the human brain requires social interaction with other people and, therefore, such interaction is a basic human need. In *Ashker*, the plaintiffs submitted an expert report from neuroscientist Matthew Lieberman, the director of the Social Cognitive Neuroscience Laboratory at the University of California, Los Angeles, and author of the award-winning book, *Social: Why Our Brains Are Wired to Connect*.[48] His declaration explained why social interaction is a basic human need on a par with sleep or exercise. The deprivation of that human need will not – unlike the deprivation of food – result in death in a short order, but like the deprivation of sleep or exercise, it will have very deleterious effects on both mental and physical health over time.

The second reason to introduce neuroscience evidence was to break down the divide between mental and physical pain. The research suggests that solitary confinement would produce physiological changes in the brain, harm that is therefore physical, potentially observable, and causes mental pain. As in the tort context, a demonstration of physiological harm would supplement the psychological research of the harm suffered by individuals who are denied social contact.

Ashker is but one of several cases in which neuroscience has been used to challenge prolonged solitary confinement. As already mentioned, the *Ashker* plaintiffs introduced Lieberman's expert report to support their claims that solitary confinement causes serious mental and physical harms and deprives those confined of the basic human need of social interaction. Lieberman had never studied prisoners nor solitary confinement in state prisons, but he

applied his general research on the effects of social isolation on the brain to the Pelican Bay context.

Lieberman started his report with the proposition that "it is considered settled science within the field of psychology that humans and all mammals have a fundamental need for social connection."[49] Lieberman then described the neuroscientific contribution to understanding social connection as a basic need. He summarized that

> the brain has a neural system that registers various kinds of physical pain – each linked to a potential survival threat (loss of food, water, shelter). . . . My lab and others have observed that when individuals are in a socially deprived state, they experience *social pain* and this produces neural activity consistent with it being a form of pain.[50]

To Lieberman, his neuroscience research, along with the work of others, provides compelling evidence that the social pain of isolation involves "the same neural and neurochemical processes invoked during physical pain."[51] Indeed, fMRI studies that he conducted in collaboration with psychologist Naomi Eisenberger demonstrated that when people were subjected to social isolation, it affected neural activity in certain cortical regions of the brain associated with physical distress, in the same way physical pain would. Lieberman's study has been replicated dozens of times in labs around the world. Lieberman concluded that the social pain caused by isolation is not metaphorical pain, but has a physical effect on brain activity causing the brain to signal distress.[52]

The Amicus Curiae Brief of Medical and other Scientific and Health Related Professionals filed in the United States Supreme Court case of *Ziglar v. Abbasi* also used neuroscience studies to support the proposition that solitary confinement causes both serious psychological and physical harm.[53] The brief cites coauthor Huda Akil for the proposition that neuroscience studies suggest that solitary confinement can "fundamentally alter the structure of the human brain in profound and permanent ways."[54] Akil's view reflects the knowledge that the human brain, like all mammalian brains, alters its structure and functioning based on stimuli from its environment. This process, termed "neuroplasticity," subsumes several mechanisms, including changes in branching or arborization of neurons to enable new connections to neighboring brain cells, changes in activity of certain brain circuits, and, in specialized brain regions, changes in the rate of birth of new neural cells that become embedded in critical circuits.

One region that is very "plastic" is the hippocampus (or seahorse, due to its shape). The hippocampus plays a critical role in handling the interface of the individual with the external world by mapping the physical environment in three dimensions: it sets the level of emotional reactivity and anxiety, it encodes stressful events and controls the body's response to stressors, and it plays a primary role in encoding memories of recent events and determining whether they are destined for long-term storage elsewhere in the brain. These changes are typically adaptive in that they enable the individual to assess a context (physical and emotional), react to it appropriately, and remember it and anticipate future responses. But under conditions of severe and sustained stress, the hippocampus loses this neuroplasticity: it physically shrinks, the rate of birth of new cells diminishes or ceases, the arbors regress, and the opportunity for contacts with neighboring cells decreases. It is therefore not surprising that this brain region begins to fail in its functioning, with loss of emotional and stress control, loss of stress regulation, sometimes defects in memory, spatial orientation, and other cognitive processes, and in extreme cases, last-

ing changes in mood, including severe depression. Moreover, since the brain is highly interconnected, this is but one node of many changes that propagate across the brain and greatly diminish the individual's affective and cognitive functions, resulting in long-term deficits in each.

As argued by Akil in the context of the *amicus* brief, each of the key features of solitary confinement – lack of meaningful interaction with others and the natural world and lack of physical activity and visual stimulation – "is by itself sufficient to change the brain . . . dramatically depending on whether it lasts briefly or is extended."[55] As noted in the brief, many neurobiological studies "reveal that certain regions of the brain of people who experience extreme psychological stress (like those in solitary confinement) literally diminish in volume because the neural cells become shriveled."[56]

A large body of animal studies strongly supports the notion of altered neuroplasticity as a result of an impoverished environment. In a Canadian case, challenging prolonged solitary confinement in British Columbia, the lawyers sought to introduce an expert report from neurologist and animal behavior scholar Michael Zigmond, who noted that the rats and mice that he studies have 99 percent of the same genes as humans and that the basic neuroanatomy of the mouse parallels that of humans.[57] Zigmond reports that his and other studies demonstrate that when mice and rats are randomly grouped into two different environments, one that is enriched with lots of activities and another that is isolated, the rodents in the isolated environment show "enormous differences," such as a "decrease in the anatomical complexity of the brain (including fewer connections between nerve cells and even fewer nerve cells) and a decrease in the number of blood vessels in the brain."[58] These animals also show differences in learning and memory, as well as susceptibility to a range of diseases that emulate human diseases such as Alzheimer's disease, Parkinson's disease, and strokes.[59]

Zigmond concludes that "some of these effects are undoubtedly related to one or more of the biochemical effects of isolation, which include a decrease in the concentration of 'neurotrophic factors' or growth factors that are responsible for the repair of neurons should they begin to atrophy."[60] A key neurotrophic factor is brain-derived neurotrophic factor (BDNF), which modulates diverse functions including learning, memory, navigation, and mood. Similarly, Zigmond has reported that isolation decreases the synthesis of the neurotransmitter dopamine, which is critical for motor function and reward, and the capacity to reduce inflammation and oxidative stress.[61]

Zigmond's most recent and in-depth study showed that brains of isolated rodents have smaller neurons, with fewer branches in the hippocampus and cerebral cortex regions, which affect learning, memory, and executive brain functions.[62] The one region that does show more activity is the amygdala, which mediates fear and anxiety, symptoms reported by human prisoners confined in solitary.

Mice and rats, of course, are not humans, and therefore these studies do not prove that human brains are affected in the same ways as those of rodents.[63] Nonetheless, there are similarities, and the fact that rodents and other mammals react to isolation in a manner that affects their brain functions is some evidence that the human brain is likely to be similarly affected. Thus, this body of work by neuroscientists is not dispositive. But, paraphrasing Justice Kennedy's observation in *Roper v. Simmons*, this research tends to confirm what common experience and years of psychological studies teach us: that prolonged solitary confinement can cause both serious psychological and physiological harm.

One would think it self-evident from a purely ethical perspective that placing a person in a small cell for twenty-three hours a day with very limited or no social contact for years, and sometimes for decades, should not be permitted in civilized society. However, the law requires evidence that such treatment would cause serious harm, and it is in this domain that neuroscience can play an important role in the legal struggle against prolonged solitary confinement. As discussed above, neuroscience is potentially relevant not just to this but to a wide range of other legal issues because an underappreciated and often overlooked contribution that neuroscience can bring to the law is to break down the division that currently exists between physiological and psychological harm and between physical and mental injury. Neuroscience challenges the law's long-unchallenged assumption that most mental suffering is inescapably subjective. Proceeding from the obvious truth that the brain is a physical organ, neuroscience can show empirically and explain theoretically that the brain both regulates and is profoundly affected by mental harm and suffering.

As the interface between neuroscience and the law evolves, several challenges are likely to emerge. While we have underscored the value of neuroscience in providing scientific support for commonsense notions, there will likely be situations in which the opposite happens. Science teaches us that, on occasion, what seem to be obvious truths are incorrect. An example is the widely held belief that children are intrinsically resilient, that they will not remember early life trauma, that they will simply not encode the stress, or that they will readily forget it. However, neurobiological evidence clearly shows that early-life traumatic events, especially if repeated, can produce a lasting deleterious effect on the individual that will manifest later in life. Societal views, as well as legal thought, will likely need to be modified to incorporate such insights.

Moreover, when neuroscience accords with common sense, it may nonetheless provide novel perspectives that may be impactful on legal decisions and legal thought. For example, neuroscience has validated the importance of so-called critical periods during human development when major epigenetic, cellular, and molecular reprogramming can take place in response to environmental conditions, but it has also shown that such key periods are not confined to early childhood. One key period occurs during adolescence. As additional biological evidence accumulates, it will be important for the law to contemplate the implications of such a major biological upheaval, both in understanding human behavior and in dealing with it from a legal standpoint.

Another major challenge stems from the fact that neurobiological changes are rarely binary. Rather, they are incremental, reflecting processes that may wax and wane, and the threshold at which a change becomes deleterious can be difficult to discern. For example, as described above, stress remodels the brain. Some level of remodeling is adaptive and enables coping with further stress, but chronic or severe stress becomes maladaptive, leading to neural damage. However, the point at which a change is likely to be damaging rather than helpful is unclear and varies as a function of the preexisting vulnerability or resilience of any given individual. Moreover, as tools and techniques in neuroscience evolve, our ability to detect changes will improve.

The existence of these continua is not readily compatible with legal formalisms that may classify matters in more binary ways. An example is the notion of competency. As neuroscientists develop more robust biomarkers of cognitive function, it may be possible to detect loss of competency in some functions (such as recall

of recent events) coexisting with maintenance of competency in other brain functions (such as recall of distant events or moral judgment). This may push legal thought toward a more nuanced definition of competency or facets thereof, informed by scientific knowledge.

Our thinking about the ethical, philosophical, and legal implications that arise from the explosion in neuroscience knowledge is in its infancy. It is clear, however, that ongoing discourse between the disciplines will profit both the science and the law, framing questions in interesting ways for the neuroscientist and challenging legal professionals to amend old or develop new conceptual frameworks.

ENDNOTES

[1] Jeffrey Rosen, "The Brain on the Stand," *The New York Times Magazine*, March 11, 2007; Greg Miller, "The Brain Gets Its Day in Court," *The Atlantic*, March 1, 2016; and Nita A. Farahany, "Neuroscience and Behavioral Genetics in U.S. Criminal Law: An Empirical Analysis," *Journal of Law and the Biosciences* 2 (3) (2015): 485–509.

[2] Owen D. Jones, René Marois, Martha J. Farah, and Henry T. Greely, "Law and Neuroscience," *The Journal of Neuroscience* 33 (45) (2013): 17624–17630.

[3] Ibid. See also Owen D. Jones, Jeffrey D. Schall, and Francis X. Shen, eds., *Law and Neuroscience* (New York: Aspen Publishers, 2014).

[4] Shaun Cassin, "Eggshell Minds and Invisible Injuries: Can Neuroscience Challenge Longstanding Treatment of Tort Injuries?" *Houston Law Review* 50 (3) (2013): 929–962; Betsey G. Jones, "The Future of Emotional Harm," *Fordham Law Review* 83 (5) (2015): 2605–2653 [neuroscientific demonstrations that emotional injury occurs with physiological injuries to the brain have begun to impact the legal landscape]; and *Allen v. Bloomfield Hills School District* 760 N.W. 2d 811, 812 (Mich. Ct. App. 2008) [using neuroscientific evidence (a PET scan) to hold that the tort bodily injury requirement was met by injury to the brain].

[5] See Matthew D. Lieberman, expert report, submitted in *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-CW (N.D. Cal. 2014), https://ccrjustice.org/sites/default/files/attach/2015/07/Lieberman%20Expert%20Report.pdf. See also Craig Haney, Michael Zigmond, Jules Lobel, and Robert King, "Neuroscience in Policy: Solitary Confinement in California," panel at Law and Neuroscience Conference 2017, University of California, San Francisco, and University of California, Hastings, February 16–17, 2017, http://www.ucconsortium.org/events/law-neuroscience-conference-2017/. *Ashker v. Governor* Case No. 4:09-cv-05796-CW was eventually settled in September 2015 in an agreement to release virtually all of the thousands of prisoners being held in indeterminate solitary confinement in California. Ian Lovett, "California Agrees to Overhaul Its Use of Solitary Confinement," *The New York Times*, September 1, 2015.

[6] Jones et al., "Law and Neuroscience," 17624 [see note 2].

[7] David Faigman, "Review: Law and Neuroscience," *Jurimetrics Journal* 56 (2) (2016): 197–200.

[8] Steven J. Morse, "Criminal Law and Common Sense: An Essay on the Perils and Promise of Neuroscience," *Marquette Law Review* 99 (1) (2015): 39–74.

[9] Erin Murphy, "Neuroscience and the Civil/Criminal *Daubert* Divide," *Fordham Law Review* 85 (2) (2016): 619, 629.

[10] *Roper v. Simmons*, 543 U.S. 551, 569 (2004).

[11] Morse, "Criminal Law and Common Sense" [see note 8].

[12] Murphy, "Neuroscience and the Civil/Criminal *Daubert* Divide," 630 [see note 9].

[13] David L. Faigman, Christopher Slobogin, and John Monahan, "Gatekeeping Science: Using the Structure of Scientific Research to Distinguish Between Admissibility and Weight in Expert Testimony," *Northwestern Law Review* 110 (4) (2016): 859 – 904.

[14] Ibid., 887 – 890.

[15] Betsey J. Grey, "Neuroscience and Emotional Harm in Tort Law: Rethinking the American Approach to Free-Standing Emotional Distress Claims," *Law and Neuroscience* 13 (2011): 203.

[16] See Jones et al., "Law and Neuroscience," 935 [see note 2]; and Grey, "Neuroscience and Emotional Harm in Tort Law" [see note 15].

[17] *Hawes v. Germantown Mutual Insurance Company*, 309 N.W. 2d 356, 360 (Wis. Ct. App. 1981).

[18] American Law Institute, *Restatement of the Law Third – Torts: Liability for Physical and Emotional Harm* (Philadelphia: American Law Institute, 2009), Section 4, Comment B ["the definition of bodily harm is meant to preserve the ordinary distinction between bodily harm and emotional harm"].

[19] Ibid., chap. 8, scope, sec. 45 – 48.

[20] Karen D. Davis, Herta Flor, and Henry T. Greely, et al., "Brain Imaging Tests for Chronic Pain: Medical, Legal and Ethical Issues and Recommendations," *Nature Reviews Neurology* 13 (2017): 624 – 638; and A. C. Pustilnik, "Imaging Brains, Changing Minds: How Pain Neuroimaging Can Inform the Law," *Alabama Law Review* 66 (5) (2015): 1099 – 1158.

[21] Alexander J. Shackman, Tim V. Salomons, and Heleen A. Slagter, et al., "The Integration of Negative Affect, Pain and Cognitive Control in the Cingulate Cortex," *Nature Reviews Neuroscience* 12 (2011): 154 – 167.

[22] *Allen v. Bloomfield Hills School District* 760 N.W. 811, 812 (Mich. Ct. App. 2008).

[23] Ibid., 815 – 817.

[24] Ibid.

[25] Ibid., 816.

[26] Sarah Baumgartel, Corey Guilmette, and Johanna Kalb, et al., "Time-in-Cell: The ASCA-Liman 2014 National Survey of Administrative Segregation in Prison," Public Law Research Paper No. 552 (New Haven, Conn.: Yale Law School, 2015).

[27] Keramet Reiter, *23/7: Pelican Bay Prison and the Rise of Long-Term Solitary Confinement* (New Haven, Conn.: Yale University Press, 2016).

[28] Complaint in *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-CW (N.D. Cal., 2014), https://ccrjustice.org/sites/default/files/assets/Ruiz-Amended-Complaint-May-31-2012.pdf.

[29] *Madrid v. Gomez*, 889 F. Supp. 1146 (N.D. Cal. 1995).

[30] Ibid., 1229.

[31] Ibid.

[32] Ibid., 1231 – 1235.

[33] Ibid., 1265.

[34] Ibid., 1265 – 1266.

[35] See, for example, Lovett, "California Agrees to Overhaul Its Use of Solitary Confinement" [see note 5].

[36] In *Ashker v. Governor*, Todd Ashker, Danny Troxell, and Ronald Dewberry were named plaintiffs who had been at the Pelican Bay SHU since the *Madrid* case was tried.

[37] *Madrid v. Gomez* quoted in Reiter, *23/7*, 1257 [see note 27].

[38] Decision and Order on Defendants' Motion to Dismiss in *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-CW (N.D. Cal., 2014), 10, https://ccrjustice.org/sites/default/files/assets/Order%20Denying%20Motion%20to%20Dismiss%204.9.13.pdf.

[39] Prison Litigation Reform Act of 1995, Pub. L. No. 104-134, § 803(d), 110 Stat. 1321 (1996), codified as 42 U.S.C. § 1997e(e).

[40] *Harris v. Garner*, 190 F. 3.d 1279, 1282 (11th Cir. 1999).

[41] *Hancock v. Payne*, No. Civ.A.1.03CV671JMRJMR, 2006 WL 21751, at *3 (S.D. Miss. January 4, 2006); and *Smith v. Shady*, No. 3:CV-05-2663,2006 WL 314514, at *2 (M.D. Pa. February 9, 2006). See Margo Schlanger and Giovanna Shay, "Preserving the Rule of Law in America's Jails and Prisons: The Case for Amending the Prison Litigation Reform Act," *University of Pennsylvania Journal of Constitutional Law* 11 (1) (2008): 139–154.

[42] U.S. Senate Resolution of Advice and Consent to Ratification of the Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, 138 Cong. Rec. S17486-01 01 (daily ed. October 27, 1990).

[43] *Davenport v. DeRobertis*, 844 F.2d 1310, 1313 (7th Cir. 1988).

[44] *Davis v. Ayala*, 135 S.Ct. 2187, 2209-10 (2005).

[45] *Roper v. Simmons*, 543 U.S. 551, 569 (2004). Emphasis added.

[46] *Wilson v. Seiter*, 504 U.S. 294, 304 (1991).

[47] See, for example, *Wilkerson v. Stadler* 639 F. Supp. 2. 654 (M.D. La. 2007).

[48] Lieberman, expert report [see note 5].

[49] Roy F. Baumeister and Mark R. Leary, "The Need to Belong: Desire for Interpersonal Attachment as a Fundamental Human Need," *Psychology Bulletin* 117 (3) (1995), quoted in Lieberman, expert report, 2 [see note 5].

[50] Ibid., 5.

[51] Ibid., 6.

[52] Ibid., 8–9.

[53] 582 U.S. ___(2017). *Ziglar* challenged the conditions under which certain alien arrestees were held in custody following 9/11, including solitary confinement in tiny cells for more than twenty-three hours a day, often in shackles, for as long as eight months. The case, however, was eventually decided on technical legal grounds relating to whether the defendants could be sued for damages under relevant Supreme Court precedent. Thus, the neuroscience arguments advanced by *amici* played no role in the decision, though the arguments further illustrate the relevance of neuroscientific evidence to litigation over conditions of confinement. Supreme Court of the United Sates, "Brief of Medical and Other Scientific and Health-Related Professionals as *Amici Curiae* in Support of Respondents and Affirmance," *Ziglar v. Abbasi*, No. 15-1358, December 23, 2016.

[54] Supreme Court of the United Sates, "Brief of Medical and Other Scientific and Health-Related Professionals as *Amici Curiae* in Support of Respondents and Affirmance," 24–25 [see note 53].

[55] Kate Allen, "Researchers Study Effects of Prolonged Isolation Among Prisoners," *The Toronto Star*, February 14, 2014, quoted in ibid., 25.

[56] Supreme Court of the United Sates, "Brief of Medical and Other Scientific and Health-Related Professionals as *Amici Curiae* in Support of Respondents and Affirmance," 25 [see note 53].

[57] See Expert Report of Michael J. Zigmond, *British Columbia Civil Liberties Association and the John Howard Society of Canada v. Attorney General of Canada*, SCBC Vancouver Registry No. S-150415 (February 22, 2017), 2 [report was rejected by the Canadian Court and not admitted into evidence]. See also Ramin Skibba, "Solitary Confinement Screws Up the Brains of Prisoners," *Newsweek*, April 18, 2017.

[58] Zigmond, "Isolated Housing of Non-Human Animals," 7 – 8 [see note 57].

[59] Ibid., 8.

[60] Ibid.

[61] Ibid.

[62] Skibba, "Solitary Confinement Screws Up the Brains of Prisoners," 52 [see note 57].

[63] Indeed, the Canadian Court rejected the Zigmond declaration on the grounds that animal-based evidence could not be extrapolated to humans.