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Neurobiology, Neuroimaging, and Free Will

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INTRODUCTION

Advances in the theoretical and clinical neurosciences have shed considerable light on the neurobiological correlates of our thought and behavior. In particular, brain imaging in the form of computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), and functional magnetic resonance imaging (fMRI) can display the structure and function of the brain regions that regulate our capacity for impulse control, reasoning, and decision-making. PET and fMRI scans are especially significant because they can display real-time brain function by measuring changes in glucose metabolism and blood flow in specific brain regions.[1] These techniques can measure activity in the cerebral cortex while subjects are engaged in cognitive tasks. They can also measure activity in subcortical areas associated with emotions when subjects are shown photos of people or events.

Although our motivational states may not be reducible to, or explained entirely in terms of, the physical properties of the brain, they are generated and sustained by the brain. Neuroimaging can reveal much of what goes on in the brain when we reason, choose, and act. It can also reveal neurobiological abnormalities that might explain impairment in the capacity to respond to prudential and moral reasons, form intentions, and execute intentions in decisions and actions. Insofar as this capacity is necessary for one to control one's behavior, and control of one's

1. See, for example, G. K. Aguirre, "Functional Neuroimaging," in Todd Feinberg and Martha Farah, eds., *Behavioral Neurology and Neuropsychology*, second edition (New York: McGraw-Hill, 2003): 363–73, and Martha Farah and Paul Root Wolpe, "Monitoring and Manipulating Brain Function: New Neuroscience Technologies and Their Ethical Implications," *Hastings Center Report* 34 (May–June 2004): 35–45.

behavior is necessary for one to have free will and be responsible for what one does or fails to do, brain imaging may be a helpful tool in determining whether persons have free will and can be held morally and legally responsible for their behavior. Depending on what imaging techniques show about the brain, and how we interpret these images, they could influence moral and legal judgments about culpability, blame, and excuse.

I will explore possible uses and examine actual uses of diagnostic brain imaging in cases where individuals have committed violent offenses or have been accused of culpable omissions. This will include discussion of whether structural or functional abnormalities in regions of the brain that regulate our ability to reason, choose, and act can excuse individuals with these abnormalities from responsibility for their actions. I will pay particular attention to what images of the brain might tell us about how much control people have over their thought and behavior, discussing whether empirical data from diagnostic neuroimaging could influence traditional criteria of free will and responsibility and lead to a better understanding of these concepts.

TRADITIONAL ACCOUNTS

Much of the historical and contemporary debate on free will has centered on the idea of alternative possibilities. Incompatibilists argue that free will requires the ability to do otherwise, which requires that alternative possible courses of choice and action be open to us. These alternative possibilities are incompatible with causal determinism, which says that laws of nature and events in the past jointly entail a unique future. This means that any action one performs at a particular time is the only action one could have performed at that time. But our deep-seated conviction that we are the ultimate authors of our actions who act freely in virtue of our ability to choose among alternative courses of action suggests that causal determinism is false.[2] This is the libertarian version of incompatibilism, as distinct from the hard incompatibilist view we do not have free will because causal determinism is true. In contrast, compatibilists argue that free will does not require traditionally conceived alternative possibilities of choice and action. They generally hold that one acts freely and responsibly when one chooses and acts in accord with one's autonomous motivational states in the absence of coercion or compulsion.[3] These motivational states are autonomous in the sense that one generates them on one's own and identifies with them after a period of critical reflection. Any alternative possibilities are internal rather than external to the agent. They are a

2. The most prominent defenders of libertarian incompatibilism have been Peter van Inwagen, *An Essay on Free Will* (Oxford: Clarendon Press, 1983), and Robert Kane, *The Significance of Free Will* (New York: Oxford University Press, 1996).

3. The most prominent defenders of compatibilism have been Harry Frankfurt, "Responsibility and Alternate Possibilities," and "Freedom of the Will and the Concept of a Person," both in *The Importance of What We Care About* (New York: Cambridge University Press, 1989): 1–10, 11–25, John Martin Fisher, *The Metaphysics of Free Will: An Essay on Control* (Cambridge, MA: Blackwell, 1994), and Fischer and Mark Ravizza, *Responsibility and Control: A Theory of Moral Responsibility* (New York: Cambridge University Press, 1998).

function of different combinations of an agent's desires, beliefs, intentions, decisions, and the different actions to which they can lead, not of states of affairs that an agent can only actualize in accord with natural laws and the past. In this regard, causal determinism is compatible with free will and responsibility.

This conception of free will is consistent with the evolutionary account of freedom recently defended by Daniel Dennett.[4] He claims that, as humans evolved, they developed the ability to speculate about the future, to consider possible threats that jeopardize their interests and plans, and to choose and act in ways that enable them to avoid these threats. The human brain has developed in a way that supports this mental ability. Dennett calls this "evitability," and it confers an evolutionary advantage on humans by promoting and enhancing their survival. This account is compatible with causal determinism because it says that the ability to plan, choose, and act in different ways is not threatened by laws of nature and events in the past.

The weaker, compatibilist account of free will that I have just outlined can be traced to Aristotle. In the *Nicomachean Ethics*, Aristotle presents the default assumption that a person acts freely (voluntarily) and is responsible for his behavior barring evidence of compulsion, coercion, or ignorance of the circumstances of action.[5] The first two of these conditions can be described as metaphysical, or freedom-relevant, conditions, while the third can be described as an epistemic, or knowledge-relevant, condition. On the Aristotelian model, free will in the broad sense requires that all of these negative conditions be met. Each condition is necessary but not sufficient; all of them are jointly necessary and sufficient for the freedom of thought and action required for one to be responsible. A more recent model formulates free will and responsibility in positive terms as the capacity to respond to reasons for or against certain actions.[6] The reasons are not just prudential but also moral, in the sense that they involve social expectations about what we should or should not do in performing actions that can affect others. The idea of reasons-responsiveness as a necessary condition of free will and responsibility can be plausibly construed as an extension of Aristotle's account. This is because the capacity to respond appropriately to reasons presupposes the capacity for appropriate beliefs about the circumstances of action. It also presupposes the capacity to have or form desires, beliefs, and emotions, and to execute these motivational states by acting in an uncoerced and uncompelled way.

These conative, cognitive, and affective capacities are all necessary for one to be responsible for one's behavior. A person can be excused from responsibility for his behavior when any one of the three conditions—coercion, compulsion, ignorance—described by Aristotle is present. It is important to emphasize that I

4. *Freedom Evolves* (New York: Viking, 2003). This work follows Dennett's earlier defense of compatibilism in *Elbow Room: The Varieties of Free Will Worth Wanting* (Cambridge, MA: MIT Press, 1984).

5. *The Complete Works of Aristotle*, Volume II, Book III, J. Barnes, trans. and ed. (Princeton: Princeton University Press, 1984). H. L. A. Hart proposes a similar default position in *Punishment and Responsibility* (Oxford: Clarendon Press, 1968).

6. Fischer and Ravizza discuss different versions of reasons-responsiveness in *Responsibility and Control*, especially chapters 2 and 3.

am describing a capacity-theoretic conception of free will and responsibility. It requires only that persons have the relevant mental capacities, not that they exercise them in every instance. Moreover, some people possess these capacities in varying degrees, suggesting that free will and responsibility may be matters of degree falling along a spectrum of control.[7] The Aristotelian model can be helpful in framing the general question of whether individuals with abnormal brain features have impaired capacity for control of thought and behavior. This in turn will help to address the question of how free they are in acting and how responsible they can be for what they do or fail to do. Framed in this way, free will is not about causal determinism but rather the relation between the mind and the brain. I will present hypothetical and actual cases to generate intuitions about free will with respect to impulse control, psychopathy, and memory. The first set of cases can be framed in terms of the Aristotelian metaphysical condition, while the last case can be framed in terms of the Aristotelian epistemic condition. Analysis of some forms of diagnostic brain imaging can test our intuitions about what it means to be free and responsible agents.

IMPULSE CONTROL, PSYCHOPATHY, AND FORGETTING

Suppose that one person kills another in a fit of rage and is charged with second-degree murder. The offender claims that his action resulted from a violent impulse he could not control. Prosecution and defense agree that a brain scan could test the veracity of this claim. He agrees to undergo a PET scan, which shows abnormally low metabolic activity in the prefrontal cortex and abnormally high metabolic activity in the amygdala. The prefrontal cortex is the seat of executive functions and is crucial for rational planning and impulse control. The amygdala is the seat of emotional processing in the limbic system, which projects to the prefrontal cortex and interacts with it in modulating executive functions. The offender and his lawyer argue that his brain abnormality undermined his capacity for moral reasoning and impulse control at the time of the crime. To be morally and legally responsible for one's behavior, one must have the capacity to control that behavior, which includes the capacity to respond appropriately to reasons and to restrain impulses. Because the brain scan indicates that he lacked this capacity when he acted, he could not be responsible for killing his victim. He lacked free will and therefore should be excused on the basis of his brain abnormality.

Or suppose that a different person performs a similar act. His act does not result from a violent, uncontrolled impulse, but instead from lack of empathy for his victim and an inability to act in accord with social norms of behavior. An MRI scan shows reduced amygdaloid volume, a feature that has been associated with psychopathy, a disorder characterized by diminished or no capacity for empathy and remorse, as well as poor behavior controls. This individual also argues that his

7. Patricia Smith Churchland discusses the concept of free will as a capacity falling along a spectrum of control in "Feeling Reasons," in Antonio Damasio et al., eds., *The Neurobiology of Decision-Making* (New York: Springer-Verlag, 1996): 181–99, and in *Brain-Wise: Studies in Neurophilosophy* (Cambridge, MA: MIT Press, 2002), chapter 5.

brain abnormality and associated psychopathy are beyond his control and that he too lacked free will when he acted. Accordingly, he should be excused from responsibility for his action.

Would either of these defenses hold up in a court of law? How do these cases test our intuitions about free will and responsibility for our motivational states and actions? To respond to these questions, we need to consider what neuroimaging studies indicate about the neurobiological basis of thought and behavior. Although it is not always clear why certain brain structures and systems are dysfunctional, brain imaging may yield important insights into explaining why dysfunction at the neural level can lead to disturbances at the mental and behavioral level.

Neuroimaging studies of violent offenders conducted by Adrian Raine and Richard Davidson have shown hyperactivity in the amygdala and diminished activity in the prefrontal cortex when compared with images of the same brain regions of normal subjects.[8] In contrast, brain images of individuals who display psychopathic behavior have shown a smaller and less active amygdala. Some images of psychopaths have shown intact functioning of the prefrontal cortex. Others have shown contrary indications. For example, Antonio Damasio and colleagues have found that lesions in the orbitofrontal cortex (OFC) correlate with impulsive and antisocial behavior.[9] Despite appearing cognitively intact, individuals with damage in this region of the brain seem unable to conform to social norms when they act. Adults and children who sustained this damage presented with a syndrome resembling psychopathy. More recently, R. J. R. Blair has obtained similar results from imaging studies on a similar group of subjects.[10] Because the OFC receives extensive projections from and sends extensive projections to the amygdala, this might explain why the emotional deficiency of psychopaths impairs their ability to deliberate about and rationally choose between different possible courses of action. This ability is not simply one of cognition alone, but of cognition and emotion

8. Adrian Raine et al., "Reduced Prefrontal Gray Matter Volume and Reduced Autonomic Activity in Antisocial Personality Disorder," *Archives of General Psychiatry* 57 (2002): 119–27. Richard Davidson et al., "Dysfunction in the Neural Circuitry of Emotion Regulation—A Possible Prelude to Violence," *Science* 289 (2000): 591–94.

9. A. Damasio, H. Damasio, S. Anderson et al., "Impairment of Social and Moral Behavior Related to Early Damage in Human Prefrontal Cortex," *Nature Neuroscience* 2 (1999): 1032–37. See also R. J. Dolan, "On the Neurology of Morals," *Nature Neuroscience* 2 (1999): 927–29, Joshua Greene et al., "The Neural Bases of Cognitive Conflict and Control in Moral Judgment," *Neuron* 44 (2004): 389–400, and Ekhonen Goldberg, *The Executive Brain: Frontal Lobes and the Civilized Mind* (New York: Oxford University Press, 2002).

10. R. J. R. Blair and L. Cipolotti, "Impaired Social Response Reversal: A Case of 'Acquired Sociopathy'," *Brain* 123 (2002): 1122–41, Blair, "Neurobiological Basis of Psychopathy," *British Journal of Psychiatry* 182 (2003): 5–7, and K. A. Kiel et al., "Limbic Abnormalities in Affective Processing by Criminal Psychopaths as Revealed by Functional Magnetic Resonance Imaging," *Biological Psychiatry* 50 (2001): 677–84. These disorders fall within a larger general framework of mental illness. Dennis Charney and Eric Nestler (eds.) provide such a framework in *Neurobiology of Mental Illness*, second edition (Oxford: Oxford University Press, 2004), as does the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, Text Revision—DSM-IV-TR (Washington, D.C.: American Psychiatric Association, 2000).

working together.[11] In particular, the emotion of regret is critical to this counterfactual reasoning and is strongly associated with the feeling of responsibility. The OFC appears to be at the interface of emotion and cognition, mediating our capacity to experience regret and responsibility.[12] Damage to the OFC can impair or undermine this combined emotional-cognitive capacity, thus suggesting that people with orbitofrontal cortical lesions might not be able to control their behavior and be morally and legally responsible for it.

Damage to the ventromedial frontal cortex can result in a similar type of psychopathology. Neuroimaging showing reduced metabolic activity in this region of the cortex, together with hyperactivity in the anterior cingulate (a subcortical structure in the limbic system), has been observed in a class of individuals displaying inappropriate social behavior and blunted responses to fear-inducing stimuli.[13] Because of its interaction with the anterior cingulate, the ventromedial cortex regulates the emotions that color decision-making. This was the main brain area implicated in the well-known case of Phineas Gage.[14] A metal projectile penetrated Gage's skull and resulted in extensive damage to the ventromedial cortex of his brain as a consequence of an explosion during construction on the Rutland & Burlington Railroad in Vermont in 1848. Gage lost his capacity to restrain his impulses, conform to social norms of behavior, and rationally deliberate and plan for the future. Because factors beyond his control caused him to lose this capacity, and hence his ability to control his behavior, one could say that he no longer had free will. The neurobiological basis of his decision-making was so damaged, and his mental capacity for making decisions was so flawed, that he was no longer able to function effectively as a social being.

Imaging studies of people with obsessive-compulsive disorder (OCD) suggest similar judgments about free will and responsibility for people with severe forms of this disorder. Studies using fMRI of people with OCD have shown reduced metabolic activity in the ventromedial cortex and increased activity in subcortical motor regions.[15] These are manifestations of dysfunction in the orbitofrontal-subcortical circuit, whose member structures include the OFC, the caudate nucleus, globus pallidus, and thalamus, which plays a critical role in the processing of sensory input. People with OCD feel that they must do certain

11. Antonio Damasio has presented compelling evidence for the inseparability of cognition and emotion in rational and moral decision-making in *Descartes' Error: Reason, Emotion, and the Human Brain* (New York: Grosset/Putnam, 1994), and *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (New York: Harcourt, 1999).

12. Nathalie Camille et al., "The Involvement of the Orbitofrontal Cortex in the Experience of Regret," *Science* 304 (2004): 1167–70.

13. Nancy Andreasen, "Linking Mind and Brain in the Study of Mental Illness: A Project for Scientific Psychopathology," *Science* 275 (1997): 1586–1593. Henrik Walter cites and elaborates on this study in his *Neurophilosophy of Free Will*, trans. Cynthia Klohr (Cambridge, MA: MIT Press, 2001), 282–83.

14. Damasio describes this case in considerable detail in *Descartes' Error*, chapter 1.

15. See, for example, L. E. Baxter et al., "Caudate Glucose Metabolism Rate Changes with both Drug and Behavior Therapy for Obsessive Disorder," *Archives of General Psychiatry* 49 (1992): 687–98. Cited by Walter in *Neurophilosophy of Free Will*, 292.

things, or that they must think certain thoughts, though they claim that they do not want to have these feelings and thoughts and often desperately try to fight them. One hypothesis for the disorder is that a "worry input" in the frontal lobes projects to the basal ganglia via the ventromedial cortex. The ganglia's reduced filter function impairs the sensory filtering function of the thalamus, producing abnormal sensory processing that disrupts other brain systems. Another hypothesis is that the obsessions and compulsions are due to a dysfunctional cingulate, which disrupts normal cognitive and emotional processing. This is the rationale for the psychosurgical procedure of cingulotomy to treat severe OCD. It involves altering the main pathway between the limbic system and the prefrontal cortex. The more general upshot is that, in severe cases at least, OCD impairs the cognitive and emotional processing necessary for one to choose and act freely.

All of the examples that I have presented thus far about impairment or loss of behavior control involve dysfunctional brain systems that previously functioned in a normal way. An argument for a lack of control of thought and behavior could also be given on the basis of immature development of the relevant structures and functions in the adolescent brain. In October 2004, the United States Supreme Court began reviewing the case of Christopher Simmons (*Roper v. Simmons*). At 17, Simmons and a friend robbed a woman, tied her up with an electrical cable and duct tape, and then threw her over a bridge to her death. Simmons was convicted of first-degree murder and sentenced to death by a Missouri court in 1994. But the Missouri Supreme Court dropped the death sentence in 2003, resentencing him to life in prison without parole. The state of Missouri then appealed to have the death penalty reinstated. In March 2005, the U.S. Supreme Court ruled that it is unconstitutional to impose the death penalty on individuals like Simmons who were under 18 at the time of their crimes.

The main argument against execution in this case is that, when Simmons committed the crime, the frontal lobe of his brain was not yet mature.[16] Presumably, this made him incapable of rational and moral decision-making and unable to restrain his impulse to kill. Because the frontal lobe is critical to the executive functions necessary to control thought and behavior, and because Simmons' frontal lobe was not yet fully developed, Simmons arguably was not capable of controlling his behavior and therefore was not responsible for his crime. This would seem to be enough to excuse him and overturn his conviction. MRI scans of children's and adolescents' brains show that the frontal lobe develops last of all brain regions and does not fully mature until around 21 years of age. Imaging studies involving these two groups generally indicate that different regions in a child's or adolescent's brain operate in a more localized way, with more activity in limbic areas associated with emotions such as fear and anger and less activity in the neocortex associate with reasoning. In contrast, adults have more distributed and collaborative interactions among different brain regions. While these interactions in the adult brain promote greater impulse control, the absence or immature development of these interactions makes impulse control more difficult for chil-

16. Mary Beckman describes and analyzes this case in "Crime, Culpability, and the Adolescent Brain," *Science* 305 (2004): 596–99.

dren and adolescents. Another explanation for the difference in the capacity for impulse and general behavior control between these age groups is that adults have more experience confronting situations requiring rational deliberation and decision-making. This enables them to cultivate strategies of choice and action that promote their short- and long-term best interests.

Consider now a case involving memory lapse that could meet the Aristotelian epistemic condition of excuse.[17] Carrie Engholm was a hospital administrator. She drove to work one morning with her young son and daughter in the back of her van. She was not accustomed to taking her daughter with her in the morning, however, and after dropping off her son at day care drove to work, forgetting that her daughter was in the van. She unwittingly left her in the van in the outdoor hospital parking lot on an extremely hot day while she worked. Unfortunately, her daughter was found dead from hyperthermia later that day.

Was Carrie responsible for not remembering? Was she responsible for not paying attention to events that day and for forgetting about her daughter? Initially charged with recklessness and brought to court, the judge ruled that she was not guilty, reasoning that forgetting is an involuntary process. But suppose that she had been charged with negligence or recklessness and was convicted for failing to exercise her capacity to remember. The hippocampus, which is part of the limbic system, is essential for the retrieval of episodic memory. This involves the ability to recall events we have experienced and is distinct from semantic memory of facts and procedural memory of motor functions such as riding a bicycle or driving a car. Functional MRI scans can show that a particular region of the hippocampus, the parahippocampal gyrus, is activated when people are asked to recall certain events.[18] Damage to this region could impair one's ability to recall having done certain things, such as leaving a child in a car. In principle, damage to Carrie Engholm's parahippocampal gyrus, displayed in an fMRI image showing significantly reduced metabolic activity in and blood flow to this part of the brain, could excuse her from any charge of responsibility or liability for her daughter's death. On the basis of this brain scan, one could argue that she lacked the capacity to recall the crucial event of leaving her daughter in the car.

In all of these cases, structural and functional abnormalities in the frontal lobe or limbic system, or immature development of these brain regions, can impair or even undermine the capacity for reasoning and decision-making. If this capacity is essential to control one's thought and behavior, and if the brain abnormalities I have described impair or undermine this capacity, then it appears that the

17. Here I closely follow Daniel Schacter's account of the Carrie Engholm case in his testimony before the President's Commission on Bioethics, Seventh Meeting, October 17, 2002, Session 3: *Remembering and Forgetting: Physiological and Pharmacological Aspects*. Transcript: 1–40, at 14–15. From http://www.bioethics.gov/transcripts/oct02/session3.html.

See also Schacter, *Searching for Memory: The Brain, the Mind, and the Past* (New York: Basic Books, 1996), and Endel Tulving and Martin Lepage, "Where in the Brain Is the Awareness of One's Past?" in Daniel Schacter and Elaine Scarry, eds., *Memory, Brain and Belief* (Cambridge, MA: Harvard University Press, 2000): 208–28.

18. See Tulving and Lepage, "Where in the Brain Is the Awareness of One's Past?" and Tulving, *Elements of Episodic Memory* (New York: Oxford University Press, 1983).

individuals in the cases I have presented lack this control. Furthermore, if control of one's thought and behavior is necessary for one to have free will and be responsible for what one does or fails to do, then presumably neuroimaging showing these abnormalities suggests that these individuals lack free will and cannot be responsible for their actions or omissions. The impulsive or immoral actions of a violent offender or psychopath, the compulsive behavior of a person with OCD, and the memory lapse of someone like Carrie Engholm would appear to meet Aristotle's metaphysical and epistemic excusing conditions. CT, PET, MRI, or fMRI scans showing structural and functional brain abnormalities correlating with these disorders would appear to confirm that their lack of control of their mental states, actions, and omissions, and hence their lack of free will, was due to something that had gone awry in their brains.

There are problems with these arguments, though. A structural or functional abnormality in, or immature development of, the prefrontal cortex, amygdala, or hippocampus by itself does not necessarily mean that individuals with these brain features lack or have impaired capacity for cognitive, conative, and affective control of their behavior. Images showing abnormalities in regions of the brain that subserve our desires, beliefs, reasons, intentions, decisions, and actions may serve to mitigate responsibility in some cases. But it is more difficult to defend the claim that brain imaging can show that individuals lack free will altogether and should be excused from responsibility for their behavior. In many cases, brain dysfunction alone will not explain violent or otherwise socially inappropriate behavior. If this is correct, then neuroimaging showing brain abnormalities by itself will not be sufficient to conclude that an individual could not control his motivational states and actions, lacked free will, and therefore could not be responsible for them. Let's now consider the shortcomings of brain imaging with respect to our understanding of free will. This will lead to a more realistic view of how useful brain scans might be in influencing our moral and legal practices of holding people responsible.

THE LIMITS OF NEUROIMAGING

Free will is often not an all-or-nothing capacity. Instead, it is a capacity that comes in degrees along a spectrum of control. At one end of the spectrum, persons are in complete control of their motivational states and actions and are completely responsible for what they do or fail to do. At the other end of the spectrum, persons have no control over their motivational states and actions and should be excused from responsibility for what they do or fail to do. But many cases of criminal or immoral behavior fall in a gray area between the two extremes. Just as there are degrees of the ability to restrain impulses or to respond to reasons when acting, there are degrees of control of behavior and of responsibility for it. Different people may possess the cognitive, affective, and conative capacities that lead to action in varying degrees.

There are no obvious problems in holding people responsible or excusing them at either end of the spectrum. When there are no abnormalities in neural processing, Aristotle's metaphysical and epistemic default conditions of voluntary action can be met, and we can safely assume that one can control one's mental states and behavior. When there are severe neurobiological abnormalities resulting in severely impaired executive functions, they would fail to meet the default conditions and provide strong reasons for saying that one could not control one's behavior. For example, the claim that a schizophrenic with full-blown psychosis and severe impairment of cognitive, affective, and conative capacities lacks control of his or her behavior would be supported when these mental impairments correlate with structural and functional abnormalities in the basal ganglia, prefrontal cortex, and hippocampus—regions of the brain that ordinarily regulate these mental capacities. A similar claim could be supported in the case of a person with severe OCD. The question of what these two conditions imply about behavior control could be analyzed by comparing brain scans of individuals with these conditions with scans of individuals with no impairment of mental capacity and normal brain structure and function.

Still, the hard cases are those that fall between the two extremes. An adolescent or adult with attention deficit/hyperactivity disorder (ADHD) may have difficulty controlling his impulses and attending to cognitive tasks. These behavioral features may correspond to neuroimaging showing abnormally high levels of the neurotransmitter dopamine in the cerebellum and temporal lobes, which are indicators of the disorder. But there can be considerable variation in the behavior of different people with the same disorder. It is not clear that these differences will be solely a function of subtle differences in the activity of neurons and neurotransmitters in the relevant brain regions. Nor will they alone tell us whether or to what extent someone with the disorder can execute his reasons, intentions, and decisions in the actions he wants to perform, or whether or to what extent he can be responsible for them.

Recall Christopher Simmons. The fact that an MRI scan showed that the frontal lobe regulating his executive functions was incompletely developed by itself could not explain why Simmons committed murder. His immature brain would not be enough to excuse him from moral and legal responsibility for his action. If all adolescents have immature frontal lobes, but not all adolescents commit violent acts, then saying that Simmons' frontal lobe was not fully developed when he committed the crime does not offer a convincing reason to excuse him. If a comparison between Simmons' brain at seventeen and the brains of many others of the same age could be made, then there might be some basis on which to argue that he lacked the capacity to control his impulse to kill and respond to reasons against killing. But the data required for a meaningful comparison could only be derived from longitudinal imaging studies involving a large number of subjects. These studies have not yet been conducted, and thus the data are not yet available. In the light of this, it is unclear to what extent images of Simmons' frontal lobe taken at age seventeen could help the Supreme Court Justices to decide whether or not he had the capacity to control his behavior at the time of his crime. Unless we could conclusively show how much frontal lobe volume and function are necessary for any person to control his behavior, it is unclear to what extent brain imaging could help to answer the legal question of Simmons' culpability.

In psychopaths, a significant reduction in the volume of the amygdala, perhaps due to a congenital malformation, might explain their blunted emotional response to other people or to fear-inducing stimuli. This could lead one to conclude that an individual displaying psychopathic characteristics was unable to empathize with others, conform to social norms, or have any understanding of how others could be harmed by his actions. But some researchers have suggested that psychopaths may have at least some understanding of what it means to harm others.[19] This understanding could be enough to influence their motivational states and provide some restraint on their irrational, immoral, or criminal behavior. So we could distinguish between individuals who cannot empathize with others and act in accord with social norms, and those who have the capacity to do this but have difficulty and fail to exercise it. It is not obvious that brain scans showing subtle differences in the volume of and metabolic activity in the amygdala, OFC, or anterior cingulate gyrus of two people will explain why one person does and the other does not respond appropriately to moral reasons. It will not explain why one person refrains from and the other engages in behavior that harms others. Nor is it obvious that differences in the brain images of two individuals performing the same type of action would justify mitigated responsibility in one case and exoneration in the other.

A person's ability to consciously form desires, beliefs, reasons, and intentions and to execute, or refrain from executing, them in action is influenced by the brain, which generates and sustains these mental states. But this ability can be influenced by factors in the social and natural environment as well. Social expectations can color our perception of the choices and actions that are open to us, and factors in the physical space in which we live can limit the availability of options that we can pursue. In addition, some people may put more mental effort into exercising their capacity to control their behavior. Just because one displays weakness of will in acting against one's all-things-considered better judgment does not mean that one lacks free will altogether. Also, brain scans cannot account for the phenomenology of free will, or why we *feel* in control (or out of control) of our actions. This feeling too can influence one's perception of the alternative courses of action that are open to one and which actions one performs.

Many people with brain damage or incompletely developed brains are not violent and do not display psychopathic behavior. So it is implausible to claim that structural or functional brain abnormalities detected by brain scans always cause these types of behavior. Except perhaps for cases of severe damage to regions of the brain directly regulating the capacity for rational and moral deliberation and choice, how much control one has of one's behavior, and whether or to what extent one is responsible for it, will not be determined by measuring brain structure or function alone.

19. R. D. Hare, *The Hare Psychopathy Checklist* (Toronto: Multi-Health Systems, 1991), and *Without Conscience: The Disturbing World of the Psychopaths among Us* (New York: Pocket Books, 1993), Hervey Cleckley, *The Mask of Sanity* (St. Louis: Mosby, 1967), and Carl Elliott, "Diagnosing Blame: Responsibility and the Psychopath," *Journal of Medicine and Philosophy* 17 (1992): 223–37.

Regions other than the OFC may play a role in the cognitive processing that subserves reasoning and decision-making. Focusing on this region alone may be an oversimplified way of explaining the link between the brain and behavior. An abnormality in this region would not necessarily mean that the balance between cognitive and emotional processing had been entirely disrupted. The parietal cortex, which regulates our orientation in space and time, may also play a role in maintaining this balance.[20] Moreover, the cerebellum, which lies below the cortex and ordinarily regulates physical balance and coordination, may also play a role in coordinating thought and behavior. Reasoning and executive functions depend on complex neural systems distributed across multiple regions of the cortex, and these functions may also depend on subcortical regions. There are strong links between the executive center in the prefrontal cortex and the parietal cortex, as well as links between these regions and the cingulate gyrus in the limbic system and the cerebellum and basal ganglia in the motor system.

It is thus misleading to think that the ability or inability to control behavior is always confined to the frontal lobe. Contrary to commonsense intuitions, there is no single locus of free will in the brain. Dysfunction in one brain region that subserves mental processes associated with choice and action does not necessarily imply that other regions are also dysfunctional, or that one regional dysfunction alone will adversely affect these mental processes. There are redundancies in the brain. Some systems can compensate for others that have been damaged or incompletely formed and can perform the same tasks associated with these other systems. This is one example of brain plasticity, the ability of nerve cells to modify their activity in response to changes in the body, brain, or external environment. Indeed, in some cases plasticity occurs to such a degree that a person's capacity to control thought and behavior can remain largely intact despite extensive damage to brain regions that ordinarily underlie that capacity.

Neuropsychiatrist Todd Feinberg describes the case of a patient to illustrate this point.[21] "Sonia" was a thirty-two-year-old secretary who was referred for a neurological exam because of mild paranoia but no significant cognitive deficit. Although her neurological exam was normal, Feinberg noticed that her head was unusually large and ordered a CT scan. Surprisingly, the scan showed that more than three-quarters of her cerebral cortex was missing. All that remained was a band of cortex around the outside of her brain. Her fluid-filled ventricles were abnormally large, a condition known as hydrocephalus. When this condition develops suddenly in an adult and is not surgically corrected, the patient can go into a coma. As Feinberg explains, "Sonia" most likely survived with so many of her mental functions intact because her condition was present from birth and her nervous system was able to accommodate itself to the increased intracranial pressure.[22] Because of its plasticity, this patient's brain was remarkably able to adjust

20. See, for example, M. L. Platt and P. W. Glimcher, "Neural Correlates of Decision Variables in Parietal Cortex," *Nature* 400 (1999): 233–38.

21. *Altered Egos: How the Brain Creates the Self* (New York: Oxford University Press, 2001), 103.

22. Ibid., 104.

to extensive damage that otherwise would have severely impaired her mental capacities. This example shows that a brain scan indicating extensive damage to regions of the brain underlying many of a person's mental states does not prove that such a person cannot control her behavior.

Let's consider neuroimaging in the context of the epistemic condition of free will and responsibility by returning to the case of Carrie Engholm. Earlier, we asked whether a brain scan of her hippocampus could have answered the question of whether she was able but failed to retrieve her memory of leaving her daughter in the overheated van. There are several complicating factors that make the question much less straightforward than it might appear at first blush.

One function of the anterior cingulate is to monitor cognitive conflicts. Carrie quite possibly was suffering from information overload when she parked her van, with too many cognitive tasks to plan and execute. This could have affected the hippocampus and led to a temporary retrieval block of her episodic memory of putting her daughter in the van. In fact, this block might have been due to dysfunction in either the anterior cingulate or neocortex, both of which play a critical role together with the hippocampus in the retrieval of episodic memory. Nevertheless, a scan of these regions would not be very helpful after the fact, since most likely they would not show the same degree of metabolic activity as when she had the memory lapse. Moreover, it is unlikely that an imaging device showing increased or decreased activity in these regions would be able to tell us whether she could or could not retrieve the memory, or whether she was not even able to form and store a memory of the event. This is also one reason why brain imaging would not be able to separate "true" from "false" memories in the debate on recovered memories that has figured prominently in cases involving charges of rape and incest. Perhaps most important, data that would allow one to draw these crucial distinctions would only be available from group studies. One would have to average data derived from brain imaging across many people before a particular image, or set of images, for a person could have any statistical significance. As brain imaging techniques become more accurate, and databases of patient populations are formed, neuroimaging may eventually be able to help in ascertaining whether one could have but failed to remember an event, thereby causing harm, and could be responsible for the omission. But presently the technology cannot show definitively whether one can or cannot form and store a memory of an event, or whether one can or cannot retrieve a memory that has been formed and stored in the brain.[23]

To convincingly argue that a person had no control over mental states leading to action because of a brain abnormality, one would have to establish a causal relationship between the abnormality and the mental states. Brain scans can show correlations between behavior and its underlying neurobiological basis. But *correlation* falls short of *causation*, which is why neuroimaging is limited in assessing whether people have free will and can be responsible for their thoughts and actions. Another reason for this limitation is that brain-imaging data can measure only the statistical likelihood of violent, psychopathic, or otherwise culpable

23. Schacter made some of these points in his testimony before the President's Bioethics Commission in 2002.

behavior over a population. It cannot predict how an individual will behave in any given situation. What further complicates this problem is that brain-based measures of mental properties have an illusory accuracy and objectivity. A PET or fMRI scan showing abnormalities in regions of the brain is not necessarily diagnostic of an inability to control behavior. This is because the activity can be modulated by the experimental tasks used by the researcher to mimic actual functions of the scanner. There is also the potential for bias in the design of structural or functional imaging of brain-damaged patients, which can influence how data from these experiments is analyzed.

If this bias could be eliminated from neuroimaging, and real-time imaging techniques could be further refined, then we might have a more accurate picture of how the brain influences behavior. But as cognitive neuroscientist Martha Farah points out, "for now, however, this is not the case, and there is the risk that juries, judges, parole boards, the immigration service and so on will weigh such measures too heavily in their decision-making."[24] There is, then, considerable potential for abuse of information derived from brain scans. This could result in the violation of the privacy and confidentiality of sensitive information about people's brains and considerable harm to those who undergo these scans.[25]

Even if neuroimaging were perfected to accurately measure the neural processes associated with our motivational states and actions, it would not directly translate into simple answers to normative questions such as whether or to what degree people can be responsible for their behavior. These judgments will always be influenced by social norms. This point follows from what may be the strongest reason for questioning the use of neuroimaging to make ethical or legal judgments about people's behavior. It would involve moving from empirical claims about the brain to normative claims about how people ought to behave. Free will and responsibility are not fundamentally empirical but normative notions reflecting social conventions and expectations about how people can or should act. Although our understanding of free will and responsibility will undoubtedly become better informed by brain science, normative claims and judgments cannot be reduced to empirical ones. Ultimately, it is not neuroscientists but society that will decide how empirical information about the brain influences our judgments about what constitutes free will and when people can be held responsible for what they do or fail to do. Morality is not just a function of neurobiology.

CONCLUSION

In the future, more sophisticated, higher-resolution, real-time brain scans may enable researchers to identify the precise features of the brain that regulate exec-

24. "Emerging Ethical Issues in Neuroscience," *Nature Neuroscience* 5 (2002): 1127. See also Farah and Wolpe, "Monitoring and Manipulating Brain Function."

25. Judy Illes points out these and other potential problems with neuroimaging in *Brain and Cognition: Ethical Challenges in Advanced Neuroimaging* (San Diego: Academic Press, 2003). Also, Illes et al., "From Neuroimaging to Neuroethics," *Nature Neuroscience* 6 (2003): 250, Illes et al., "Ethical and Practical Considerations in Managing Incidental Neurologic Findings in fMRI," *Brain and Cognition* 50 (2002): 358–65.

utive functions such as reasoning and decision-making. Moreover, they may enable researchers to distinguish between true and false memories, to determine when people can form and retrieve memories, and when people are lying or telling the truth. Ideally, the combination of this technology and established clinical criteria will contribute to a clearer understanding of free will and the difference between full responsibility, mitigation, and excuse. If brain scans could enable us to move from a correlation to a causal connection between the brain and the mind, then the information derived from functional neuroimaging could be a helpful diagnostic tool indeed. But it should supplement, not supplant, existing moral and legal criteria of responsibility. Because it is still an imprecise science, it will be some time before diagnostic brain imaging becomes feasible for these purposes. In particular, if it does become feasible, then as a society we will have to decide how information about the brain can or should be used as evidence in criminal law, analogous to the way in which DNA evidence is now used.

The brain is the most complex and least understood organ in the human body. It is the source of free will, personal identity, and other dimensions of the self, which is why information about the brain is so sensitive and must be protected. In the light of this, neuroscientist Joseph LeDoux points out that brain imaging studies "force us to confront ethical decisions as a society. How far should we go in using brain images to read minds, and how should we use the information we discover? It is testimony to the progress being made that these questions need to be asked."[26]

26. *The Synaptic Self: How Our Brains Become Who We Are* (New York: Viking, 2002), 221.