

The Lucretian swerve: The biological basis of human behavior and the criminal justice system

Anthony R. Cashmore¹

Department of Biology, University of Pennsylvania, Philadelphia, PA 19104-6018

This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected in 2003.

Contributed by Anthony R. Cashmore, January 12, 2010 (sent for review September 09, 2009)

It is widely believed, at least in scientific circles, that living systems, including mankind, obey the natural physical laws. However, it is also commonly accepted that man has the capacity to make “free” conscious decisions that do not simply reflect the chemical makeup of the individual at the time of decision—this chemical makeup reflecting both the genetic and environmental history and a degree of stochasticism. Whereas philosophers have discussed for centuries the apparent lack of a causal component for free will, many biologists still seem to be remarkably at ease with this notion of free will; and furthermore, our judicial system is based on such a belief. It is the author’s contention that a belief in free will is nothing other than a continuing belief in vitalism—something biologists proudly believe they discarded well over 100 years ago.

consciousness | free will | stochasticism | criminal law | vitalism

Many discussions about human behavior center around the relative importance of genes and environment, a topic often discussed in terms of nature versus nurture. In concentrating on this question of the relative importance of genes and environment, a crucial component of the debate is often missed: an individual cannot be held responsible for either his genes or his environment. From this simple analysis, surely it follows that individuals cannot logically be held responsible for their behavior. Yet a basic tenet of the judicial system and the way that we govern society is that we hold individuals accountable (we consider them at fault) on the assumption that people can make choices that do not simply reflect a summation of their genetic and environmental history. As de Duve has written, “If . . . neuronal events in the brain determine behavior, irrespective of whether they are conscious or unconscious, it is hard to find room for free will. But if free will does not exist, there can be no responsibility, and the structure of human societies must be revised” (1).

It is my belief that, as more attention is given to the mechanisms that govern human behavior, it will increasingly be seen that the concept of free will is an illusion, and the fallacy of a basic premise of the judicial system will become more apparent. Certainly, the determination of the sequence of the human genome and the assignment of function to these genes is having a dramatic effect on our understanding of the role of genetics in human behavior. Similarly, developments in imaging techniques, allowing changes in neuronal activity to be correlated with thought processes, is affecting our thinking about relationships between the functioning of the mind and chemical activity in the brain. Here I propose that the time is opportune for society to reevaluate our thinking concerning the concept of free will, as well as the policies of the criminal justice system.

The Biological Basis of Behavior

At birth, the brain of a child contains about 100 billion neurons, each one forming on average about 1,000 synapses. With time, the majority of these neurons are lost, and the properties of the remaining neurons and their connections reflect a combination of both the genetics and the experiences of the individual from the time of conception. This information is translated into action via the

motor neurons, joined to the muscles and the glands of the body, using a mechanism of both electrical and chemical transmission. Despite the essentially unlimited theoretical capacity of the brain to store and use information—enough to confer individual personalities to multiple billions of individuals—one still hears a sense of certainty that “surely I am more complicated than that!”

Descartes and the Magic of the Soul

At least as long ago as the early Greek civilization, people have worried about the compatibility or otherwise of the laws of nature and the apparent capacity of mankind to make conscious decisions that are not simply a reflection of their makeup and the surrounding environment. As noted by Dennett (2), the Epicureans, in attempting to reconcile the phenomenon of cause and effect that they saw to be characteristic of the physical world, with the contrasting apparent freedom of individual behavior, posed the following problem: “If all movement is always interconnected, the new arising from the old in a determinate order—if the atoms never swerve so as to originate some new movement that will snap the bonds of fate, the everlasting sequence of cause and effect—what is the source of the free will possessed by living things throughout the earth?” As described by Lucretius, their reconciliation of this problem was to propose that atoms occasionally exhibit “random swerves” (3). The causal component of these random swerves could have been the Greek gods, of whom there was no shortage. Indeed, the self consistency of this line of thinking can be seen in early Greek literature, where the gods had a daily impact on the lives of individuals (4).

In the 17th century, Descartes, in addressing what is often referred to as the mind—body problem, proposed that the body obeyed the laws of the physical world, however the soul (and hence the mind), acting through the pineal gland, was not restricted by these limitations (5). The mechanism by which this was achieved was, understandably, not understood, although Descartes offered some suggestions. In reference to this problem, Eccles, in an imaginative proposal, has suggested that the interaction between mind and soul could proceed via the uncertainty of quantum mechanics (6). He achieves the capacity to “swerve atoms” — a requirement for free will (as noted by Epicurus)—by taking the “magic of the soul,” afforded by the dualism of Descartes, and combining it with Heisenberg’s uncertainty principle.

Whereas this so-called Cartesian duality, at least superficially, provides a nice mechanism whereby one could entertain the concept of free will, belief in this mechanism among scientific circles has ostensibly disappeared (7). However, if we no longer entertain the luxury of a belief in the “magic of the soul,” then there is little else to offer in support of the concept of free will. Whereas much is written claiming to provide an explanation for free will, such writings are invariably lacking any hint of molecular details concerning mecha-

Author contributions: A.R.C. wrote the paper.

The author declares no conflict of interest.

Freely available online through the PNAS open access option.

¹E-mail: cashmore@sas.upenn.edu.

nisms (8). Also, it is often suggested that individuals are free to choose and modify their environment and that, in this respect, they control their destiny. This argument misses the simple but crucial point that any action, as “free” as it may appear, simply reflects the genetics of the organism and the environmental history, right up to some fraction of a microsecond before any action.

Genes, Environment, and Stochasticism: A Trinity of Forces Governing Biological Systems

If our genes and environment govern our actions, does this mean that our behavior is deterministic? Not necessarily. Rather, there is a trinity of forces—genes, environment, and stochasticism (GES)—that governs all of biology including behavior, with the stochastic component referring to the inherent uncertainty of the physical properties of matter. Schrodinger popularized the notion that the randomness that physicists were familiar with at the level of individual atoms, was apparently lacking in biological systems (9). Whereas biological systems may have evolved mechanisms to minimize some features of randomness, it is my contention that in contrast to this philosophy, other aspects of the complexity of living systems actually reflect selection in favor of random events.

Examples in support of this notion are the process of mutation (which Schrodinger was aware of), and genetic recombination and assortment; other examples are genetic rearrangement associated with the development of the immune system, and the process of X-chromosome inactivation. Recently there have been numerous reports demonstrating a stochastic response at the level of transcription (10). Variations among individuals of isogenic lines, often ascribed to developmental noise, also likely reflect this stochasticism; similarly, the phenomena of penetrance and expressivity are also likely due to stochastic processes that are normally minimized in the wild type and are uncovered in mutants. Of particular relevance to this article, the formation of neuronal connections reflects a degree of stochasticism, with no two individuals, even those that are genetically identical and under constant environment, displaying the identical neuronal network (11). Hence, the popular debate concerning the relative importance of genes and environment on behavior, is commonly inadequate for two reasons: both because it ignores the question of responsibility (or lack of) and because of the additional stochastic component that influences biology (12). A common practice in behavioral studies involving genetically identical twins is to ascribe any differences (a lack of concordance) to environmental factors—clearly, if one accepts a role for stochasticism, this conclusion is not necessarily correct, as aptly noted by Goodman (13). Rather, differences in genetically identical twins may reflect not only environmental factors but also biological stochasticism.

The introduction of stochasticism would appear to eliminate determinism. However there are three additional points that need to be addressed here. The first point is that, at least in some instances, what at first glance may appear to be stochastic might simply reflect microenvironmental differences and may not be the direct consequence of some inherent stochastic property of atomic particles. The second point is that some physicists, for example 't Hooft (14), do not necessarily accept the apparent unpredictability associated with the quantum mechanical view of matter (It was concern about this unpredictability that prompted Einstein to offer the viewpoint that “God does not play dice”). Finally, even if the properties of matter are confirmed to be inherently stochastic, although this may remove the bugbear of determinism, it would do little to support the notion of free will: I cannot be held responsible for my genes and my environment; similarly, I can hardly be held responsible for any stochastic process that may influence my behavior!

Having now introduced the three forces that govern behavior, it is appropriate, at this rather late stage, to define what is meant by “free will.” Searle has described free will as the belief “that we could often have done otherwise than we in fact did” (15). A difficulty with this definition is that it does not distinguish free will

from the variability associated with stochasticism. For this reason, I believe that free will is better defined as a belief that there is a component to biological behavior that is something more than the unavoidable consequences of the genetic and environmental history of the individual and the possible stochastic laws of nature. Here, in some ways, it might be more appropriate to replace “genetic and environmental history” with “chemistry”—however, in this instance these terms are likely to be similar and the former is the one commonly used in such discussions.

Biologists and Free Will

Earlier I noted that, throughout history, philosophers have repeatedly questioned the validity of free will. However, in spite of this and the sparsity of evidence or credible models in support of free will, it has been my experience that relatively few biologists seriously question the concept of free will. This holds in spite of the fact that we live in an era when few biologists would question the idea that biological systems are totally based on the laws of physics and chemistry. For example, in a beautifully lucid account of the origin and complexity of life, de Duve (1) rather critically analyzes the attempts by others to rationalize a belief in free will, but ends with the rather noncommittal thought: “We still know too little about the human mind to affirm categorically that it is a mere animation of neuronal activity lacking the power to affect this activity.” Similarly, Edelman argues that, “. . . a human being has a degree of free will. That freedom is not radical, however, and it is curtailed by a number of internal and external events and constraints.” (16).

Wilson has argued that, “because the individual mind cannot be fully known and predicted, the self can go on passionately believing in its own free will. . . . Without it, the mind, imprisoned by fatalism, would slow and deteriorate” (17). Crick proposed a model for free will whereby he addressed the reality concerning our consciousness of free will (18). Concerning the reality of free will in reference to the way we use this concept in society, he contemplated, “. . . could it not be that our Will only appears to be free?” (18). In an interview shortly before he died, Crick expanded on his disbelief in free will. When asked if “those decisions you’ve just told me about, concerning your scientific choices . . . were made by underlying mechanical deterministic processes, and the feeling of will is an illusion,” Crick replied, “That’s right. I think it must be deterministic” (19).

Darwin was aware of the implications of his theories concerning evolution in reference to free will as indicated in these notes: “This view should teach one profound humility, one deserves no credit for anything. Nor ought one to blame others” (20).

A willingness, or lack of willingness, to accept the notion of free will is likely to be influenced by several factors, including the following: first, a constant personal awareness of making decisions that have the appearance of being driven by free will; and second, an awareness of the apparent usefulness of the concept, and hence a reluctance to disturb the status quo. In reference to this second possibility, note again the writing of Darwin: “This view will not do harm, because no one can be really *fully* convinced of its truth, except man who has thought very much, and he will know his happiness lays in doing good and being perfect, and therefore will not be tempted, from knowing every thing he does is independent of himself to do harm.” Robert Wright’s (20) description of this writing of Darwin’s is, “In other words: So long as this knowledge is confined to a few English gentlemen, and doesn’t infect the masses, everything will be all right.”

Some will argue that free will could be explained by emergent properties that may be associated with neural networks. This is almost certainly correct in reference to the phenomenon of consciousness. However, as admirably appreciated by Epicurus and Lucretius, in the absence of any hint of a mechanism that affects the activities of atoms in a manner that is not a direct and

unavoidable consequence of the forces of GES, this line of thinking is not informative in reference to the question of free will.

I suspect that we inherit a belief that free will is perfectly logical, and therefore not worthy of questioning. Note that the way we think is influenced by the inheritance of both cultural ideas (memes) as well as genetic material (21), and in some cases, ways of thinking may survive, somewhat in contrast to the logic, or lack of that is associated with that process. The way we in society think about free will (and religion) is likely to be an example of such a process—the line of thinking may have survival value, despite the fact that it is nonsensical and unsupported by any evidence.

Consciousness—Cause or Effect?

I have argued that one of the reasons that it is common to believe in free will is the constant awareness of the capacity to make conscious decisions that appear to causally affect one’s behavior. This relationship is depicted in Fig. 1A, where consciousness, reflecting in part a force WILL, impacts in a causal way the unconscious neural activity of the brain and thus affects behavior. The dilemma here, stressed throughout this article and illuminated in Fig. 1, is that WILL has causal properties (WILL affects behavior) and yet WILL arises in a noncausal way; society “demands” that WILL be “free”—we want to be able to hold people accountable for their actions. Some might argue that there should be an arrow indicating information flow from “unconscious neural activity” to WILL (Fig. 1B). This would provide a causal component for WILL; however, WILL would then lose its “freedom”—it would then simply be a product of GES.

One resolution for this dilemma is that consciousness, rather than being a means by which we influence behavior, is simply a mechanism by which we follow unconscious neural activity and behavior. This model is depicted in Fig. 1C, where the causal component of consciousness is the unconscious neural activity of the brain, and this in turn reflects GES; consciousness has no independent impact on behavior. If there is a flow of information from consciousness to unconscious neural activity of the brain (Fig. 1C, arrow 2), then the causal component of this information does not differ in any way from the input information (Fig. 1C, arrow 1).

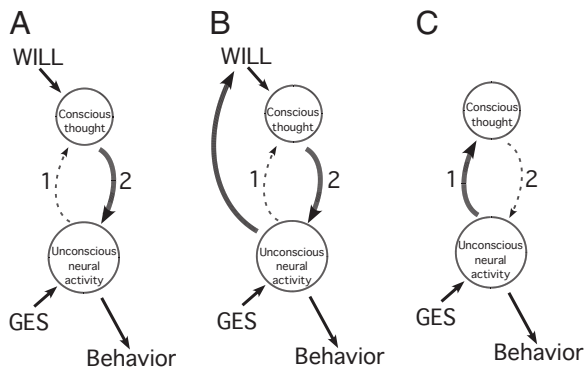


Fig. 1. Models for the flow of information between unconscious neural activity and conscious thought. In A, the commonly accepted model is shown whereby WILL influences conscious thought and, in turn, unconscious neural activity, to direct behavior. The difficulty with this model is that there is no causal component directing WILL. In B, a causal component for WILL is introduced; however WILL now simply reflects unconscious neural activity and GES (genes, environment, and stochasticism). That is, WILL loses its “freedom.” In C, WILL is dispensed with, and conscious thought is simply a reflection of unconscious neural activity and GES. Conscious thought is now primarily a means of following—more than a means of influencing—the direction of behavior by unconscious neural activity. This subservient role of conscious thought in directing behavior in model C, is indicated by the dotted arrow 2 (contrasting with the solid line for the corresponding arrow in A and B).

In keeping with this line of thinking, are studies that indicate that consciousness is something that follows, and does not precede, unconscious neural activity in the brain. In experiments performed by Libet et al., subjects were asked to move a finger (at “will”) and electrophysiological measurements were determined, both for the finger and the brain (22). Activity of the brain preceded finger movement by ≈500 ms. When the participants were asked to record the time of their conscious decision to move their finger, this also preceded finger movement (in keeping with the apparent causal relationship between will and behavior). However, this conscious awareness followed in time, by a full 300 ms, the initial onset of neural activity. Although such experiments are certainly not proof that consciousness is nothing more than a mechanism of following the activity of the brain, the observations are in keeping with this line of thought (23, 24). Furthermore, a more sophisticated version of these experiments has recently been performed whereby neural activity was measured, not by electrophysiological means but by functional magnetic resonance imaging (fMRI). In these experiments, brain activity was detected in the prefrontal and parietal cortex up to 10 s before subjects were conscious of any decision-making process (25).

Another phenomenon that is consistent with the idea that consciousness plays only a peripheral role in behavior is that of blindsight. Individuals who have suffered damage to the striate cortex of the brain often show varying degrees of blindness; they are not aware of being able to see. However, when such patients are asked to make decisions that are dependent on their visual ability, they clearly demonstrate some capacity to see, even though they are not conscious of it (26). In reference to Fig. 1C, for such blindsight individuals, the pathway from GES to behavior is at least partly functional, even though a lesion in the brain has disrupted the link between the neural basis of vision and conscious awareness. Other behavioral phenomena that indicate a non-essential role for the conscious mind are sleepwalking and some forms of concussion.

I am constantly struck by the anomaly associated with the commonly accepted model of consciousness (depicted in Fig. 1A)—namely, WILL lacks any causal component. This problem of causality was appreciated by the Greeks more than 2,000 years ago; and yet, as far as I can tell (and after “constant” conversations on this topic for more than two decades), this anomaly is appreciated by only a relatively small fraction of my professional colleagues. I have suggested earlier that one of the reasons for the popular acceptance of the notion of free will is the constant awareness of conscious thought processes that seem to affect our behavior. Biologists may have an additional reason for entertaining the possibility that there is a biological basis to free will. In the space of a few decades, biologists have been remarkably successful in providing a molecular and cellular framework for most of the fundamental problems in their field. Examples include the description of DNA as the genetic material, the diversity of the immune system, a molecular genetic basis for development, and a molecular model for circadian behavioral rhythms. It occurs to me that the confidence associated with these successes may contribute to the notion that eventually a molecular basis for free will be forthcoming. However, as noted, there are “causal” difficulties with this line of thinking, as appreciated by the early Greeks and as discussed by some philosophers and biologists.

Concerned that, in reading this article, some may continue to believe that the viewpoints questioning the validity of free will that I have expressed here are those of an uninformed minority, I would like now to quote some thoughts by some of the preeminent thinkers of recent centuries. The famous Scottish philosopher David Hume, in his discussion of *Liberty and Necessity*, stated that “whatever capricious and irregular actions we may perform, as the desire of showing our liberty is the sole motive force of our actions, we can never free ourselves from the bonds of necessity.” (27). Thomas Huxley stated, “The feeling we call volition is not

the cause of the voluntary act, but simply the symbol in consciousness of the stage of the brain which is the immediate cause of the act. Like the steam whistle which signals but doesn't cause the starting of the locomotive" (28).

In a similar vein Albert Einstein said, "If the moon, in the act of completing its eternal way around the earth, were gifted with self-consciousness, it would be fully convinced that it was traveling its way of its own accord. . . . So would a Being, endowed with higher insight and more perfect intelligence, watching man and his doings, smile about man's illusion that he was acting according to his own free will" (29).

When we add these quotations to those referred to earlier by Darwin and Crick, it is clear that the willingness of many present-day biologists to rather uncritically accept the notion of free will is not obviously in keeping with the lines of thought expressed by some of the greatest minds of the last three centuries. Questioning the causal anomalies of the popular notions of human behavior is, thankfully, not restricted to the early Greeks!

The Selective Advantage of Consciousness

In discussing free will, Susan Blackmore has noted that "many scientists believe that the real causal factors are all those interacting neurons that do many things including creating a sense of self, and a sense of free will—both of which are illusions" (19). She goes on to say, "I think nature has played this enormous joke on us." In addressing the same issue, Rita Carter has asked, "If free will is an illusion and each of our actions is determined by unconscious cognitive processes in response to external stimuli, why should our brains delude us into thinking otherwise?" (30). A variation on this question is: what is the evolutionary selective advantage of consciousness? One answer to this question is that consciousness provides us with an *apparent* sense of responsibility: "Along with the illusion of control, our sense of agency brings the burdens of individual responsibility. Though this may sometimes weigh heavily on us personally, for society as a whole it is hugely beneficial. Our entire morality and judicial system is dependent on everyone accepting that they are agents of their own misdeeds, and those who don't acknowledge this are—by legal definition—insane. We may not consciously control our own actions, but the cognitive mechanisms that create the illusion that we do keep society functioning" (30). A similar argument has been made by Wegner: "The ability to know what one will do . . . would seem to be an important human asset. . . . This preview function could be fundamentally important for the facilitation of social interaction" (23).

I find that the above are attractive explanations for the existence (the selective advantage) of consciousness. Furthermore, I believe that for these to be true, and somewhat in contrast to the above conclusions derived from Libet's "finger moving experiment," there must be a mechanism by which consciousness does influence behavior. There must be a flow of information from consciousness to neural activity (Fig. 1C, arrow 2). However, in keeping with the requirement for causality and the necessity to comply with the laws of nature, this flow of information provides nothing other than a product of the input information (Fig. 1C, arrow 1). Although, like any biosynthetic process, the product may be quite distinct from the input material, it is still a direct consequence of these materials. I suggest that consciousness acts on behavior in a similar manner, such as to commonly reinforce the negative effects that are associated with antisocial behavior. Similarly, for some of us, consciousness heightens our desire to listen to music, for example, or to watch or participate in sporting activities. Whereas the impressions are that we are making "free" conscious decisions, the reality is that consciousness is simply a state of awareness that reflects the input signals, and these are an unavoidable consequence of GES. The mechanistic details of these conscious processes are unknown, and remain the major unsolved problem in biology (31).

In summary, then, I believe that free will is clearly an illusion. However, this is not to say that consciousness does not have a

function. I believe it does, and from this I assume that it must give rise to an evolutionary selective advantage. Consciousness confers the illusion of responsibility. No wonder the belief in free will is so prevalent in society—the very survival of those "selfish free-will genes" is predicated on their capacity to con one into believing in free will!

A belief in free will is akin to religious beliefs. Indeed, I would argue that free will makes "logical sense," as long as one has the luxury of the "causal magic" of religion. Neither religious beliefs, nor a belief in free will, comply with the laws of the physical world. However, despite this similarity, although in scientific circles a skeptical viewpoint is very common regarding religious forces and their day-to-day impact on biological systems, it is my observation that similar skepticism is not widely held regarding a belief in free will.

If the existence of free will is so widely accepted and has strong survival value, then why would we want to change it? Because, as a consequence of the advance in our understanding of the molecular basis of human behavior, it will become increasingly difficult to entertain this fallacy that currently has such a strong influence in the way we govern society. As Crick has written in reference to the relationship between human values and scientific knowledge, "To construct a New System of the World we need both inspiration and imagination, but imagination building on flawed foundations will, in the long run, fail to satisfy. Dream as we may, reality knocks relentlessly at the door. Even if perceived reality is largely a construct of our brains, it has to chime with the real world or eventually we grow dissatisfied with it" (18).

The Criminal Justice System

Our understanding of the functioning of the brain and the molecular details that result in individual acts of behavior has implications for the criminal justice system. Furthermore, although it may be relatively easy to critically comment on the popular thinking about free will, it is not quite so easy to introduce alternatives to the notion of free will and responsibility that presently form an integral component of the judicial system. In Anglo-American law, for a person to be found guilty of a crime, he must be aware of his wrongdoing at the time of the crime—he must display *mens rea*: that is, the mind must be guilty. In certain circumstances, a defendant can be found not guilty by reason of insanity. Rules governing this defense vary according to country and state, but many are based on the M'Naghten rules, which for a claim of insanity, required that: "the party accused was laboring under such a defect of reason, from disease of the mind, as not to know the nature and the quality of the act he was doing; or, if he did know it, that he did not know he was doing what was wrong" (32).

In fact, the successful application of the insanity defense is quite rare, both in the United States and elsewhere. An example where such a defense was not successful concerned the case of Jeffrey Dahmer, who was found guilty and sentenced to 957 years in prison (where he was subsequently murdered) for the death of seventeen young men from 1978 to 1991. Dahmer was a necrophiliac, performing gross sexual acts on the dead bodies, as well as performing frontal lobotomies and boiling their skulls in acid. The rationale for the guilty verdict was that it was claimed that he knew what he was doing was wrong, as evidenced by the fact that he lied to the police about his activities. I raise this case to illustrate two points: First, the legal system assumes a capacity for individuals not only to distinguish between right and wrong, but to act according to those distinctions—that is, an integral component of the legal system is a belief in free will. Furthermore, the legal system assumes that it is possible to distinguish those individuals who have this capacity of free will from those who lack it (32).

To many there is clearly a difficulty—indeed, a disturbing degree of arbitrariness—associated with any decision that evaluates the degree of mental and legal responsibility that accompanies such criminal acts. Indeed, there is extensive and ongoing debate concerning this topic (32). As noted by Lady Barbara

Wootton, the British criminologist, “If mental health and ill-health cannot be defined in objective scientific terms that are free of subjective moral judgments, it follows that we have no reliable criterion by which to distinguish the sick from the healthy mind. The road is then wide open . . . to dispense with the concept of responsibility altogether” (33). And, as argued by the New York psychiatrist Abraham Halpern, “There is no morally sound basis to select a mental disease or defect as a justification for exculpability while excluding other behavioral determinants, such as heredity, poverty, family environment, and cultural deprivation.” (34). And as noted by Wilson and Herrnstein, “The recurrent theme for the concept of responsibility, hence for the appropriateness of punishment, is behavior freely and intentionally engaged in. The difficulty is that this conception places the legal sanction against offensive behavior in direct confrontation with the sciences of human behavior. If society should not punish acts that science has shown to have been caused by antecedent conditions, then every advance in knowledge about why people behave as they do may shrink the scope of criminal law” (35).

A Proposal

If free will is an illusion, then it becomes more difficult to hold people responsible for their actions. I have argued that one of the reasons that individuals have been so reluctant to question the reality of free will is the belief that it would be difficult for society to function under a system in which this concept was abandoned. However, this has not stopped people from speculating about the inadequacies of the present system and alternative possibilities. As argued by Wright, “All told, then, “free will” has been a fairly useful fiction, a rough proxy for utilitarian justice. But all of the time-wasting debates now in progress (Is alcoholism a disease? Are sex crimes an addiction? . . .) suggest that it is beginning to outlive its usefulness. After another decade or two of biological research, it may be more trouble than it’s worth; and in the meantime, the scope of “free will” may have shrunk considerably” (20). Wright then suggests, as one alternative, that we “...dispense with volition altogether and adopt explicit utilitarian criteria of punishment.”

Progress in understanding the chemical basis of behavior will make it increasingly untenable to retain a belief in the concept of free will. To retain any degree of reality, the criminal justice system will need to adjust accordingly. However, to retain a degree of orderliness in society it will still be necessary to incarcerate individuals found guilty of certain criminal acts. This is rationalized in various ways including the following: To a), protect society; b), protect the offending individuals from society; c), provide such individuals with appropriate psychiatric help; d), act as a deterrent (the act of incarceration and the presence of a criminal code forming part of the environment); and e), alleviate the pain of the victim. The proposal is a pragmatic one, based on the belief that the welfare of society at large is more important than the welfare of the individual offender.

One might ask: How does this proposal differ from the present system? Whereas in some ways, not significantly; in other ways it differs fundamentally. The primary difference would be the elimination of the illogical concept that individuals are in control of their behavior in a manner that is something other than a reflection of their genetic makeup and their environmental history. Furthermore, psychiatrists and other experts on human behavior should be eliminated from the initial judicial proceedings—the role of the jury would be to simply determine whether or not the defendant was guilty of committing the crime; the mental state of the defendant would play no part in this decision. However, if a defendant were found guilty, then a court-appointed panel of experts would play a role in advising on matters of punishment and treatment. This is a system that would hopefully minimize the retributive aspect of criminal law; concerns about this aspect of law, which have probably been around since laws were first intro-

duced, include those expressed by Wootton (33), Menninger (36), and, more recently, Greene and Cohen (37). Also I note that I am not the first to propose that psychiatrists should be excluded from the initial court proceedings; Glueck (38) and Menninger (36), for example, who both had substantially more expertise than I have in this field, long ago made similar suggestions.

Here, at this rather late stage, I should acknowledge that it has been argued by Morse that the question of free will does not form part of the US legal system (39). This being the case, then even though the law assumes that the brain can function as a responsible decision-making machine in a manner that is *not* simply a reflection of the genetic and environmental input, this assumption is apparently made without actually using the term “free will.” In keeping with this line of thinking, Morse notes, “The law does not treat people generally as non-intentional creatures or mechanical forces of nature. It could not be otherwise.” In response to this, I provide another quotation of Thomas Huxley: “Volition . . . is an emotion *indicative* of physical changes, not a *cause* of such changes . . . The soul stands to the body as the bell of the clock to the works, and consciousness answers to the sound which the bell gives out when struck. . . . We are conscious automata.” (28). That is, Huxley believed (as I and many others do) that we are mechanical forces of nature and that, by some mechanism we have evolved the phenomenon of consciousness, which, I would argue, has conferred upon us the illusion of responsibility. Furthermore, I believe that it is time for the legal system to confront this reality—increasingly indicated by studies in both genetics and neurosciences—that we are indeed “mechanical forces of nature.”

Concluding Thoughts

I noted earlier that belief in what I refer to as the magic of the soul and Cartesian dualism has *ostensibly* disappeared. The emphasis that I now give to “ostensibly” reflects my belief that, in the absence of any molecular model accommodating the concept of free will, I have to conclude that the dualism of Descartes is alive and well. That is, just like Descartes, we still believe (much as we pretend otherwise) that there is a magic component to human behavior. Here I argue that the way we use the concept of free will is nonsensical. The beauty of the mind of man has nothing to do with free will or any unique hold that biology has on select laws of physics or chemistry. This beauty lies in the complexity of the chemistry and cell biology of the brain, which enables a select few of us to compose like Mozart and Verdi, and the rest of us to appreciate listening to these compositions. The reality is, not only do we have no more free will than a fly or a bacterium, in actuality we have no more free will than a bowl of sugar. The laws of nature are uniform throughout, and these laws do not accommodate the concept of free will. Some will argue that once we understand better the mechanistic details that underlie consciousness, then we will understand free will. Whatever the complexities of the molecular details of consciousness are, they are unlikely to involve any new law in physics that would break the causal laws of nature in a non-stochastic way. If I am wrong on this point, then I eagerly await the elucidation of this principle. In the meantime it would be prudent to assume (in keeping with the thoughts of William of Occam, where one always adopts the simplest of competing hypotheses) that any search for some new “Lucretian” law of physics, or some startlingly novel emergent principle, will not be successful.

Many believe that the consequences of a society lacking free will would be disastrous. In contrast, I argue that we do not necessarily need to be pessimistic about confronting a world lacking free will. Indeed, it is quite possible that progress in some of the more vexing sociological problems may be better achieved once we clarify our thinking concerning the concepts of free will and fault. Certainly, crime is a problem that society has much difficulty dealing with, and in the United States we have the highest rate of incarceration in the world (40). For these and other reasons, surely it is inexcusable that in addressing these

problems we continue to entertain this fallacious assumption concerning the most basic feature of human behavior.

Finally, I would like to make the following point: In the introductory chapter of many undergraduate texts dealing with biology or biochemistry, it is common to stress (as I have in this article) that biological systems obey the laws of chemistry and physics; as living systems we are nothing more than a bag of chemicals. It is almost with a sense of pride that the authors of such texts may contrast this understanding with the alternative earlier belief in vitalism—the belief that there are forces governing the biological world that are distinct from those that determine the physical world. The irony here is that in reality, a belief in free will is nothing less than a

continuing belief in vitalism—a concept that we like to think we discarded well over 100 years ago! It is my concern, that this vitalistic way of thinking about human behavior—a style of thinking that is present throughout our scientific institutions—serves only to hinder what should be a major onslaught on determining the molecular genetic and chemical basis of human behavior.

ACKNOWLEDGMENTS. I thank the many colleagues who have participated in discussions on this topic over the years. Particular thanks are given to Eran Pichersky (University of Michigan, Ann Arbor, MI) and to Nancy Bonini and Sally Zigmund (University of Pennsylvania, Philadelphia, PA) for their comments and support. I also thank the reviewers of this manuscript for their many helpful comments.

1. de Duve C (1995) *Vital Dust* (Basic Books, New York).
2. Dennett DC (1984) *Elbow Room: The Varieties of Free Will Worth Wanting* (MIT Press, Cambridge, MA).
3. Lucretius (1951) *On the Nature of the Universe* (Penguin, Harmondsworth); trans Latham RE.
4. Homer (1990) *The Iliad* (Penguin Books, New York); trans Ewings V.
5. Descartes R (2003) *Discourse on Method and Meditations* (Dover Publications); trans Haldane ES and Ross GRT.
6. Eccles JC (1989) *Evolution of the Brain* (Routledge, London, New York).
7. Damasio AR (1994) *Descartes' Error: Emotion, Reason, and the Human Brain* (Avon Books, New York).
8. Dennett DC (2003) *Freedom Evolves* (Viking, New York).
9. Schrodinger E (1944) *What Is Life? The Physical Aspects of the Living Cell* (Cambridge University Press, Cambridge).
10. Ford E, Thanos D (2009) Time's up: Bursting out of transcription. *Cell* 138:430–432.
11. Macagno ER, Lopresti V, Levinthal C (1973) Structure and development of neuronal connections in isogenic organisms: Variations and similarities in the optic system of *Daphnia magna*. *Proc Natl Acad Sci USA* 70:57–61.
12. Monod J (1971) *Chance and Necessity* (Knopf, New York).
13. Goodman R (1991) Growing Together and Growing Apart: The Non-Genetic Forces on Children in the Same Family. *The New Genetics of Mental Illness*, eds Mc Guffin P, Murray R (Butterworth-Heinemann, Oxford), pp 212–224.
14. 't Hooft G (2005) A theory of everything? *Nature* 433:257.
15. Searle J (1984) *Minds, Brains and Science* (Harvard University Press, Cambridge, MA).
16. Edelman G (1992) *Bright Air, Brilliant Fire: On the Matter of the Mind* (Basic Books, New York).
17. Wilson EO (1998) *Consilience: The Unity of Knowledge* (Knopf, New York).
18. Crick F (1994) *The Astonishing Hypothesis* (Simon & Schuster, New York).
19. Blackmore S (2006) *Conversations on Consciousness* (Oxford University Press, Oxford).
20. Wright R (1994) *The Moral Animal* (Pantheon Books, New York).
21. Dawkins R (1989) *The Selfish Gene* (Oxford University Press, Oxford).
22. Libet B, Gleason CA, Wright EW, Pearl DK (1983) Time of conscious intention to act in relation to onset of cerebral activity (readiness-potential). The unconscious initiation of a freely voluntary act. *Brain* 106:623–642.
23. Wegner DM (2003) *The Illusion of Conscious Will* (MIT Press, Cambridge).
24. Libet B (2005) *The Temporal Factor in Consciousness* (Harvard University Press, Cambridge).
25. Soon CS, Brass M, Heinze HJ, Haynes JD (2008) Unconscious determinants of free decisions in the human brain. *Nat Neurosci* 11:543–545.
26. Weiskrantz L (1997) *Consciousness Lost and Found* (Oxford University Press, Oxford, UK).
27. Hume D (1739) *A Treatise of Human Nature* (Oxford University Press, 2002, Oxford).
28. Huxley T (1874) *On the Hypothesis That Animals Are Automata, and Its History* (University Publications of America, 1978, Washington, DC).
29. Home D, Robinson A (1995) Einstein and Tagore: Man, Nature and Mysticism. *J Conscious Stud* 2:167–179.
30. Carter R (2002) *Exploring Consciousness* (University of California Press, Berkeley).
31. Koch C (2004) *The Quest for Consciousness: A Neurobiological Approach* (Roberts, Englewood, CO).
32. Reznick L (1997) *Evil or Ill: Justifying the Insanity Defence* (Routledge, London).
33. Wootton B (1959) *Social Science and Social Policy* (Macmillan, New York).
34. Halpern A (1977) The insanity defence: A judicial anachronism. *Psychiatr Ann* 7: 398–409.
35. Wilson JQ, Herrnstein RJ (1985) *Crime and Human Nature: The Definitive Study of the Causes of Crime* (Simon and Schuster, New York).
36. Menninger K (1968) *The Crime of Punishment* (Viking, New York).
37. Greene J, Cohen J (2004) For the law, neuroscience changes nothing and everything. *Philos Trans R Soc Lond B Biol Sci* 359:1775–1785.
38. Glueck G (1936) *Crime and Justice* (Little Brown, Boston).
39. Morse SJ (2007) The non-problem of free will in forensic psychiatry and psychology. *Behav Sci Law* 25:203–220.
40. Walsmsley R (2007) *World Prison Population List* (International Center for Prison Studies, School of Law, King's College, London), 7th Ed.