An Analysis of the Role of Neuroscience in the Legal System

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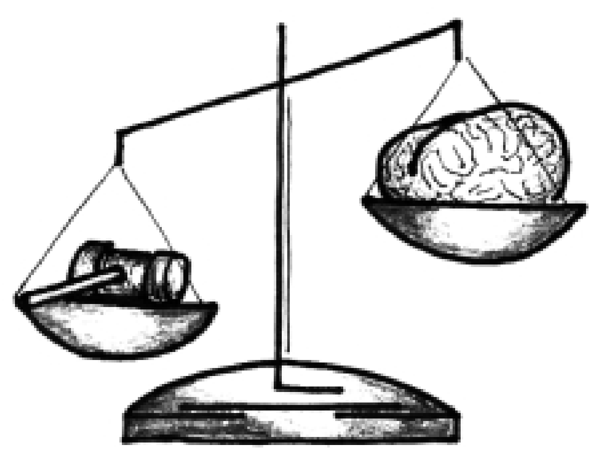
Lawyers often depend on psychologists and medical doctors to provide expert physical and causal behavioral evidence as testimony in the determination of a defendant's innocence or guilt. Based mainly on patterns of behavior and subjective opinion, psychological evidence is prone to manipulation in order to corroborate with either side of an argument. Still, medical testimonies are persuasive and can be an effective tool to use, and misuse, to convince a jury and a judge. Legal judgments are based upon the de-termination of responsibility and culpability. Responsibility, defined legally, presumes volition, free will, and competency. Culpability infers intent by identifying the negligence and purposefulness of the crime. In terms of criminal liability, these concepts are important in determining the actus reus, the proscribed act, and the *mens rea*, the guilty mind, of a defendant (Morse, 1992). Thus the legal system integrates the state of one's mind with one's actions. Neuroscience makes parallel connections between the mind and brain and the production of action, but according to different theories and laws. Beyond this similarity of the topic of inquiry, neuroscience and the law diverge on most other aspects. When considered from an inductive neuroscientific viewpoint, the law's assumptions are obscured and subverted and thus neuroscience cannot offer the proof (beyond a reasonable doubt) for diminished capacity legally required to exempt a defendant from the legal liabilities of responsibility and culpability.

The legal understanding of behavior relies on the influence of endogenous and exogenous stimuli, as well as circumstance. Endogenous factors, such as the neuro-anatomical and genetic configurations, comprise the biological components of action. The imposition of the law varies based on the determinance of diminish capacity and upon a person's mental condition: diseased, damaged, or healthy. Environmental, social, and cultural factors contribute to exogenous forces upon behavior. Based upon these effects, the legal system assumes that an average person is able to choose one's actions rationally and without coercion, and consequently may be held responsible. Neuroscience operates on the premise that action is causally deterministic; neural processes instigate behavior. The deterministic nature of these and how they are initiated is still debated and research has been inconclusive.

Current scientific methodology is too sterile and controlled to elucidate complex behavioral systems such as volition, consciousness, and the neural initiators of both. Restricted by a limited variability and by reliance on deductive analysis, neuroscience research makes isolated discoveries in a complex network of systems. Experimental isolation of causal effects renders the scientific discoveries incomparable to real life situations that require the consideration of the complexities of numerous environmental, biological, and social variables. Sean Spence,



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reflecting upon his own research on consciousness, remarked, neuropsychiatric and psychological literature… repeatedly considered individuals divorced from their context, their environmental milieu. Whereas the purpose of this paper has been to question the emphasis upon the conscious (over the non-conscious) in considerations of free will, there is clearly a case to be made for work that questions the emphasis of individual above community in the exercise of healthy mental life (Spence, 1996).

With this said, the decades of research dedicated to these higher order cognitive functions have untangled some of the processes involved in volitional and conscious sys-tems. Consciousness, in the context of this paper, is an awareness of self and environment. It is not a physical system, but an invisible boundary or threshold analogous to the earth's equator through which sensorimotor information as well as emotions and decisions pass. Free will relates to the freedom of choice in determining which neural activities to perform. In relation to neuroscience's potential role of commenting on criminal behavioral choices and actions, the neurophilosophical concepts of free will and consciousness are paramount. Neuroanatomical structures have been associated with different capacities of behavior modulation, though this association does not signify sole responsibility. A single structure can be implicated in many actions and stimulated by multiple inputs. Conversely, "identical regions are not activated with different modalities (Libet, 1996)," like speech and sensorimotor information.

The frontal cortex, composed of the primary motor, premotor, and prefrontal cor-tices, exhibits organizational control over the execution of actions. Research indicates these structures command the selection and inhibition of actions and could be instrumental in converting electrical motor behavior information into consciousness or self-awareness (Walter, 2001). Activation in the dorsolateral prefrontal cortex (DLPFC) occurs when one must voluntarily inhibit or activate a response to a stimulus. Scientists at Yale University recently discovered that the DLPFC is activated during working memory tasks (Raye, 2002), "willed action" tasks (Hyder et al., 1997), planning and execution, self-awareness, and verb generation.

The premotor cortex helps plan motor action and select from several options. Imbedded in the medial section of the premotor cortical region is the supplementary motor area (SMA). A readiness potential (RP), an endogenous, slowly developing electric negativity that begins up to a second before initiated movements or voluntary actions, is believed to originate in the SMA (Walter, 2001, Libet, 1983). The change in potential can be recorded on the skull and traced "…at first on both sides, [it] becomes steep about 500 milliseconds before motion commences, and, at 100 milliseconds before movement begins, it concentrates over the motor cortex of the moved body part on the contralateral side (Walter, 248)." Libet's experimental exploration of RP required the minimalization of external influences on decision-making to move and encouraged unadulterated, endogenous self-initiated action (Libet, 1983). He asked his subjects to spontaneously flex their hands or fingers any time after their fixation point completed a movement. The results showed three distinct types of RPs, each with different onsets. Type I occurred 1050 milliseconds before the onset of the action, type II, 575 milliseconds before onset, and type III 240 milliseconds before onset (Libet, 1983). Though these electrical potentials are well documented, the temporal values are still being contested, Deeke, Scheid and Kornhuber reported three differently timed potentials. "Type I", a RP, occurred 850 milliseconds prior to voluntary movement, "type II", a Pre-motion Positivity (PMP), occurred 86 milliseconds in advance, and "type III", a surface negative motor potential, began 56 milliseconds before voluntary movement (Deecke, Scheid and Kornhuber, 1969).

This evidence of offset chronological

sequencing leads to the speculation on the order of neural events in these systems. But establishing a sequence of events and their relative timing has proved controversial and difficult. There are philosophic complications implicated in these ideas, including the consideration of the difference between mind and brain, dualism and materialism, etc. Furthermore how do biological correlates effect one's conception of volition and control and on the actual possibility of control? The latter query is the more pertinent question of this paper.

Starting at the most external stage and working backward to the origin of an action, the steps include the execution of an action, the conscious choosing of an action, the conscious awareness of the urge to act, the subconscious (or non-conscious) selection of action, and possibly the cyclical feedback system sustaining the neural processes behind these systems. According to this sequencing, consciousness precedes the remembrance and reporting of thoughts and actions. Consciousness serves as a filter for action and perception on their way to physical realization. Libet distinguishes between the physical readiness of the cortex and the subjective report of awareness. In studies of consciousness, he identified a half-second delay (related to the readiness potential) between when the cortex is sufficiently stimulated to initiate an action and when a person claims awareness of the intent to act (Libet, 1973, 1978, 1979). He attributed this temporal lag to the time it takes the cortex to reach neuronal adequacy to pass on the sensorimotor information (Libet 1982, 1983). Cortical readiness is accomplished by temporal summation of stimuli. The "train duration", the rate of stimulus repetition, and the stimulus intensity cause the electrical current to exceed threshold; only then is a conscious experience elicited (Libet, 1973). Libet explains, by the "subjective referral of the timing for a conscious sensory experience," the average person reconciles this time delay between "internal" neurological readiness and "external" sensory awareness of an action. He postulates that primary evoked potentials (type I) "serve as 'time-marker' and there is an automatic subjective referral of the conscious experience backwards in time to this time-marker, after the delayed neuronal adequacy [after type III] has been achieved (Libet, 1978)."

In an experiment entitled "the precognitive carousel", Grey Walter further demonstrated this disjunction of cortical readiness and subjective referral, and illustrated the implications that the temporal lapse has on mitigating behavior (Walter, 1963). He instructed his patients, who already had electrodes implanted in their cortices for medical reasons, to look at slides from a carousel projector and directed them to advance to the next slide at will. Walter did not tell the patients that he connected the slide advancer to the electrodes implanted in their motor cortices so they believed they had control over the remote. Walter therefore entitled the brain to activate the advancement of a slide when the cortex reached neuronal adequacy and the hand movement became a dummy task. The patients reacted with dismay to the premature movement of the slide, commenting that the slide projector seemed to anticipate their decision to advance the picture. These findings suggest that volition and rationality might not affect an action until after the conscious stage. Because the experiment removed the time delay so the cortex became the task initiator instead of caretaker of the peripheral limbs, the patient was denied the ability to mediate his/her action. The brain executed the action before conscious awareness had a chance to affect the process (Grey Walter, 1963).

According to this sequencing, it seems unlikely that volition and rationality consistently and reliably dictate behavior. How