Biology 202
1998 Third Web Reports
On Serendip

Defining the Neurobiology of Insanity: Law, Science, and the I-function Reconciled

Anneliese Butler

During the last week or so of class, after a semester of being teased with glimpses of, allusions to, and deferred explanations for the I-function, we at last came face to face with this previously elusive property of the nervous system which allows us to experience experience. The detour was necessary, for it corrected the general misconception that something like an I-function encompasses everything that makes one an individual and defines one's unique personality; it demonstrated the true importance of "the rest" of the nervous system. Indeed, we were shown how the I-function is, in some ways, superfluous, in that it is not necessary for survival. Not to downplay it, however, the I-function is key to understanding what makes us (human beings) what we are, to distinguishing our experience of the world from that of other species. It allows us to conceive of ourselves (our selves) as objects and to perform such behaviors as planning, dreaming, in short, imagining ourselves in situations other than the one in which we 'really' are.

The last few classes were dedicated to addressing issues which still troubled the majority of the class, such as choice and the supernatural; I, however, found my self wondering about another issue, which no one had yet brought up: insanity. What does it mean to insane? What are the (if any) criteria which determine whether or not a person is sane? Are they reflected in said individual's neurobiological make-up? And finally, how does insanity relate to the I-function? As it turns out, research related to these issues is fairly recent, but increasing rapidly, thanks to technological advances and important contributions from several fields in the neurosciences. My goal here is to report on the answers I was able to find to my questions, as well as to ponder the questions raised by these and foreseeable answers.

As might be expected, the term "insanity" has no neurobiological definition and, as a concept in everyday language, is extremely broad and vaguely defined. Not surprisingly, therefore, it is a concept which is neither used nor useful to professionals in the neurosciences, who regard so-called "insane" behaviors as the results of abnormalities or changes within the brain: "...a rough medical translation would be 'psychosis-that is, the more severe kinds of mental illness, involving hallucinations or delusions," (1). In searching for a working criteria of insanity, the closest I came to a formal definition was the criteria used in law to determine whether or not a defendant could be absolved of responsibility for his or her crime. Key here is the issue of volition, or rather the lack of it, which is "a defence...where the accused has acted in a state of automatism, that is, involuntary automatic conduct over which he or she has no control;" automatism is considered to be "insane" if it "arise[s] from a mental disorder," as opposed to an external event (1). In order to be labeled (legally) insane, to be "recognised as acting involuntarily as a result of his illness [and thus] not liable," the "accused must show...that he was suffering from a defect of reason AND...that this was the result of a disease of the mind...so that either...he did not know the nature and quality of his act OR...he did not know that it was wrong," (1). Without going into the problems inherent in such criteria (see 1 for details), one can gain from them a sense of direction, as they indicate, though imprecisely, certain characteristic symptoms of "insanity."

In searching for a neurobiological parallel to insanity, one approach is to look for disorders which exhibit these symptoms; of these, schizophrenia is one of the most potent examples, and, indeed, schizophrenics tend to

qualify for the insanity defense. Literally meaning " 'fragmented mind'" (2), schizophrenia refers to the "ungluing of the mind,...the...dissociation of reason and emotion" (3), a "cognitive disorder" in which "normal connections or associations [are] no longer present," (2). Although symptoms vary from one individual to the next, they encompass nearly all domains of function: perception (hallucinations), inferential thinking (delusions), fluency of though and speech (alogia), clarity and organization of thought and speech ('formal thought disorder'), motor activity (catatonia), emotional expression (affective blunting), ability to initiate and complete goal-directed behavior (avolition), and ability to seek out and experience emotional gratification (anhedonia). (2) A number of discoveries concerning the localization of these symptoms in the brain have been made over the past few years by specialists from several different fields, using a variety of research techniques to test their hypotheses and models (2). However, many of these symptoms occur in other, non-schizophrenic, individuals, as well, and are being studied using the same or similar methods. I shall attempt to provide examples of each, thus giving you a taste of some of the theories which are currently being investigated, and then to explain the implications which are common to them all.

One study, conducted by C.D. Frith, has focused its attention on "three broad groups" of schizophrenic symptoms, those affecting "willed action..., ...self-monitoring..., and...monitoring the intentions of others," which Frith hypothesizes to be "special cases of a more general underlying mechanism: a disorder of consciousness or self-awareness that impairs the ability to think with 'metarepresentations,'" (2). Nancy Andreasen explains that such metarepresentations are "higher order abstract concepts that are representations of mental states," (2); this statement is highly evocative of the I-function, which, as we learned, builds "models of the models of the rest of the nervous system and its relation to the world," (Grobstein, 4/30/98).

Frith's method of testing this model involved specific tasks known to require volition, self-monitoring, and the ability to monitor others, respectively, and the use of positron emission tomography (PET) to monitor blood flow in the brain; these tasks were given both to a control group and to people with schizophrenia, and their PET scans compared. To investigate which areas of the brain were (or were not) activated during acts requiring volition, they assigned tasks "for which the correct response is not evident from context, such as verbal fluency," and which were known to activate frontal regions in 'normal' people. Initially, they observed a relative decrease in activity in frontal regions and an increase in the activity of temporal regions compared to controls, but when "the pace of the verbal fluency task is slowed, frontal function is similar to that of normals and only the temporal abnormality remains." By comparing "blood flow in frontal and temporal regions," Frith concluded that "the normal relationship between them has broken down and that there is abnormal functional connectivity." In other words, functions such as "fluency of thought and speech" and "the ability to initiate and complete goal-directed behavior" (volition) depend, at least in part, on the existence of a specific balance between areas in the frontal and temporal lobes. (2)

Abnormalities in a person's ability to monitor themselves, Frith hypothesized, led to (for example) "an erroneous attribution of the person's own inner speech to another person," i.e., to auditory hallucinations. The task used in this case was to complete a sentence "and imagine that the response was spoken in another person's voice," which, in the control group, activated brain areas related to "speech production and perception, such as Broca's area, the supplementary motor area, and the left superior and middle temporal regions." In schizophrenics, however, those with hallucinations had abnormally low blood flow in speech-monitoring areas, "such as the left middle temporal gyrus and supplementary motor area." Frith and his colleagues have also observed blood flow during auditory hallucinations, finding "activations primarily in subcortical regions (the thalamus and striatum), limbic and paralimbic regions (the anterior cingulate and parahippocampal gyrus), and cerebellum," causing them to "speculate that activity in subcortical regions may generate or moderate hallucinations, whereas the content...may be determined by the specific neocortical regions that are engaged." (2) These observations thus provide yet further clues as to the physical location and neurobiological nature of a very important determinant of insanity.

Another current line of research involves what is known as working memory, described as "an erasable mental blackboard that allows you to hold briefly in your mind and manipulate the information...essential for comprehension, reasoning, and planning," (4). It is what allows us to "guide behaviors by representations," and thus, if impaired, might possibly cause many of the symptoms seen among schizophrenics and other individuals, notably "disorganized speech and thought disorder..., avolition...alogia..., delusions...[and] hallucinations," (2). Work in this area has been ongoing for the past two decades, or so, and now researchers are beginning to discover which areas of the brain are involved, and in what relationship, in producing working memory. A variety of methods have been and continue to be used to test this model, with experiments being done on both humans and nonhuman primates, including techniques such as PET scans, fMRIs, lesion studies, and single-cell recordings (2, 4). Observations seem to point towards a model proposed by Goldman-Rakic, which indicates "prefrontal regions and their multiple distributed cortical, thalamic, and striatal connections," as being the areas involved in working memory (2). However, further investigations show that the prefrontal cortex plays a special role in the process: it seems that it is divided into functional subdivisions, with separate areas for "spatial, object, and verbal working memories;" at the same time, though, this division is not "absolute," as at least one area, known as area 46, has been observed to "[act] as a processor for working-memory information regardless of its type." (4)

Thus, the prefrontal cortex appears to assume the lion's share of the working-memory duties, both holding relevant information online and performing complex processing functions. To do its job, however, this cortex must cooperate with connected sensory regions that hold and use the information for briefer periods of time. Now the race in on to determine exactly what role these posterior regions play and how that role depends on the prefrontal cortex. (4) Although we have no definite answers, the possibility of localizing the 'seat of reason' is slowly but surely being realized, and with it clues as to what areas of the brain must be affected in order for an individual to exhibit the 'symptoms of insanity.' (for more details on individual experiment which contributed to the findings on working memory, see 4).

As I implied earlier, several of the symptoms displayed by schizophrenics are also exhibited by other, non-schizophrenic individuals. Adrian Raine, a psychophysiologist at the University of Southern California, is currently investigating whether there are any significant differences in the brains of murderers which might, so to speak, predispose them to acts of crime (5). He is particularly interested in those whose background is relatively free of social and environmental factors which might contribute to such a predisposition to violence, such as "physical or sexual abuse, neglect, extreme poverty, foster home placement, severe family conflict, a broken home or having a criminal parent," (5). Using PET, he scanned the brains of "38 men and women charged with murder," at the same time doing extensive research on their backgrounds; twelve of the 38 subjects qualified, under the criteria he and his fellow researchers established, as having "suffered significant psychosocial abuse and deprivation," but the remainder of the group had fairly normal or "benign" backgrounds (5). The scans showed that this latter group "averaged 5.7% less activity in the medial prefrontal cortex," and that "[m]ore significantly, one particular part...the orbifrontal cortex on the right hemisphere--showed 14.2% less activity," (5). Studies performed with animals in the past have shown the prefrontal cortex to act as an inhibitor of "functions of the limbic system," as well as the involvement of the right orbital frontal cortex in "fear conditioning--that is, in making a subconscious association between antisocial behavior and punishment...[which, in humans] is thought to be key to developing a conscience," (5). This all points towards a biological, in addition to a sociocultural, basis for behavior deemed criminal by society; it thus seems that for some individuals, the crimes they commit may be due to abnormalities in the structure and function of specific areas of the brain, and that these acts are committed due to the absence or malfunction of critical neural circuits which give rise to certain characteristics fundamental to being an 'upstanding,' 'normal' human being. The criminals mentioned above would not necessarily be deemed insane, however, unless they were proven to be suffering from "a defect of reason [resulting from] a disease of the mind," and it were established that this defect disabled their ability to know what they were doing (1). Nevertheless, they are comparable to so-called 'insane'

or 'mentally ill' individuals in that their aberrant behavior appears to be directly related to patterns of activity within specific areas of the brain, notably the prefrontal cortex and the cortical and subcortical regions to which it is connected (2).

In reviewing the recent work on schizophrenia, Nancy Andreasen points out that [t]he cognitive dysfunction in schizophrenia is an inefficient temporal and spatial referencing of information and experience as the person attempts to determine boundaries between self and not-self and to formulate effective decisions or plans that will guide him or her through the small-scale or large-scale maneuvers of daily living. This capacity is sometimes referred to as consciousness. (2) One of the ways we described the I-function in class was through reference to this very same word: "consciousness," the awareness and experience of experience. Based on the data presented so far and the summary statement quoted above, can insanity be defined as a dysfunction of consciousness, a faulty I-function? If so, what is doing wrong? I wrote earlier that the I-function allows us to imagine ourselves in situations other than the one we are 'really' in; if insanity involves the failure to recognize 'reality,' is the I-function working too well, overpowering other areas of the brain which usually keep us grounded in reality? Do 'insane' people continuously imagine themselves in a situation other than the one they are (from the viewpoint of others) in? But the I-function is also what allows us to experience our experience of so-called reality; so perhaps the problem lies elsewhere, perhaps the parts of the brain involved in dreaming are overpowering sensory and motor signals which are interacting with the environment. I regret that I failed to look for studies concerning whether or not schizophrenic and other severely mentally ill individuals have a concept of self--but it seems likely that they do: we human beings are inevitably self-centered, whether or not we are mentally well, and I do not mean that in a derogatory way; but irrational thoughts and fears, at least to my knowledge, always involve, either directly or indirectly, a "me". Therefore, I think it is safe to assume that 'insane' individuals have an I-function, though I stand to be corrected should there be data proving otherwise.

I have obviously reached the point in my discussion at which I am pondering and no longer presenting 'known and proven facts.' One last issue I would like to address is a concern raised by one of my classmates, both in class and in the forum, regarding the implications of our notion of the relationship between the I-function and the rest of the nervous system for law and social justice. She was disturbed by the idea that the I-function is separate from personality, that we can "act [ourselves]" in its absence. Given this, she asked, how can we possibly determine whether it was an individual's I-function, their personality, or the rest of their nervous system which committed the crime? In our last class together, Professor Grobstein acknowledged that, yes, there are two parallel systems within the nervous system, but that, under normal circumstances, they interact with one another and the environment to produce behavior. Thus, the concept of someone's personality committing a crime is unreasonable, because this cannot occur without the cooperation of other parts of the nervous system. "Mr. YouPNS" is one entity, not three separate ones. The situation becomes more complicated, however, when the I-function of an individual loses its normal connections with the rest of the nervous system, as it seems to be doing in individuals suffering from schizophrenia and other severe mental disorders. How can a court of law possibly determine whether or not the accused knows that what he or she did was wrong, or even that the crime occurred? One of the leading opponents of the so-called Insanity Defense, Thomas Szasz argues: Insanity is a legal concept involving the courtroom determination that a person is not capable of forming conscious intent and, therefore, cannot be held responsible for an otherwise criminal act.

The opinions of experts about the 'mental state' of defendants ought to be inadmissible in court, exactly as the opinions of experts about the 'religious state' of defendants are inadmissible. (6) The current summary of observations, however, indicates that properties such as reason, volition, and awareness can be traced to specific neural circuits within the brain; it is therefore possible that, in the near future, as techniques are refined and researchers are able to observe these circuits more closely and in greater detail, criteria based on solid, physical evidence will replace the 'best guesses' of specialists who have nothing to go by other than what they can glean by observing the individual's outwardly expressed behavior and personal history. "Excusing a person

of responsibility for an otherwise criminal act on the basis of inability to form conscious intent" will no longer be "an act of legal mercy masquerading as an act of medical science," (6): one will look to the brain in order to explain behavior.

Important issues remain, however; as indicated in the quotation above, interesting parallels are being drawn between science and religion: in her essay, "Medicine For the Soul," Claudia Wallis describes recent discoveries concerning the localization "in the brain of an intricate system that serves, among other things, as the human moral compass," and speaks of the possibility that "[m]edicine in the 21st century...offers a shot at cheering the despondent, repairing the unpopular, perhaps even doing the job of religion - correcting moral defects," (7). It is here that I see the real problems arising, where the social and cultural aspects of science come into play, when the knowledge gained through observations is to be applied to everyday life. It is not that the "conclusions" cannot be reconciled with "reality," or that we cannot "live with it," (see final topic in forum). Rather, it comes down to a question of agency: when we put the human soul on the operating table, we had better watch where we cut. Any one of us could be better than we are, but who's to say who needs fixing? (7)

Works cited:

(1) Volition and Insanity-- Steve Uglow of Kent Law School.

(2) "Linking Mind and Brain in the Study of Mental Illnesses: A Project for a Scientific Psychopathology." Nancy C. Andreasen. Science, vol. 275 (14 March 1997), pp. 1586-1592.

(3) "Divided Selves." Tony Dajer. Discover, September 1992.

(4) "Getting a Grasp on Working Memory." Ingrid Wickelgren. Science, vol. 275 (14 March 1997), pp. 2580-1582.

(5)"Functional Families, Dysfunctional Brains." University of Southern California news services.

(6) "Thomas Szasz's Summary Statement and Manifesto." Thomas S. Szasz. The Thomas S. Szasz, M.D. Cybercenter for Liberty and Responsibility.

(7)"Medicine for the Soul." Claudia Wallis. Time, vol. 144, no. 2 (11 July 1994).

| Course Home Page | Back to Brain and Behavior | Back to Serendip |

Send us your comments at Serendip
