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Serotonin Deficit and Impulsive Violence *Does Your Case Fit?*

by Dr. Paul Rossby, Ph.D.

A frequent fact in issue in capital murder cases is why one child reared in an abusive family environment becomes a killer whereas his siblings, who experienced virtually the same abuse, do not? Scientifically, the most plausible answer is brain chemistry i.e., no two brains are identical. Interestingly, this also explains why approximately 20 years after the end of the Vietnam War, only 15.2 percent of veterans continued to re-experience their traumas in hallucinatory detail while their peers, who experienced virtually the same inescapable terrors, were able to readjust and get on with their lives.¹

In order to appreciate the critical differences in brain chemistry that can lead to seemingly inexplicable acts of cruelty, it is necessary to have a basic understanding of the brain itself, the *organ of behavior*. We are born with species-specific instinctual behaviors including self-preservation, predatory attack and defense, sexuality, eating, sleeping, and dreaming. Fortunately, we are also born with developmental programs of gene expression that ultimately enable us to control our (animal) instincts to a greater or lesser extent.

Mechanisms of “Self-control”

The brain is essentially comprised of 100 billion nerve cells (neurons) that conduct “electrical” impulses. Brain chemicals are classified as “excitatory,” i.e., those that cause neurons to fire, and “inhibitory,” i.e., those that inhibit (prevent) nerve cell firing. In other words, despite the obvious complexity of the brain it is a binary system (like a computer); nerve cells fire or they don’t fire. Epileptic seizures and convulsions are examples of uninhibited neuronal firing (loss of control) during which neurons in a region of the brain discharge and spread like an electrical storm. In contrast to seizures and convulsions, the normal functioning of the brain involves constant interplay between excitatory and inhibitory chemicals.

Unconscious control mechanisms develop in the “amygdala,” a very primitive region of the brain significantly associated with fear, whereas *conscious* intentional control develops in the pre-frontal cortex (located just above the eyes). Known to scientists as the “executive/cognitive” region of the brain, the pre-frontal cortex is where we humans do our thinking and imagining, where we make informed decisions based on facts, and where we engage in an almost constant “internal dialog.” The fact that these control mechanisms can break down entirely indicates that our human nature exerts tenuous control over our animal nature. This is certainly evident when a ship is sinking and men climb over women and children to get to the life boats.

¹ *Trauma and the Vietnam Generation*, Kukla, Schlenger and Fairbank (Bruner Mazel, 1990).

A body of scientific evidence has accumulated internationally during the past 20-plus years indicating that there is a link between low *serotonin* activity in the brain (serotonin is predominantly an inhibitory chemical) and deficient impulse control that can lead to intermittent explosive disorder, suicide, and severe unrestrained aggression (rage). Furthermore, the evidence indicates that a majority of “type-2” alcoholics (“mean drunks”) have abnormally low brain serotonin activity. In 1994, it was reported that among all perpetrators of recidivist homicides in Finland, 85 percent had type-2 alcoholism. Finally, a tendency toward hypoglycemia (low blood sugar) reduces serotonin activity in the brain and can produce a non-specific sense of impending doom with heart palpitations, anxiety, and in some cases, panic attacks (www.forensic-serotonin.com).

Serotonin

The predominant effects of serotonin in the brain are *inhibitory*. It reduces pain by releasing a chemical similar to morphine into the spine at the site of pain entry, and reduces fear by boosting the action of “GABA,” the most ubiquitous inhibitory substance in the brain. Pharmaceuticals that enhance serotonin activity in the brain are prescribed for impulse-control disorders such as Intermittent Explosive Disorder, Kleptomania, Pyromania, Pathological Gambling, Obsessive-Compulsive Disorder and unrestrained violence (rage). In all of these conditions, the underlying pathology is *loss of control*.

A profoundly important *excitatory* role of serotonin in the brain is its positive effect on the release of dopamine, a natural brain chemical that produces normal drives and rewards (pleasure) for behaviors including eating, love and sex, plus reduced stress and a general sense of well-being. Dopamine is critical for survival. Individuals with dopamine deficiencies due to genetic abnormalities and/or deficient *serotonin* activity in the brain may be virtually incapable of experiencing normal positive rewards. These people are at high risk of becoming addicted to substances and behaviors that produce *unnatural* rewards. This is not mere conjecture. It is firmly established in the scientific literature that dopamine activity in the brain is enhanced by alcohol, cocaine, methamphetamine, heroin, nicotine, marijuana, and by compulsive activities including risk-taking behaviors.

Loss of Serotonin

The serotonin “system” can be damaged *in utero*. There is significant evidence that exposure of the unborn fetus to alcohol, cocaine, and inescapable fear (in cases of severe domestic violence) can have devastating developmental effects. Postnatal traumas can overwhelm the serotonin system resulting in Posttraumatic Stress Disorders (PTSD) that are frequently misdiagnosed as Attention-Deficit/Hyperactivity Disorder (ADHD). Lack of impulse control (disruptive behavior) observed in pre-K and kindergarten is often an antecedent of early alcohol/drug abuse and aggressive behavior.

Does Your Case Fit?

The following criteria indicate that an analysis of serotonin function is warranted in order to assess the defendant’s biological capacity to control his impulses:

- The defendant began drinking alcohol on a regular basis and demonstrated persistent alcohol-seeking behavior prior to age 25.
- The defendant's father, uncle, or maternal male relatives abused alcohol and were generally regarded as "mean drunks."
- The defendant has a history of drug abuse (other than alcohol) associated with personality changes, erratic behavior and violent outbursts.
- The defendant's behavior in adolescence and early adulthood is/was associated with impulsivity, risk-taking (thrill-seeking), low harm avoidance, and a tendency toward antisocial behaviors such as fighting and arrests for reckless driving while intoxicated.
- The defendant or family member(s) have been treated with antidepressant drugs such as Prozac (Fluoxetine), Paxil (Paroxetine), Desyrel (Trazodone), Celexa (Citalopram), Zoloft (Sertraline), Effexor (Venlafaxine), or other selective serotonin reuptake inhibitors (SSRIs).
- The defendant has a history of suicide attempts.
- The defendant has a history of fire-setting.
- The facts of the case suggest that the defendant's act of violence may have been the consequence of a sudden, rapid loss of control "triggered" by some known or unknown factor (similar to the kindling of a forest fire by a single spark).

Serotonin/Dopamine Analyses

Levels of serotonin and dopamine activity in the brain are measured by lumbar puncture (spinal tap) followed by high-pressure liquid chromatography (HPLC), electrochemical detection, and a computer-based data analysis system. The spinal tap is performed in the morning after overnight bed rest and fast (usually in the infirmary of a correction facility). Six 1-ml samples of cerebrospinal fluid (CSF) are drawn from the lumbar region of the spine, immediately frozen on dry ice, and subsequently stored at -70 degrees. Concentrations of 5-HIAA (the major serotonin metabolite) and HVA (the major dopamine metabolite) are measured by electrochemical detection. These measurements are automatically fed into a computer-based analysis program to eliminate human error. The mean (average) concentrations of 5-HIAA and HVA in the defendant's CSF samples are then compared statistically with the mean concentrations of 5-HIAA and HVA in CSF obtained from a group of male control subjects diagnosed as normal at the time of testing. Although there are alternative methods for measuring serotonin and dopamine activity in the brain, the method described here is utilized by the majority of neurobiologists in the field. If the samples are analyzed in triplicate and the analysis is repeated three times the potential for error is negligible.

Treatment and Prevention

An article entitled "The Treatment and Prevention of Violence" was presented by Kathleen Brady, MD, PhD, at the 153rd Annual Meeting of the American Psychiatric Association on May 15, 2000. The article is extensive and highly recommended. Briefly, Brady reports that a number of agents, including lithium, phenytoin, and carbamazepine, have been shown in placebo-controlled trials to decrease impulsive aggression in prison inmates with personality disorders. She reports that serotonin-enhancing drugs are being used to treat impulsive aggression "across the psychiatric disorder spectrum." She

describes the use of serotonin reuptake inhibitors (SSRIs) in the treatment of personality disorders, anger attacks, and violent behavior associated with substance abuse, writing that –

Dysregulation of the serotonin system has been implicated as a causal factor in aggression and violent behavior, and there is also considerable evidence that the serotonin system is involved in substance use disorders, particularly alcoholism. As alcohol decreases serotonin synthesis, serotonin depletion is associated with an increase in alcohol-induced aggression in laboratory studies.

Treatment More Effective than Punishment

The preponderance of international scientific evidence indicates that chemical imbalances in the brain caused by pre- and postnatal factors can significantly impair or virtually eliminate one's biological capacity to control impulsive behaviors, including violence. The notion that punishment can correct these imbalances and thus restore the capacity for self-control is probably erroneous. However, treatment with various psychotropic drugs in a structured environment (primarily serotonin enhancing medications), has proven to be effective in reducing impulsive aggression and violence.

Dr. Paul Rossby, Ph.D is a neurobiologist in El Paso, Texas. He has served as faculty at NLADA's annual training event on death penalty litigation and mitigation investigation, Life in the Balance, which will next be held in Memphis, Tennessee, March 13-16, 2004.