

The investigators gave the youngsters an opportunity to retaliate for perceived slights during a social interaction game, which unfolded during brain scans using functional MRI. The team found that the pathophysiology of retaliatory aggression is independent from that of callous-unemotional traits. In other words, the kinds of sociopathic features that are associated with serial criminals are not the same as those associated with aggression that occurs in the context of retaliation. The retaliatory behavior was elicited in a game in which the research subjects were offered either “fair” or “unfair” arrangements. The subjects could “punish” an opponent who has been “unfair” by way of a financial penalty. All children were willing to punish markedly unfair behavior, but children with DBD were about 50% more likely to punish a moderately unfair behavior. The underlying neuropathophysiology involved an abnormal interaction between brain areas closely related to emotional behavior—the amygdala, the periaqueductal gray, and the ventromedial prefrontal cortex. In general terms, the healthy children appear better able to use their ventromedial prefrontal cortices to modulate their amygdalar responses. Retaliatory behavior is associated with diminished capacity for this control.

The physiological differences do not at this point have enough specificity and sensitivity to be useful for identifying individuals at risk of committing violence. Where they could have some use, as suggested by the authors of the study, is in helping to design and monitor treatment studies. Pharmacological treatments or desensitization techniques might diminish the amygdala or periaqueductal gray response. Educational efforts, perhaps delivered in traditional individual, group, or family psychotherapy settings or through multimedia web-based systems, or both, might increase the regulatory role of the ventromedial prefrontal cortex. Imaging might be useful in monitoring the potential therapeutic effects of these interventions, since actual violent retaliatory acts are generally too sudden and unpredictable to be useful in assessing the efficacy of intervention.

These possible uses are in the future, and there are caveats to the findings of this study that should be considered. Comorbid ADHD and anxiety have effects that need to be addressed in any treatment plan. Although functional MRI provides more mechanistic information than the subjects' behavior alone, this measure of hemodynamic activity is only an indirect indication of how the brain works. Nonetheless, we have the beginning of an answer to the question of *why*, a question that has vexed moral philosophers for hundreds of years: Why do individuals engage in seemingly purposeless acts of mass violence?

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Dr. Freedman is Editor-in-Chief of the Journal and Dr. Michels is a Deputy Editor. Dr. Freedman has a patent through the Department of Veterans Affairs on CHRNA7 sequences; he derives no income from it. Dr. Michels reports no financial relationships with commercial interests.

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