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Math Formula May Explain Why Serial Killers Kill

By Natalie Wolchover | January 18, 2012 11:52am ET

Anthony Hopkins as Hannibal Lecter, a serial killer in the 1991 film "The Silence of the Lambs."

Credit: MGM

Researchers have discovered that the seemingly erratic behavior of the "Rostov Ripper," a prolific serial killer active in the 1980s, conformed to the same mathematical pattern obeyed by earthquakes, avalanches, stock market crashes and many other sporadic events. The by earthquakes, avalanches, stock market crashes and many other sporadic events. The finding suggests an explanation for why serial killers kill.

Mikhail Simkin and Vwani Roychowdhury, electrical engineers at the University of California, Los Angeles, modeled the behavior of Andrei Chikatilo, a gruesome murderer who took the lives of 53 people in Rostov, Russia between 1978 and 1990. Though Chikatilo sometimes went nearly three years without committing murder, on other occasions, he went just three days. The researchers found that the seemingly random spacing of his murders followed a mathematical distribution known as a power law.

When the number of days between Chikatilo's murders is plotted against the number of times he waited that number of days, the relationship forms a near-straight line on a type of graph called a log-log plot. It's the same result scientists get when they plot the magnitude of earthquakes against the number of times each magnitude has occurred — and the same goes for a variety of natural phenomena. The power law outcome suggests that there was an underlying natural process driving the serial killer's behavior.

Simkin and Roychowdhury hypothesize that it's the same type of effect that has also been found to cause epileptics to have seizures. The psychotic effects that lead a serial killer to commit murder "arise from simultaneous firing of large number of neurons in the brain," they wrote. The paper, a preprint of which is available on the arXiv, has been submitted to Biology Letters.

In the brain, the firing of a single neuron can potentially trigger the firing of thousands of others, each of which can in turn trigger thousands more. In this way, neuronal activity cascades through the brain. Most of the time, the cascade is small and quickly dies down, but occasionally — after time intervals determined by the power law — the neuronal activity surpasses a threshold.

In epileptics, a threshold-crossing cascade of neurons induces a seizure. And if the Simkin and Roychowdhury's theory is right, a similar buildup of excited neurons is what flooded the Rostov Ripper with an overwhelming desire to commit murder. Sometimes he went years without his neurons crossing the threshold, other times, just days.

When Simkin and Roychowdhury factored a delay into their model to account for the time it took for Chikatilo to plan his next attack, and when they treated his murders as having had a sedative effect on him by damping down the activity of his neurons, their model fit strongly with his murder pattern. [Bridge Theft, and Other Weird Crimes]

Murder rhythm

James Fallon, a neuroscientist at UC Irvine who studies the brains of psychopaths, said the new findings are well-aligned with prior observations about serial killers, many of whom seem to behave similarly to drug addicts. In both cases, Fallon said, withdrawal from their addiction "builds and builds and then hits a threshold trigger point, after which they go on a spree to release that 'longing.'"

And as with a drug addiction, withdrawal from killing may cause a buildup of hormones in a part of the brain called the amygdala, "and this very, very unpleasant feeling can only be reversed by acting out whatever the addicting stimulus might be," Fallon told Life's Little Mysteries, a sister site to LiveScience.

Though the new paper presents a compelling systems-engineering quantitative analysis of serial killing, the theoretical model must be adjusted, Fallon said. "The time course of [neuronal cluster firing] is in terms of milliseconds to seconds, and not months to years (which the authors acknowledge). So I think they need to add a component, perhaps a hormonal-type damping mechanism that has a time constant over weeks, months and years," he wrote in an email.

These types of hormonal clocks are involved in producing many types of biological rhythms, including the sleep-wake cycle, reproductive cycle and even the "sexual rut," Fallon said. If the authors were able to model a hormonal influence on the behavior of serial killers, "they may uncover a 'serial killer rhythm,' or some such beast."

Puppets of biology

Amanda Pustilnik, an assistant professor at the University of Maryland School of Law whose work focuses on models of the mind and neuroscience in criminal law, believes that a more rigorous, expanded version of the new paper could be admissible in court cases involving serial killers. However, as it stands, there isn't enough to go on.

"Certain patterns can occur randomly in nature without meaning anything. While it is interesting in itself that the case of this one serial killer fits a power law distribution, it would be incorrect to draw conclusions from that," Pustilnik said. "If [the authors] can expand their data set and it can turn out to be a more statistically valid model, then it might be an interesting line of research on recurring human behaviors caused by an urge or drive and the discharge of an urge or drive."

According to Pustilnik, neuroscience research demonstrating that a psychopath is merely a victim of his own faulty biology cannot be used in court as an argument for his innocence. It is admissible, however, as evidence that a jury should be lenient during sentencing.

"When we're trying to figure out 'how blameworthy is this person?', I can imagine that a serial killer could use this finding at sentencing to argue that he was not morally blameworthy, but rather the puppet of his biology," she said."As in, 'the neuron firing pattern makes me do this.'"

To be used as such, though, the result of the case study would need to be generalized across a much larger set of cases to determine whether its finding is significant, or merely a chance correlation, Pustilnik said.

As well as expanding the research to include a larger data set, there are many other lines of further inquiry. The study authors say they suspect many common human behaviors that stem from urges or addictions may also follow a power law distribution. For example, "shopping or getting drunk may follow similar pattern for some people," Simkin wrote in an email. Like some murders, these behaviors might be even less governed by free will than previously believed.

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