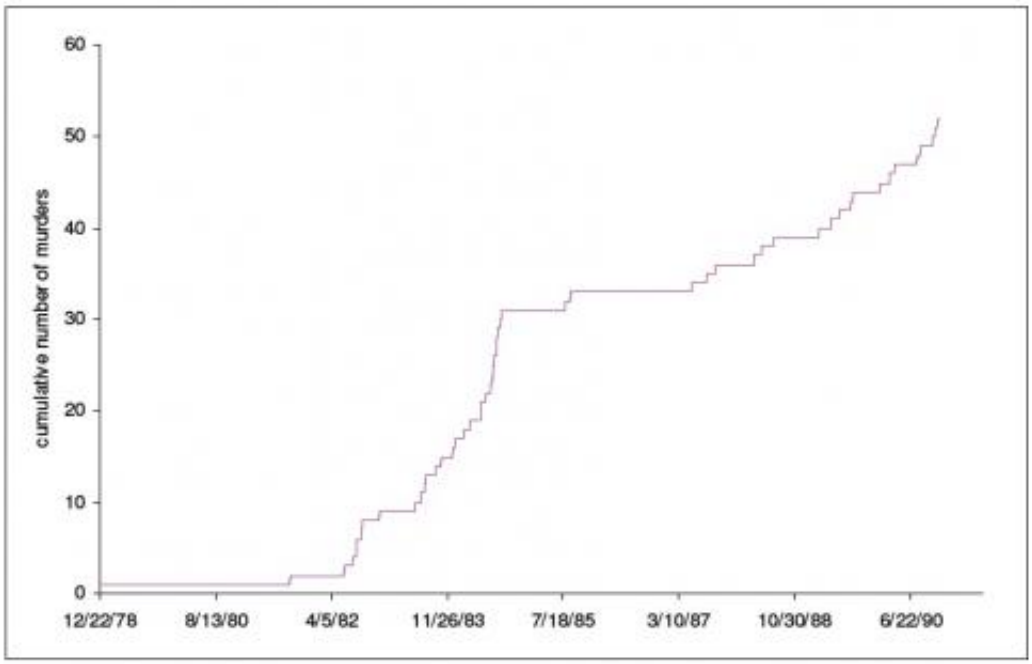
Serial killing follows predictable pattern based on brain activity

January 18 2012, by Lisa Zyga



A graph of the cumulative number of murders committed by Andrei Chikatilo over 12 years. The irregular plot is a “Devil’s staircase.” Image credit: Simkin and Roychowdhury

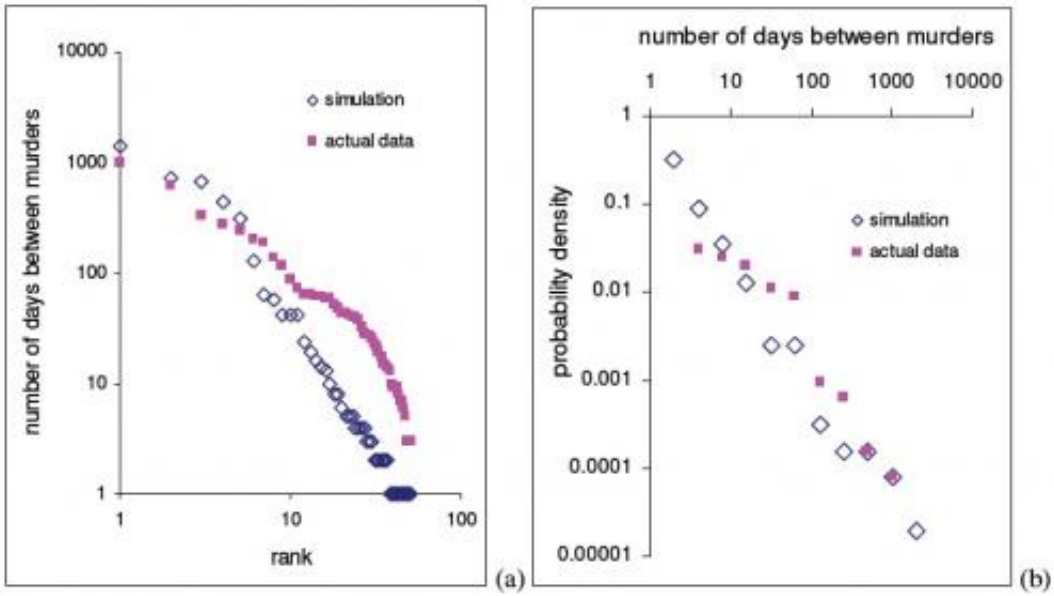
(PhysOrg.com) -- Over a period of 12 years, Andrei Chikatilo murdered at least 53 people before being arrested in Rostov, Russia, in 1990. While Chikatilo’s killings, mainly of women and children, may have been senseless, a new study has found some sense in the distribution of intervals between the murders, which closely follows a power law. The

researchers propose that the murder activity can be explained by a model describing neuronal firing in the brain, very similar to the model that describes the distribution of intervals between epileptic seizures.

The researchers, Mikhail Simkin and Vwani Roychowdhury, both electrical engineers from the University of California, Los Angeles, began their analysis by making a graph showing Chikatilo's cumulative number of murders over the 12-year period. The graph is highly irregular, with long time periods with no murders interrupted by short time periods with many murders. The shortest interval between murders was three days, while the longest was more than two years. Due to this irregularity, and the step-like appearance of the plot, mathematicians call this distribution a "Devil's staircase."

Next, the researchers graphed the distribution of intervals between murders, clearly showing that short intervals are more common than long intervals. Somewhat surprisingly, this distribution of intervals between murders is very similar to the distribution of intervals between epileptic seizures, with both following a similar power law. Simkin and Roychowdhury note that previous research has suggested a link between epilepsy and criminality (and psychosis), so the possibility that similar processes in the brain may lead to both epileptic seizures and serial murders is not unreasonable.

The researchers previously proposed a model based on the brain's neuron firing to explain the distribution of intervals between epileptic seizures, and here they've applied the same model to explain the distribution of intervals between murders. They hypothesize that the simultaneous firing of a large number of neurons in the brain induces psychotic effects that cause a serial killer to commit murder, similar to the effects that induce epileptic seizures.



Distributions of intervals in the Devil's staircase plot closely obey a power law simulation. Short intervals between murders occur much more often than longer intervals. Image credit: Simkin and Roychowdhury

The researchers explain that the probability of any neuron firing randomly is small. But since the axon of one neuron can connect to the synapses of thousands of other neurons, if that neuron fires then its impulse could cause others to fire if they're close to the firing threshold. The model predicts that the killer commits murder when the total number of firing neurons reaches a certain threshold - or "murder zone" - for a certain period of time. During this time of abundant neuron firing, the killer plans, prepares, and carries out the crime.

The model assumes that committing a murder has a sedative effect on the killer, causing neural excitation to fall below the threshold. (Otherwise, the neural excitation would be in the murder zone for half the total time.) But neuron firing must still be close to the threshold, since the probability of a new murder is significantly higher in the days after a murder compared to the average murder rate.

Although the model closely approximates Chikatilo's behavior, the researchers note that it's not exact. The biggest disagreement is that the model predicts several one-day intervals between murders, while Chikatilo's shortest interval was three days. The researchers think that accounting for successful and unsuccessful murder attempts could improve the agreement between the model and data.

Although it's difficult to tell if understanding the patterns of a serial killer will help prevent murders, the fact that any kind of rational explanation may exist for seemingly irrational behavior is both uncomfortable and revealing.

More information: M.V. Simkin and V.P. Roychowdhury. "Stochastic modeling of a serial killer." arXiv:1201.2458v1 [physics.soc-ph]

via: Physics arXiv Blog