Deep learning to analyze neurological problems

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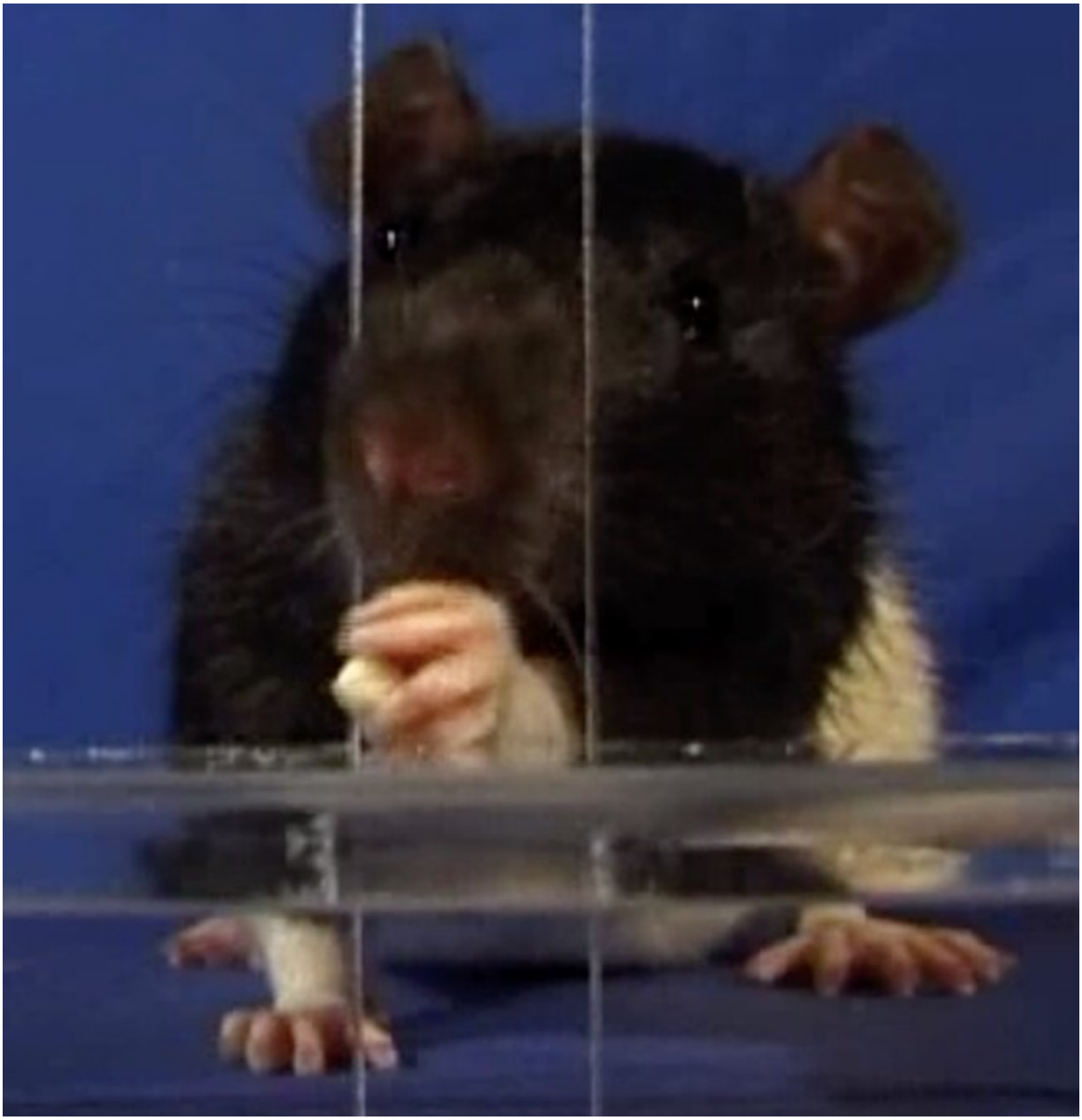

Movement inaccuracies during reaching for a food pellet can reveal brain damage in rats and humans. Artificial neural networks can be trained to score motor deficits to monitor the progress of neurological disorders with human-expert accuracy. Credit: Artur Luczak

Getting to the doctor's office for a check-up can be challenging for someone with a neurological disorder that impairs their movement, such as a stroke. But what if the patient could just take a video clip of their movements with a smart phone and forward the results to their doctor? Work by Dr. Hardeep Ryait and colleagues at CCBN-University of Lethbridge in Alberta, Canada, publishing November 21 in the open-access journal *PLOS Biology*, shows how this might one day be possible.

Using rats that had incurred a stroke that affected the movement of their fore-limbs, the scientists first asked experts to score the rats' degree of impairment based on how they reached for food. Then they input this information into a state-of-the-art deep neural network so that it could learn to score the rats' reaching movements with human-expert accuracy. When the network was subsequently given video footage from a new set of rats reaching for food, it was then also able to score their impairments with similar human-like accuracy. The same program proved able to score other tests given to rats and mice, including tests of their ability to walk across a narrow beam and to pull a string to obtain a food reward.

Artificial neural networks are currently used to drive cars, to interpret video surveillance and to monitor and regulate traffic. This revolution in the use of artificial neural networks has encouraged behavioural neuroscientists to use such networks for scoring the complex behaviour of experimental subjects. Similarly, neurological disorders could also be assessed automatically, allowing quantification of behaviour as part of a

check-up or to assess the effects of a drug treatment. This could help avoid the delay that can present a major roadblock to patient treatment.

Altogether, this research indicates that deep neural networks such as this can provide a reliable score for neurological assessment and can assist in designing behavioural metrics to diagnose and monitor neurological disorders. Interestingly, the results revealed that this network can use a wider range of information than that included by experts in a behavioural scoring system. A further distinct contribution of this research is that this network was able to identify features of the behaviour that are most indicative of motor impairments. This is important because this has the potential to improve monitoring the effects of rehabilitation. This method would aid standardization of the diagnosis and monitoring of neurological disorders, and in the future could be used by patients at home for monitoring of daily symptoms.

More information: Ryait H, Bermudez-Contreras E, Harvey M, Faraji J, Mirza Agha B, Gomez-Palacio Schjetnan A, et al. (2019) Data-driven analyses of motor impairments in animal models of neurological disorders. *PLoS Biol* 17(11): e3000516. doi.org/10.1371/journal.pbio.3000516