How gamblers plan their actions to maximize rewards

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In their pursuit of maximum reward, people suffering from gambling disorder rely less on exploring new but potentially better strategies, and more on proven courses of action that have already led to success in the

past. The neurotransmitter dopamine in the brain may play an important role in this, a study in biological psychology conducted at the University of Cologne's Faculty of Human Sciences by Professor Dr. Jan Peters und Dr. Antonius Wiehler suspects. The article "Attenuated directed exploration during reinforcement learning in gambling disorder' has appeared in the latest edition of the *Journal of Neuroscience*, published by the Society for Neuroscience.

Gambling disorder affects slightly less than one percent of the population—often men—and is in some ways similar to substance abuse disorders. Scientists suspect that this disorder, like other addiction disorders, is associated with changes in the dopamine system. The brain's reward system releases the neurotransmitter dopamine during gambling. Since dopamine is important for the planning and control of actions, among other things, it could also affect strategic learning processes.

"Gambling disorder is of scientific interest among other things because it is an addiction disorder that is not tied to a specific substance," Professor Dr. Jan Peters, one of the authors, remarked. The psychologists examined how gamblers plan their actions to maximize rewards—how their so called reinforcement learning works. In the study, participants had to decide between already proven options or new ones in order to win as much as possible. At the same time, the scientists used functional magnetic resonance imaging to measure activity in regions of the brain that are important for processing reward stimuli and planning actions.

Twenty-three habitual gamblers and twenty-three control subjects (all male) performed what is known as a 'four-armed bandit task." The name of this type of decision-making task refers to slot machines, known colloquially as 'one-armed bandits." In each run, the participants had to choose between four options ('four-armed bandit," in this case four colored squares), whose winnings slowly changed. Different strategies

can be employed here. For example, one can choose the option that yielded the highest profit last time. However, it is also possible to choose the option where the chance of winning is most uncertain—the option promising maximum information gain. The latter is also called directed (or uncertainty-based) exploration.

Both groups won about the same amount of money and exhibited directed exploration. However, this was significantly less pronounced in the group of gamblers than in the control group. These results indicate that gamblers are less adaptive to changing environments during reinforcement learning. At the neural level, gamblers showed changes in a network of brain regions that has been associated with directed exploration in previous studies. In one previous study by the two biological psychologists, pharmacologically raising the dopamine level in healthy participants had shown a very similar effect on behavior. "Although this indicates that dopamine might also play an important role in the reduction of directed exploration in gamblers, more research would have to be conducted to prove such a correlation," said Dr. Antonius Wiehler.

Further research also needs to clarify whether the observed changes in decision-making behavior in gamblers are a risk factor for, or a consequence of, regular gambling.

More information: A. Wiehler et al, Attenuated Directed Exploration during Reinforcement Learning in Gambling Disorder, *The Journal of Neuroscience* (2021). DOI: 10.1523/JNEUROSCI.1607-20.2021

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