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Study uncovers surprising differences in brain activity of alcohol-dependent women

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A new Indiana University study that examines the brain activity of alcohol-dependent women compared to women who were not addicted found stark and surprising differences, leading to intriguing questions about brain network functions of addicted women as they make risky decisions about when and what to drink.

The study used functional magnetic resonance imaging, or fMRI, to study differences between patterns of brain network activation in the two groups of women. The findings indicate that the anterior insular region of the brain may be implicated in the process, suggesting a possible new target of treatment for alcohol-dependent women.

"We see that the network dynamics of alcohol-dependent women may be really different from that of healthy controls in a drinking-related task," said Lindsay Arcurio, a graduate student in the Department of Psychological and Brain Sciences. "We have evidence to suggest alcohol-dependent women have trouble switching between networks of the brain."

The research is part of a larger new effort to understand the differences between men and women with respect to alcohol. Arcurio said most of the research on alcohol dependence has been conducted with men or groups of men and women. Yet several factors make looking at women "really important."

One such factor is that the physiological effects of drinking alcohol,

which include liver damage, heart disease or breast cancer, set in much earlier in women than in men. For this reason, the suggested limit on the number of drinks per week that women can safely consume is eight, whereas for men, it is 14. Secondly, binge-drinking in women is on the rise. One in five adolescent girls is binge-drinking three times a month. In women between the ages of 18 and 54, that number is one in eight.

A 'sledgehammer' approach to defining differences in brain network activation

Research on decision-making mechanisms in alcohol-dependent individuals typically involves a general risk-taking situation in which money or points are at stake. In this study, participants were placed in the fMRI brain scanner and asked to consider low-risk and high-risk situations specifically related to alcohol—what the researchers describe as "ecological" tasks. Participants were then asked to make decisions regarding control stimuli—food as well as a presumably neutral stimuli, a stapler—to observe whether risky behavior was greater with respect to drinking than with these other items. The same picture cues were used to present high-risk and low-risk scenarios, and these two extremes were as follows:

For the low-risk situation, participants were told: Imagine you are at a bar. You are offered a drink, already paid for, with two shots of alcohol, and you have a safe ride home. For the high-risk, they were told: You are at a bar and are offered a drink already paid for, with six shots of alcohol, but you do not have a safe ride home.

The reason for such an extreme contrast between the two situations, Arcurio said, is that "as one of the first ecological tasks used in the scanner, we wanted to take a sledgehammer approach to really find the differences between cases that are definitely high-risk and those that are

definitely low-risk."

The findings, however, reflect an equally sharp contrast in differences between the brain network activation in alcohol-dependent women versus the controls.

For the control group, high-risk decisions to drink led to the deactivation of regions associated with "approach behavior," deciding to take the drink in a risky situation. Conversely, women in the control group activate regions associated with the default mode network, a region traditionally thought to involve resting-state behavior or inactive or relaxed mental state, but which some now speculate plays a role in conceptualizing one's future.

"It gets really interesting," Arcurio said, "comparing this pattern of activation to those in alcohol-dependent women, who behaviorally say they're more likely to take the high-risk drink compared to the controls. They don't deactivate anything. In contrast to the controls, alcohol-dependent women activate all three regions in question. They activate regions associated with reward (which release dopamine). They also activate frontal control regions involved in cognitive control and regions associated with the default mode network, involved in resting-state behavior. They are activating everything."

The investigators infer from these findings that alcohol-dependent women have trouble switching between networks. Being unable to activate one region and deactivate another in response to an alcohol-related situation means they are unable to use one strategy over another.

Furthermore, Arcurio said, "a lot of evidence suggests that switching between networks is influenced by the anterior insular and anterior cingulate regions of the brain, and we did find major differences in the insula between the alcohol-dependent women and controls. We're

thinking the issue is pinpointed to that region."

The researchers are now running analyses to test the hypothesis that the insula helps in this process, which could offer new possibilities for intervention, with both behavioral therapy and medication.

The research is part of a whole research program, both planned and in the works, to further explore the questions about risky decision-making in alcohol-dependent women: studies of adolescent drinking, risky sexual behavior in alcohol-dependent women, the interaction of visual networks with decision-making networks, as well as the way music (or auditory networks) interacts with decision-making mechanisms in alcohol-dependent women. In the latter experiment, college-age participants choose a song that they associate with drinking and one with quiet reflection.

"There's a lot of Miley Cyrus in the first category," Arcurio said.

More information: The current study, "Neural mechanisms of high-risk decisions-to-drink in alcohol-dependent women," appears in the Dec. 23 issue of *Addiction Biology*.

Provided by Indiana University