What increases someone's risk of developing addiction?

Why are some people more likely to develop alcohol or drug problems than others? **Professor Ashley Acheson**, a behavioural neuroscientist at the **University of Arkansas for Medical Sciences** in the US, is exploring how risk factors, such as having a family history of alcohol or other substance use disorders, can affect the brain, immune system and behaviour of children and young adults. By studying the biological factors that may increase addiction risk, he aims to identify a 'pre-addiction' stage so that serious alcohol and drug problems could be prevented.

Professor Ashley Acheson

Department of Psychiatry, University of Arkansas for Medical Sciences, USA

PROFILE

Field of research
Behavioural neuroscience

Research project
Investigating biological and behavioural factors associated with risk for alcohol and other substance use disorders

Funder
US National Institutes of Health (NIH)

doi: 10.33424/FUTURUM648

Talk like a ...

behavioural neuroscientist

Alcohol or other substance use disorders — medical conditions in which someone struggles to control their alcohol or drug use, despite negative consequences

Bacterial endotoxin — the outer membrane of a bacterial cell that causes an immune response

Cognitive performance — how well the brain carries out mental tasks such as memory, attention and decision-making

Cortisol — a hormone released in response to stress

Cytokines — proteins released by immune cells that coordinate the body's immune response

Early life adversity — negative experiences during childhood

Magnetic resonance imaging (MRI) — a technique that can take images of a living brain

Stress response — how the body reacts to challenges or threats

White matter — bundles of nerve fibres that allow different brain regions to communicate

"Addictive disorders have tremendous costs for afflicted individuals, their families and their communities," says Professor Ashley Acheson, a behavioural neuroscientist at the University of Arkansas for Medical Sciences. "If we better understood what makes people vulnerable to addiction, we could do better at preventing it." Ashley's research focuses on identifying behavioural and biological traits associated with addiction risk factors, such as having a family history of alcohol or other substance use disorders and exposure to early life adversity. "Just having these risk factors doesn't mean someone will develop alcohol or drug problems," he emphasises. "However, they are more likely to have behavioural characteristics that put them at increased risk."

Research by Ashley and others has found these characteristics include things like increased impulsivity and, to a lesser extent, increased tendencies for depression and anxiety. The underlying biology driving these behavioural characteristics is much less clear, and Ashley believes that understanding this may be critical for improving prevention and treatment of addictive disorders. Much of this work has been done as part of the Family Health Patterns Project, a long-running study aimed at identifying behavioural and biological factors underlying risk for addictions, started by Professor William Lovallo in 2001.

What biological systems does Ashley study?

Ashley and his team have focused on

Ashley and his collaborator Professor Xiawei Ou in the MRI control room where they scan Arkansas children for the HEALthy Brain and Child Development Study.

studying brain differences associated with having a family history of alcohol or other substance use disorders. They have found evidence for reduced or altered white matter in frontal regions of the brain which are critical for decision-making and impulse control. They have also found evidence for altered brain activity while performing tasks involving these same processes.

Ashley and his team have found that a family history of alcohol or other substance use disorders is also associated with decreased stress responses. They observed this by asking young adults to take part in a mock job interview or give a short speech – situations in which most people feel nervous. Typically, stress causes the heart to beat faster and leads to a spike in the hormone cortisol. However, those with a family history of alcohol or other substance use disorders generally had smaller increases in heart rate and cortisol.

While decreased stress responses may seem beneficial, this could be problematic as stress hormones play important roles in regulating the immune system. This led Ashley to hypothesise that immune regulation could be altered or impaired in people with a family history of alcohol or other substance use disorders. Indeed, blood tests showed that having a family history of alcohol or other substance use disorders was associated with having more white blood cells, and when Ashley and the team exposed these immune cells to bacterial endotoxin in the lab, more cytokines were released. They are now studying why this immune overreaction occurs, and how it may affect the brain. "We think that altered immune regulation and increased immunoreactivity could result in neural changes that are responsible for risk-related behavioural characteristics," says Ashley.

How does Ashley study brains and behaviours?

Ashley uses advanced magnetic resonance imaging (MRI) techniques to capture high resolution anatomical images of young adults' brains. For example, diffusion MRI tracks water movement and can be used to study white matter characteristics, while functional MRI can be used to study blood flow through the brain. "Brain differences in people with alcohol or drug problems are often assumed to be a consequence of excessive use," explains Ashley. "But we have seen similar differences in at-risk people before alcohol or drug problems start."

To assess behavioural traits, Ashley and the team use self-reported measures. Participants complete questionnaires about their mood, social behaviours and alcohol and drug use, and they take computer-based tests of attention, memory and reactions to stimuli. Decision-making tasks are also important. For example, participants are asked whether they would rather receive a smaller reward now or wait for a larger one later. By varying the size and timing of rewards, Ashley and the team can observe how participants value immediate versus delayed outcomes, giving insight into self-control and future planning. They have discovered that participants with a family history of alcohol or other substance use disorders are more likely to choose smaller, immediate rewards than larger delayed ones. They have also observed that people who were exposed to more early life adversity (whether or not this was associated with a family history of alcohol or other substance use disorders) are less likely to value delayed rewards.

Why are some people at increased risk of addiction?

"We don't know for sure why some people have an increased risk of addiction," says Ashley. "However, we have found that having a family history of alcohol or other substance use disorders and exposure to early life adversity can set a chain of events in motion that can increase the risk for addiction." The team believes that altered immune system regulation contributes to neurological changes, including disruption to white matter development and white matter damage. These brain changes are linked to cognitive differences, such as not valuing delayed rewards. This reduced cognitive control can influence behaviour, contributing to traits such as impulsivity and, ultimately, making people more vulnerable to addictions.

** Do you need support? **

The National Association for Children of Addiction provides help and support for people with a family history of alcohol or other substance use disorders:
US: **nacoa.org**
UK: **nacoa.org.uk**

In the US, the Substance Abuse and Mental Health Services Administration provides support for substance use disorders: **samhsa.gov**

In the UK, FRANK provides information about drugs (including alcohol) and a confidential helpline: **talktofrank.com**

The HEALthy Brain and Child Development Study

"At the moment, we don't know how much of addiction risk is inherited or a result of stress and other exposures during pregnancy and early life," says Ashley. To help better understand this, Ashley is one of the principal investigators of the nationwide HEALthy Brain and Child Development (HBCD) Study. "This is the largest study of childhood brain development ever conducted in the US," he says. "We are following over 7000 mother-child pairs from before birth to at least age 10, to investigate how external factors influence brain development throughout childhood." The study uses MRI, other brain scanning techniques, cognitive tests and observations of family interactions to track how children's brains develop over time. Researchers also examine how external factors, including parental alcohol and drug use, early life adversity, and the social and physical environments children grow up in, affect development.

Could we prevent addiction?

Ashley hopes his research will be used to identify the early signs that someone may be at higher risk of developing an alcohol or other substance use disorder, much like doctors can detect pre-diabetes before the full condition develops. "We want to do the same for addiction," says Ashley. "We want to identify a pre-addiction state where we can intervene before major problems start. Understanding the underlying biology of addiction risk is crucial for this. I think there is tendency to think people should just make better choices about alcohol and drugs, but the reality is there are likely underlying biological differences that makes that a lot harder for some people."

About *behavioural neuroscience*

"Behavioural neuroscience is the study of how the brain controls and influences behaviour," explains Ashley. It combines psychology and neuroscience, integrating an understanding of brain structure and function with the study of behaviour and associated processes. Researchers in this field investigate how biological processes in the brain regulate behaviour, emotions, decision-making, learning, memory and social interactions. By linking behaviour to brain activity, behavioural neuroscientists explore why people think and act the way they do, including studying biological mechanisms underlying addiction and other mental health conditions.

Ashley's team collects blood samples from participants to investigate immune regulation in people with a family history of alcohol or other substance use disorders.

Pathway from school to *behavioural neuroscience*

At high school, study biology and psychology to learn about the brain and human behaviour.

At university, study an undergraduate degree in neuroscience or psychology, followed by a graduate degree in behavioural neuroscience.

"Get research experience," advises Ashley. "Look for opportunities to work or volunteer in a behavioural neuroscience research lab and help with experiments or analysing data. This will give you useful practical experience, which is important for graduate school admissions."

Explore careers in *behavioural neuroscience*

Many behavioural neuroscientists work as academic researchers in universities, conducting studies to investigate how the brain influences behaviour. There are also opportunities for careers in the pharmaceutical and other industries.

Ashley highlights the importance of getting exposure to research. "This is important to get a sense of what research careers involve," he says. "Talk to researchers to get a good understanding of what their jobs are really like and whether this is a career path that seems right for you."

International organisations such as the American Psychological Association (**apa.org/education-career/k12**), the Society for Neuroscience (**sfn.org/outreach**) and the British Neuroscience Association (**bna.org.uk**) provide educational resources and careers guidance.

Meet *Ashley*

My brother and I were the first in our family to graduate from college. I wasn't very motivated in high school, and I wasn't excited about going to college, but my parents encouraged us to at least give it a try. However, once I started, I discovered how much more interesting studying at college was. High school was a lot of homework and memorisation, but in college everything became much more conceptual and interesting.

At college, I became interested in psychology. Ever since I was a little kid, I've loved watching nature shows and learning about animal behaviour – and I still do! I've always thought behaviour was fascinating, and that drew me to psychology.

I wasn't sure what I would do with psychology after college. I considered working in human resources (HR), so I took some business classes, but I didn't enjoy them. Eventually, I took a class called physiological psychology (essentially behavioural neuroscience), and I loved it. I volunteered in my professor's lab and completed my honours thesis with her. She was a great mentor, and it's hard to imagine getting from where I started to where I am now without my college experience and her guidance.

My favourite part of being a scientist is coming up with new ideas. The most rewarding parts of my job are developing hypotheses, interpreting data, and figuring out how my findings integrate with work others are doing. My colleagues make my work enjoyable, especially ones from different training backgrounds who have different perspectives.

A lot of my free time goes to family activities with my wife and kids. I also exercise a lot. Most people in my neighbourhood probably know me as the guy who lifts weights in his garage and walks his dogs every day. I used to scuba dive regularly and am looking forward to getting back into that when the kids are older.

Ashley's *top tip*

Look down the road. My summer job after my freshman year in college was unloading semi-trucks for a wholesale food and restaurant supply distributor. I would ride along with the drivers, and we'd make deliveries to restaurants, cafeterias, grocery stores and prisons throughout Wisconsin, Minnesota and Illinois. Not long I after I started, I asked one of the drivers how he managed to drive through busy metro areas. He told me he was always looking several blocks down the road, because if he only looked at a few car lengths ahead he never would have enough time to deal with anything. Something about that stuck with me. Life is a lot easier when you're not just focused on the challenge right in front of you and can see a bigger picture instead.