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The Centre for Studies on Human Stress is dedicated to improving the physical and mental health of individuals by empowering them with scientifically grounded information about the effects of stress on the brain and body.



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Stress and Addiction: **Two Closely Related Phenomena**

By Catherine Raymond, Julie Katia Morin-Major and Robert-Paul Juster

We can be addicted to many things... this is something we all know. When talking about addiction, we often think about addiction to various substances. In fact, we probably all have someone in our immediate or distant environment that suffers from alcohol or cigarette addiction. However, when we stop to think about it, we certainly also know someone who is emotionally addicted to others, addicted to his cell phone, to games of chance or even to food. If you are a regular reader of the *Mammoth Magazine*, you are probably asking yourself: “where are you going with this?”, because we always talk about stress! Well as you’ll learn, stress and addiction are two closely related phenomena. As a matter of fact, stress can play a big role in the acquisition and relapse of addictive behaviors. It can also bring about a lot of stress to the addict and to his/her family and friends.

Whether you’re addicted to alcohol, drugs, games of chance or even to people that surround you, the cerebral mechanisms responsible for many of these self-destructive behaviors are similar. Yes, you heard right... addiction is partially a cerebral phenomenon. Although a popular conception states that addiction is a simple lack of willpower, science reveals that it is far more complicated a problem. In keeping with the new *Mammoth Magazine* edition’s theme, it is not simply psychological phenomenon either. Could it be possible then that people suffering from addiction and who are conscious of their condition and have all of their willpower in tact can experience difficulties stopping their self-destructive behaviors just because their brains are playing tricks on them? Science has showed that addictive behaviors are in fact not dependent of the person’s good will alone. We actually know today that many factors play roles in this type of struggle.

Continued on page 2



Stress and Addiction. . .

The principal objective of this *Mammoth Magazine* edition is to describe what 'addiction' is and the role of stress in the acquisition and relapse of an addictive behavior. The second objective building upon many years of research and based on the opinion of a specialist well-known in the field, is to demolish the popular conception that addiction is only due to a lack of willpower on the addict's part. In this *Mammoth Magazine's* edition, you'll be able to read many decades of research about addiction. Through this research, we hope you'll be able to read between the lines the message that helps dispel stigma.

This 15th Mammoth Magazine edition focuses on the phenomenon of addiction and also on the influence that stress has on it. So that we can offer you a quality issue, we asked Dr Stéphane Potvin, researcher at the Centre de recherche de l'Institut universitaire en santé mentale de Montréal (CRI-USMM) and expert in the phenomenon, to be our invited chief editor.

In the first article, Olivier Bourdon and Sophia Cayer-Falardeau, both Bachelor students in psychology and summer interns at the Centre for Studies on Human Stress (CESH), will establish the basis of this issue by giving a psychological and biological definition of "addiction" and also by explaining the impact of stress on the acquisition and relapse of addictive behaviors.

Secondly, Anne-Laure Dubé, a Bachelor student in psychology and summer intern at the CESH, gives a voice to Gilles (fictional name), a former alcoholic who tells his story and explains how he made it through his addiction.

In the third article, Dr Stéphane Potvin tells us about his most recent research. Throughout his article, he will describe the cerebral mechanisms responsible for addictive behaviors and how personality and stress can influence the persistence of substance use in addicts.

The fourth article written by Julien Ayotte, a Master student in Neuroscience at the CESH, will explain the reason why we tend to eat high-fat and high-sugar foods when facing a stressful event. Julien will also tell us more about the controversial phenomenon of "food addiction".

In our fifth article, Julie Katia Morin-Major, a Master student at the CESH, will review the latest news on a contemporary subject: addiction to technology.

Finally, Catherine Raymond, a PhD student in Neuroscience at the CESH and Nathalie Wan, a research assistant at the CESH, created a list of many resources available in the region of Montréal that you can consult if you or someone close to you needs help.

We hope you enjoy reading this issue! 



Par amour du stress

Sonia Lupien, Ph.D., Director of the Centre for Studies on Human Stress of the Institut universitaire en santé mentale de Montréal and professor in the Department of Psychiatry at University of Montreal published her first book titled "Par amour du stress" in French only at the moment.

"Contrary to what people think, stress is not a disease: it is essential to human survival", explains the author who also directs the Research Centre of the Institut. "On the other hand, if you endure chronic stress, this can have dire consequences."

In this book, Sonia Lupien writes in a simple style full of imagery and with a pinch of humour, the combined results of 20 years of scientific studies on stress, its' causes, its' symptoms, and its' long-term consequences on the human body. She proposes surprising methods to control it, which all of us can achieve.



What is Addiction?

By Olivier L Bourdon and Sophia Cayer-Falardeau, B.Sc.,
Summer Interns at the Centre for Studies on Humain Stress.
Translated by Julien Ayotte, B.Sc.

Human beings have many needs. Fortunately for the survival of our species, we are motivated towards many pleasant things and are more-over driven by our need to satisfy essential needs (eating, drinking, clothing, housing, etc.). But what happens when we crave things that are not needed for our survival? What happens when we behave against our nature for things that are not needed and potentially even damaging? In most cases, we are able to apply reason and control ourselves from these unnecessary needs. However, for some people, the “quest for pleasure”¹ becomes a bottomless pit, an insatiable quest. As a result, some will gradually develop “addiction”.

So... what is addiction? Despite decade of scientific advances on this topic, the idea that addiction is a problem based on willpower rather than on biological processes persists even today. In 1950, the American Medical Association declared addiction a disease, an important first step in changing the popular view of this behavior (Lemonick, 2007). Many definitions of this disorder have since been proposed. For example, Joseph Frascella of the National Institute on Drug Abuse defines addiction as behaviors continuously repeated in spite of their negative consequences (Frascella in Lemonick, 2007). There are two types of addiction: psychological addiction and physical addiction. The first is defined as a state of anxiety or discomfort following deprivation of the addictive stimulus, whereas the second expresses itself as a physical sensation known as craving following the same deprivation. This article aims to provide you with a psychosocial and biological definition of the “science of pleasure” and addiction, as well as demonstrate how stress is connected in various ways to this phenomenon.

The science of pleasure

Maggie is hungry. She opens the food cabinet, takes out a chocolate bar and proceeds to eat some of it, providing her with some pleasure. This is an example of the desire-action-satisfaction cycle allowing us to fulfill primary needs and thus maintain physiological balance. By making basic needs pleasurable and fulfilling, this cycle contributes to the survival of our species. However, this cycle can lead to adverse effects by making everything that brings satisfaction desirable. In other words, our reward system can become addicted to things unnecessary for survival.



Many environmental factors will influence our desire-action-satisfaction cycle. For example, when facing a stressor, a cascade of neuronal and hormonal events will perturb our physiological balance. To dampen this stress response and thus re-establish physiological balance across the body, an individual will instinctively look for a solution and overlook whether it is suitable or not. For instance, some will go for a run whereas others will kick back a couple of more drinks. If the chosen solution is followed by lowered stress (and thus a feeling of satisfaction), the individual will probably try it again in the future. This is how stress can impact the desire-action-satisfaction cycle.

Defining substance use disorders

Following the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (APA., 2013b), specific criteria must be manifested by a person to diagnose a substance use disorder. It is important to note that these criteria should manifest themselves during a certain time, that severity of the disorder is based on the number of symptom criteria, and that not all criteria have to be met to diagnose the disorder.

We want to point out that only a physician may diagnose a substance use disorder, therefore this tool is provided for information purposes only.

Stress and addiction: two “tightly-knit” phenomena

It seems counter-intuitive to think some people express self-destructive behaviors even though they know the possible negative consequences for their social environment and themselves. Yet if we take a closer look at this, we quickly realize that few of us ever had too much coffee or drank too much alcohol in one sitting. In these cases, why can't we go the rational way?

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Continued on page 4

CRITERIA
1. Recurrent substance use may result in a failure to fulfill major roles and obligations at work, school, or home.
2. Recurrent substance use in situations in which it is physically hazardous.
3. The individual may continue substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.
4. Tolerance is signaled by requiring a markedly increased dose of the substance to achieve the desired effect or a markedly reduced effect when the usual dose is consumed.
5. Withdrawal is a syndrome that occurs when blood or tissue concentrations of a substance decline in an individual who had maintained prolonged heavy use of the substance.
6. The individual may take the substance in larger amounts or over a longer period than was originally intended.
7. The individual may express a persistent desire to cut down or regulate substance use and may report multiple unsuccessful efforts to decrease or discontinue use.
8. The individual may spend a great deal of time obtaining the substance, using the substance, or recovering from its effects.
9. Important social, occupational, or recreational activities may be given up or reduced because of substance use.
10. The individual may continue substance use despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance.
11. Craving is manifested by an intense desire or urge for the drug that may occur at any time but is more likely when in an environment where the drug previously was obtained or used.

1. *The Brain from top to Bottom*, McGill University, n.d.

What is Addiction?

Many psychosocial theories try to explain how a “bad habit” can develop into addiction, in spite of our goodwill (Angres & Bettinardi-Angres, 2008). Interestingly, behaviors we adopt following a stressful situation are very similar to those we do if addicted to something. Here is a summary of the most important psychosocial theory on addiction and its similarities to stress.

In the first place, the *reward* brought about by a substance or an action is the key concept to explain what motivates an individual to repeat an experience. For example, if we take a coffee and like the effect it provides, we will be tempted to repeat the experience. This can be applied to all substances and behaviors that put the individual in a pleasurable state, no matter if the result is beneficial or not in the end. The reward following the addictive substance or activity explains in part the development of this pathology in people affected by an addiction problem.

So what is stress doing in all of this? As seen earlier, when facing a stressful situation we try to re-establish equilibrium in our body, without taking into account the beneficial or harmful effects of a given solution. If a solution creates a pleasurable state – a diminution of the stress response – the probability we try it again in the future will go up. As in an addiction scenario, the pleasurable effect produced by the diminution of stress can be interpreted as a reward, which will drive an individual to reproduce the same behaviour in the future.

In the second place, authors insist on how *learning and memory* play a role in addiction. Indeed, the brain of an individual dealing with an addiction problem is biased towards the advantages of their addiction and to the detriment of the disadvantages. In fact, the cerebral treatment of the positive aspects of an addictive behavior is done with such emotional intensity that it forms a stronger memory when compared to the negative aspects (Angres and Bettinardi-Angres, 2008; Christianson, 1992). This bias in the individual's brain will promote the repetition of the addictive behavior, overlooking the harmful consequences.

So what about stress? Imagine this scenario. You had a very stressful day at work and for this reason you decide to go shopping at the end of the day. This will effectively lower your stress, and is the phenomenon we call reward. Now your brain will recall the positive aspect of shopping: “it is so good to go shopping, it lowers my stress response”. However, your “naughty” brain won't recall as well the fact that you spent money you didn't budget (the negative aspect). Owing to this, the next time you'll have a stressful day at work your brain will tell you to go shopping!

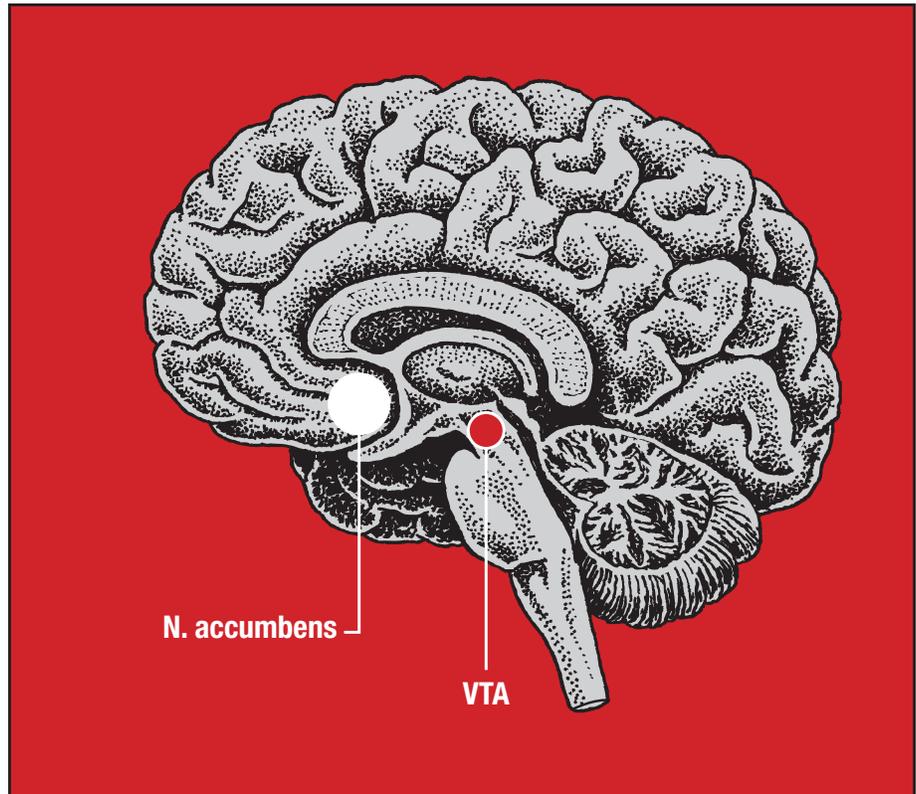


Figure 1. Addiction related brain regions (Inspired from: *The Brain from top to bottom*, McGill University)

In the third place, authors consider that normal *decision-making* – thinking before acting – is not as well developed in individuals at risk of addiction. Because of this, such a person's decisions will tend to be impulsive rather than analytical. Generally, a person suffering from addiction will be more likely to choose to drink rather than do therapy, the first being more readily and easily available than the second.

So what about stress? In a stressful situation, most of the time we don't have time to consider all our options... we must act. Faced with a mammoth, there is no time to think; you either fight or fly! Thus, we'll act impulsively rather than analytically, and this could play a role in addiction (Vocci in Lemonick, 2007). As in the previous example, if there is no time to think whether these new shoes are really needed, we will buy them.

This theory provided science with a better understanding of addiction on the psychosocial level and its similarities with behaviors following a stressful situation. Nonetheless, how can we understand how “harmful” behavior that happens from time to time can become “pathological”?

A fine line

It can be hard to distinguish desire and addiction since there is a fine line between them. Whether it is gambling, alcohol, tobacco, drugs, interpersonal relationships or any other desire, a behavior can

quickly become addictive. We're using the word addiction when an activity which was pleasurable at first, such as work, “becomes an end in itself” (Marzano, 2004). It's when a life domain aimed at self-development is now aiming compulsively towards perfection. It's when a substance such as alcohol, previously taken in moderation in a social context, becomes the easy way out in the face of daily challenges. It's when a behavior such as internet chatting, which was once another way to socialize, now completely replaces real interactions with people. A healthy relationship with our desires differs from an unhealthy one in degree and frequency towards a chosen behavior. Of course, many factors play a major role in the development of this kind of pathology.

“Only psychological”?

There is no doubt that psychological factors that influence addictive behaviors. However, the impact of biological factors should not be ignored. The majority of studies on addiction are done on animals and this is for good reasons. The scientific methodology used to find the functions of brain neurotransmitters (small molecules released by the brain) is simple: take out something, observe what happens, put it back and observe again! Of course, it's not possible to do so in human beings. At the very least, this research method allowed us to discover key brain regions and neurotransmitters involved in this kind of pathology.

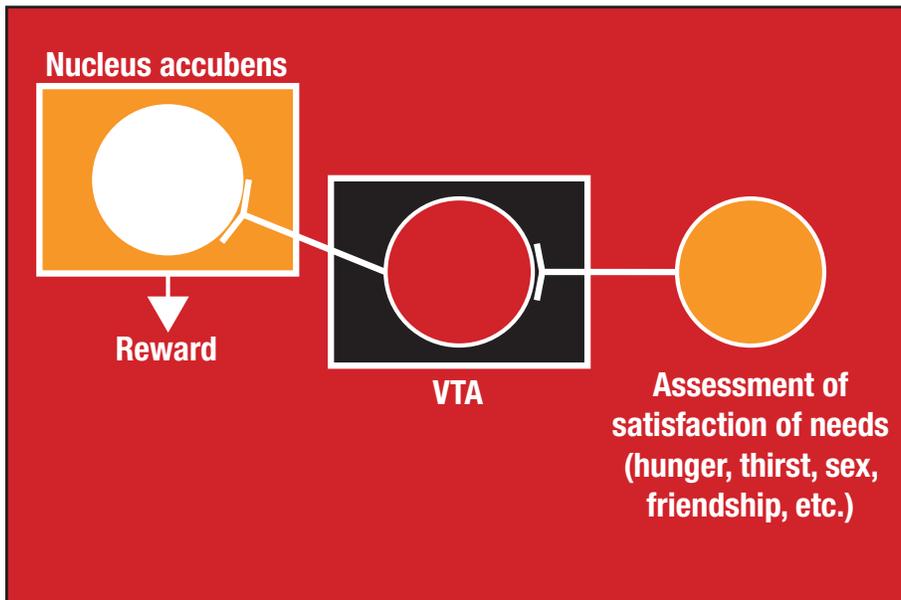


Figure 2. The reward circuit (Inspired from: *The Brain from top to bottom*, McGill University)

Even though many brain regions (see Figure 1) are involved in addictive behavior, the emphasis is put on the **ventral tegmental area** (named VTA on the figures) and the **nucleus accumbens** (named n. accumbens on Figure 1) because they are part of a very important network called “reward circuit” (see Figure 2). The ventral tegmental area is in charge of dopamine synthesis, an essential neurotransmitter in rewards detection. Then dopamine is directed to the nucleus accumbens, which is implicated in the control of motivations.

This circuit is thought to have been favored throughout evolution, allowing the fulfilment of basic needs to be pleasurable and therefore helping the survival of the species. It seems logical enough: “eating and breeding are pleasurable, therefore I’ll start again!” Hence, reward ensures species’ survival. But there is the flip side of the same coin: this cycle also allows harmful pleasurable behaviors to be reproduced, even though these threaten survival. By acting directly on the reward circuit, the pleasure following drug intake makes it more likely that this behavior will be repeated, consequently making the organism vulnerable to the development of addiction.

It should not go unnoticed that neurotransmitters are also influenced by drugs. Each drug will impact specific neurotransmitters. Indeed, “drugs act by imitating, stimulating, or blocking the effects of certain neurotransmitters” (The-brainMcGill, 2013). The central neurotransmitter in addiction is *dopamine*. Actually, all addictive drugs have in common the fact that they raise dopamine levels in the neuronal reward circuits (Angres, 2008).

So what about stress?

Impact of acute stress on addiction — When we face a stressor, a message is sent to our brain, then to our adrenal glands which secrete hormones of the glucocorticoids class. In humans, this is mainly *cortisol*. The aim of this response is to favor a better environmental fit, by giving us the required energy to fight or fly against a threat. Animal studies show that stress hormones can influence desire for drugs; for example, when it is subjected to a stressful situation a rat will tend to increase the frequency and the quantity of used substance (Piazza, 1998; Lemonick, 2007; Fox, Bergquist, Hong, & Sinha, 2007). It is no surprise then that stress is given a lot of attention in studies of addiction. Besides, we now know the mechanism by which stress hormones influence the reward circuit. Indeed, these will potentiate the effect of dopamine, thus boosting the pleasure associated with substance use.

Impact of chronic stress on addiction — Because of this, substance use can become a self-regulation method and a solution to lower stress for people experiencing chronic stress. In fact, when the stress system is repeatedly activated (a chronic stress scenario), it tends to get deranged. The brain will try to act as if the stressful situation is habitual. In order to do so, it will try to set a new body equilibrium while accounting for the stressors. But if this state is maintained for too long, it can lead to pathologies such as anxiety problems, depression... or addiction (Aubry, 2009)! In other words, an individual will consume drugs to retrieve the initial effect of the substance or to prevent withdrawal symptoms (Koob, 2007); two behaviors related to the diagnostic criteria of *substance use disorders* we saw earlier.

Substance use can become a self-regulation method and a solution to lower stress for people experiencing chronic stress.

To sum up, we know today that acute and chronic stress both act on consumptive behaviors. It seems acute stress influences the “here and now” intake and can contribute to **relapse** in weaned individuals (that is individuals who are no longer in contact with their addictive stimuli), whereas chronic stress acts on the **acquisition** of an addiction disorder.

But apart from stress, how can we explain how some people will develop an addiction disorder and others won’t? Is every person at risk of developing an addiction following risky behaviors? Seldom can we conclude things so easily, but in this case the answer is simply: no. Numerous factors play in the development of addiction and among these we find a role for genetics, the environment, external support and life experiences.

The origin of addiction beyond stress

A lot of studies support the role of **genes** in alcoholism, substance use and other “addictive” behaviors (Angres, 2008). This would mean a person with both parents showing a substance use disorder is more at risk of developing such behaviors than another person born from parents not showing addiction, even after taking into account the kind of environment the child grew up in. However, genetics is not the only factor leading to addiction. In fact, it would seem the **environment** and the presence of **stressors** (as mentioned before) can generate the acquisition of an addiction, or lead to relapse. Finally, **family support** and **life experiences** can ensure that a vulnerable person will never develop an addiction, or vice versa; that a person with no family history of support becomes addicted.

To conclude, we hope we convinced you that addiction is not only psychological or biological in nature, but a phenomenon bringing together a myriad of factors influencing acquisition, maintenance and relapse into addiction. With this in mind, you’ll have no problem seeing how addiction is not simply a matter of will power. Knowing that addiction can have a significant impact on a person and the people around them, we encourage you to turn to the last article of this edition of the *Mammoth Magazine* entitled: “Do you need help? Here is a list of references at your fingertips!”. This may prove helpful if you think you recognize yourself or a member of your surroundings while reading this article.

Gilles' Testimony

By Anne-Laure Dubé, Psychology undergraduate student and Summer Intern at the Centre for Studies on Humain Stress.

'It was a Wednesday in June, around twenty years ago, during the late afternoon. I was sitting on a bench in a park, facing a river. In one hand, I was holding a piece of yellow paper and in the other, my phone. I was shaking; cold sweat ran down my back. I glanced at the river and told myself: this is it, either I call, or I jump and forget everything once and for all.'

If Gilles (a fictive name) is alive to tell us about his experience with addiction today, it is because he finally decided to make that call. He chose life. Indeed, Gilles, a 55 year old former alcoholic, has been sober for nearly twenty years, and his eyes gleam with hope, kindness, and with a love of life. Gilles is an engineer who had a peaceful childhood, without any violence, mistreatment or abuse of any kind. He went to private school, then to University. His life, at least from the outside, is exemplary, which is proof that stereotypes are not always accurate.

In fact, Gilles knew how to hide his suffering and his lifeline, and did so for many years. This left him deep in a fog of despair which only seemed to get thicker with every gulp.

'It began when I was a teen, with my friends. We would often meet at night to smoke... many things other than cigarettes' he explained.

'Then, it became a lifestyle, a constant stage of being.'

One day however, his significant other told him that if he did not stop, he would only drive them further apart. 'She liked me better when I was not high. I felt weird when she told me because I could not remember a single moment when I was not high,' he revealed. The very thought of losing her was unbearable, and without noticing it, he turned to alcohol when his friends continued to smoke without him. Little by little, he started drink-

ing alone, in his basement, and soon he started drinking as soon as it was possible. Since alcohol abuse brings about a certain tolerance to alcohol, his consumptions kept growing as time went on.

In spite of his ever growing inebriated state, Gilles was able to finish his studies with flying colors, and was able to get the job of his dreams. He married his sweetheart and soon added two amazing children to his growing family.

Contrary to what scientific literature reveals, which is that stress has an impact on consumption and dependency, Gilles did not go through any major stress which would have pushed him toward the bottle, nor any stress which would have made him drink more in certain periods of great stress. 'I couldn't be an alcoholic, because in my mind I did not drink in the morning, and besides I was far from being in the streets, dressed in rags, with yellow teeth and an empty stare with my hand outstretched. I was able to perform at work, was able to think like I needed to. I did not fit into the stereotype that I had of alcoholics, thus in my mind I could not be one', he reveals.

After twenty years of drinking, it was his wife's turn to repeat her concerns. One morning, she left a small yellow paper on which a phone number was written, the number for an alcohol support group. Seeing the number, Gilles suddenly felt dizzy: his throat got stuck and he realized that he could not continue like this. Even though he could not possibly be an alcoholic, not him!

Little by little, he started drinking alone, in his basement, and soon he started drinking as soon as it was possible.



And thus we come back to the park, to the river and the small yellow paper, and to the moment when Gilles decided to stick with life. After calling the number, he went to the place indicated by the person on the phone. Aggrieved, with shame twisted inside him and his head lowered, he arrived. However, he was not judged, on the contrary, he was welcomed with warmth, comprehension and patience. He was given as much time as he needed.

'During the first six months, I still drank. I think that the thing that helped me the most is that no one mentioned it, even though I am sure they could smell it on my breath.' The only thing they asked is that he truly wanted to stop drinking, which he had. Little by little, certain tasks were given to him, such as getting the coffee ready or acting as the secretary. 'I was congratulated for my good work, which helped me get my confidence back. I could see that these people appreciated me as I was, even if I sometimes felt worthless.' Gilles started getting his self-esteem back.

However, the hill was steep, and for many months he did not participate, never saying a single word in the meetings and locking himself in the bathroom during the breaks to avoid revealing himself. One day however, another member went in front of the gathering to speak. Instead of sharing his experience, he stated in front of everyone that he was certain his friend in this room would get out of this mess.

'I was shocked by this act of kindness. He was taking about me! He believed in me! I was deeply touched by this show of confidence and empathy.' He recalled. It was at that moment, when he realized that he was not alone in his suffering, that he stopped trying to fix everything by himself and accepted the help that was given to him. Gilles stopped drinking. He threw away his bottle once and for all in the past and started melting the 'block of ice' that was wedged in-between his head and his heart. He risked meeting his emotions head-on and renewed his relationship with himself and with others.

'For me, the most important part is that I knew no matter where I was, no matter what I was doing or feeling, there was always someone available to give me a hand or a shoulder to lean on, to reach out and help when I needed it. That made a huge difference and without the patience of my peers, I can say that I would not be where I am today, but I definitely would not be here.' He confided.

The message Gilles wants to transmit today is that alcohol is not a solution, nor is it something impossible to overcome. Help is available, and to get it you only need to muster your courage and reach out, accepting that you need help. To help melt the block of ice inside you, because once it is gone you can finally taste happiness, and you will find it is worth it. Each has to walk his own path, but hope is there for all. Gilles swears it is true! 

Researcher's Profile:

Dr. Stéphane Potvin, Ph.D.

Smoking and Mental Health: Are the Odds Stacked in Smokers' Brain?

By **Stéphane Potvin**, Ph.D., Professor under grant in the Department of Psychiatry, Université de Montréal
Translated by **Julien Ayotte**, B.Sc.

Stéphane Potvin is our invited Editor-in-Chief for this edition of the *Mammoth Magazine*. Dr. Potvin is a researcher at the Institut universitaire en santé mentale de Montréal who is interested in how some addictive substances work on brain structures of not only healthy people but also of those affected by mental health problems. His research notably focuses on the brain's reward system that will be described further in this article. In this *Researcher's Profile*, Dr. Potvin describes his most recent work carried out with his research team, as well as with collaborators such as Dr. Adrianna Mendrek's team from Bishop University and Dr. Sonia Lupien's team from the Université de Montréal and Editor-in-Chief of the *Mammoth Magazine*.

Introduction

Who doesn't know that cigarettes kill? Practically no one. Following many decades of awareness campaigns targeting the general population, it is now a well-known fact. Still, despite a decline in the prevalence of smoking, an important portion of the population continues this practice even if they are *conscious* of the noxious consequences associated with smoking. Besides, for smokers, it is often very hard to stop doing so. To better understand the nature of smoking addiction, our laboratory launched a series of studies based on the simple idea that in smokers' brain, the odds are stacked. Specifically, when it comes to how appetitive and aversive sides of smoking are treated by the brain, they might favor the cycle of consumption. This reasoning has been especially guided by mental health, since people with a psychiatric disorder are not only more at risk of smoking, but they also have greater difficulty stopping.

Stacked odds

Traditionally, **physical addiction** (tolerance and withdrawal) has long been considered the hard-core component in the field of toxicomania. Over time, we realized that relapse rates stay very high (between 40 and 60% in a year) even after withdrawal symptoms are dampened, so we tend to think that **psychological addiction** is the fundamental characteristic of toxicomania. Owing to this finding, research is now looking at the phe-

nomenon of consumptive desires ("cravings"), and much effort has been invested in identifying the factors triggering cravings (such as stress, boredom, peer pressure, the environmental context of drug use, etc.) and to pinpoint the neurophysiological bases. In contrast, few studies looked at how consumers' brains treat the negative aspects of consumption. Yet clinical evidence suggests there is a motivational imbalance in addicted users, making him/her on the one hand overestimate the positive aspects of consumption, and on the other hand underestimate the negative aspects. These clinical observations underscore the necessity to study further, at the physiological level, how a user's brain reacts to *both* positive aspects *and* negative aspects of consumption.

To tackle this question, we showed pictures of the enjoyable side of cigarettes to chronic smokers while they were undergoing a functional magnetic resonance imagery (fMRI) exam. This technology allows us to visualize indirectly the activity of specific brain regions. To contrast the smokers' response to enjoyable pictures, we also showed them pictures of the harmful consequences of smoking (lungs filled with cigarettes, a smoking skeleton, a pregnant woman smoking, etc.), and aversive pictures *not related* to cigarettes (a sick person, human conflicts, etc.).

In collaboration with Dr. Adrianna Mendrek (Bishop University), this research has shown that smokers have more cerebral activation in response to appetitive pictures of cigarettes than in response to aversive pictures. This is shown in brain regions such as the medial prefrontal cortex and the precuneus that are implicated in autoreflexive states (which we call metacognition) and in autobiographical memory. We observed that antismoking pictures trigger activations typical of aversive responses, that is, activations of the limbic system regions (the emotional brain). Interesting fact: we also observed that smokers' cerebral activations are more pronounced following non-tobacco related aversive stimuli than following cigarette aversive pictures, especially in key regions of the limbic system.

Taken together, these results suggest smokers would feel more *subjectively* concerned by appetitive aspects of cigarettes, rather than its harmful



This could explain why decades of research have shown that anti-smoking campaigns are effective in raising general awareness on the bad sides of smoking, but are hardly as effective in influencing smokers' consumptive behavior.

consequences. Thus, their brain is sort of desensitized emotionally regarding the harmful consequences of smoking. In brief, this is in accordance with our starting hypothesis, in that it would seem that the odds are stacked in smokers' brain. This causes a motivation bias towards the appetitive aspects of cigarettes disfavoring its harmful aspects. This could explain why decades of research have shown that anti-smoking campaigns are effective in raising general awareness on the bad sides of smoking, but are hardly as effective in influencing smokers' consumptive behavior.

Smoking and mental health

While the prevalence of smoking is falling in the general population, the speed of this decline is slower in people affected with mental health problems. These people are thereby not only more at risk of developing a smoking addiction, they also have greater difficulty stopping than smokers with no co-occurring psychiatric disorders. With this in mind, we decided to focus on the links between mental health and smoking in our laboratory. More specifically, we wanted to evaluate how impulsivity and stress, two obvious vulnerability factors for smoking, modulate the treatment of the appetitive aspects of cigarettes. Also, we wanted to explore how smokers with a co-occurring psychiatric disorder (in this case, schizophrenia) respond on the cerebral level to appetitive pictures of cigarettes.

Continued on page 8

In a first study, still in collaboration with Dr. Mendrek, we first looked at the influence of impulsivity on cigarette cravings, impulsivity being one of the factors predicting the transition from only trying once to compulsive consumption during adolescence. This personality trait is also one of the factors causing relapse when smokers try to stop this behavior. For these reasons, we showed appetitive pictures of cigarettes to about thirty chronic smokers while they were doing a fMRI exam. We also measured impulsivity levels with a validated questionnaire. First, behaviorally we observed a positive relationship between cravings and impulsivity. Second, physiologically we have shown that in smokers who experience cravings, impulsivity seems related to difficulty in inhibiting the insula, a limbic region thought to play a key role in toxicomania. Unless we are mistaken, this was the first study using fMRI describing how impulsivity modulates cravings that are a fundamental component of smoking.

In the continued aim of understanding the close relation between mental health and smoking, our laboratory partnered with Dr. Sonia Lupien's lab to better identify the role of stress in smoking addiction. As we saw previously, toxicomania is a disorder characterised by high relapse rates. For reasons still not well understood, it seems the experience of substance use leaves vivid traces in the consumer's mind, sometimes lasting long after using stopped. In the consumer's everyday life, many factors can trigger a relapse, starting with stress.

While it is well-known that stress is one of the main factors of relapse in toxicomania, the mechanisms through which stress produces this are largely misunderstood. Theoretically, we could postulate that stress reactivates the memory of pleasure associated with consumption, thus triggering cravings that ultimately lead to relapse. This theoretical model coincides with recent discoveries, showing that: (i) memory (including



emotional memories) can be modulated, not only during learning but even after it has been consolidated; and (ii) stress is one of the modulating factors of consolidated (emotional) memories. Based on these findings, we postulated that addiction is

For reasons still not well understood, it seems the experience of substance use leaves vivid traces in the consumer's mind, sometimes lasting long after using stopped. In the consumer's everyday life, many factors can trigger a relapse, starting with stress.

a disorder where pleasurable memories of substance use (here cigarettes) are overconsolidated, and that stress acts on this overconsolidation of pleasurable memories in smokers.

With this general perspective in mind, we elaborated a project aiming at establishing, concretely, whether hedonic memories (related to pleasure) of smokers are malleable during the moment when they are reactivated via modulation of stress hormone levels. To do this, we are currently recruiting smokers and non-smokers, who are invited to participate to three distinct experimental sessions. During the first session, participants learn a word list, some related to tobacco use (hedonic memory), and others non-tobacco related (neutral memory). Participants must afterwards recall these words during the same session. Two days later, with the words anchored in their memory, participants come back to the laboratory. They must then recall again the words they learned during the first session. This recall acts by reactivating hedonic memory and neutral memory. Subsequently, half of the participants (half smokers and half non-smokers) are exposed to a stressor in the laboratory, whereas the other half are ex-

posed to a control condition (reading magazines). The memory for the word list is re-evaluated again after the stress (or the control condition) and five days later. Saliva samples and blood pressure and heartbeat measurements are taken at each session, at 10 minute intervals, to quantify physiological stress. In the short term, this project will give us a better understanding of how stress modulates the hedonic memories of smokers. Ultimately, this kind of work could allow use to develop new therapeutic approaches to "mute" the hedonic memories of cigarette use by modulating smokers' stress.

In addition to looking at traits (impulsivity) and states (states) which play a critical role in toxicomania, our laboratory also sought to study the biological basis underlying the motivation to smoke cigarettes in smokers with a co-occurring psychiatric disorder. To do so, we launched a study using fMRI where we examine the neuronal correlates of cravings in people with schizophrenia. This study is done in collaboration with a team of psychiatrists from the Psychotic Disorders Program, namely Drs. Olivier Lipp, Jean-Pierre Melun, Pierre Lalonde and Alexandre Dumais.

Of all psychiatric disorders, schizophrenia is the one in which smoking prevalence is the highest. Also important in schizophrenia is that smoking is linked to morbidity and mortality risk factors. Furthermore, it's been shown that smoking relapse rates are higher in people with schizophrenia than in smokers with no mental health problem. Knowing that the performance of the reward system (the "pleasure circuit") is impaired in schizophrenia, we put forth the hypothesis that patients with schizophrenia will have stronger activations of the reward system than smokers in response to appetitive pictures of cigarettes. To date, we have observed that appetitive pictures

1. A mix of cocaine and heroin.

of cigarettes induce stronger cravings in schizophrenic patients than in smokers with no psychiatric disorder. Neurophysiologically, our results also show that patients with schizophrenia display cerebral activation patterns typical of a craving state for cigarettes, even when the same pictures do not provoke cravings in smokers with no co-occurring psychiatric disorder. These results correspond with the hypothesis that people with schizophrenia are highly motivated to smoke cigarettes, and that this motivation disorder is, at least in part, biological.

Therapeutic avenues

An addict's decisions are often hard to understand for his peers who are helpless towards his self-destructive behavior. Step by step, research illuminates the numerous biases in the mind (and brain!) of the consumer, biases which make him minimize the harmful consequences of his substance use by only perceiving the enjoyable aspects. Parallel to this, we also know that addictive phenomena is associated with a narrower variety of hedonic experiences. Indeed, the deeper an addict will sink into substance use and abuse, the more this substance will acquire a strong motivational value and the addict will, in counterpart, abandon activities he/she previously valued as pleasant. Exit goes times with friends or playing baseball, now it's only *speed-ball*. Biologically, we have more and more reasons to think this narrower variety of hedonic experiences is due to disturbances in the reward system. With time, this system becomes hypersensitive to the appetitive aspects of the substance, and hyposensitive to the pleasurable aspects of daily activities, which we call natural pleasures. Clinically, this model suggests that we could eventually be able to treat toxicomania by re-establishing an equilibrium in the reward system of the user.

Until very recently, it was excessively hard, nay impossible, to explore such therapeutic avenues simply because we could not modify the activity of the reward system without opening the

An addict's decisions are often hard to understand for his peers who are helpless towards his self-destructive behavior.

skull and putting electrodes in. With the development of transcranial magnetic stimulation (TMS), it is now possible to stimulate certain brain regions, thus modulating the reward system activity, without having to open the skull of participants. Rather we apply a magnetic field at the surface of their head. On animals, it has been demonstrated that applying *high* frequency stimulation to the dorsolateral prefrontal cortex (dlPFC) activates the reward system, whereas applying *low* frequency stimulation to the same region, on the contrary, inhibits the reward system.

In humans, several studies have shown that high frequency stimulation of the dlPFC lowers cravings for cigarettes, but we do not know which mechanisms this occurs through. With a team from the Department of Psychiatry composed of Didier Jutras-Aswad, Patricia Conrod and Paul Lespérance, we undertook a research project using TMS with chronic smokers to better understand these mechanisms. After they received a train of stimulations, we ask them to carry out a decision-making task while we record their cerebral activity with electroencephalography, a recording technique of the brain's electrical activity using electrodes placed along the scalp. During this task, participants navigate a virtual environment and receive a natural reward (money) in one condition or an artificial reward (cigarette puffs) in the other condition. By combining high and low frequency stimulation of the dlPFC, known for (respectively) causing exciting and inhibiting effects on the reward system, the goal of this project is to demonstrate that it is possible, even partially, to correct the motivational bias of smokers towards cigarettes over and above natural rewards. On a sample of about twenty participants, our first results tend to corroborate this hypothesis. More precisely, our results seem to show that high



NEXT ISSUE

Stress et orientation sexuelle

For many individuals around the world, sexual orientation is a stressful and sometimes a controversial topic. While much progress has been made in Quebec in terms of civil rights, many lesbian, gay, bisexual, and transgender individuals experience tremendous distress in self-identification, self-acceptance, and disclosing or "coming out" to others.

This unique source of stress is the main topic of our next Mammoth Magazine devoted to sexual orientation.

frequency TMS enhances the motivational value of natural rewards whereas low frequency TMS diminishes the motivational value of cigarettes. Clearly, these kind of results could have important benefits regarding the treatment of smoking.

The research conducted over the last years in our laboratory shows there are numerous biases in the mind (and in the brain) of smokers and that mental health problems can amplify these biases or even contribute to their apparition. Shedding light on these biases opens, without a doubt, new perspectives that are therapeutic, technologic, and more. 

For additional information, please take a look at the following papers:

- BOURQUE J., MENDREK A., DINH-WILLIAMS L., POTVIN S. "Neural circuitry of impulsivity in a smoking craving paradigm." *Frontiers in Psychiatry* 2013; fpsyt.2013.00067
- DINH-WILLIAMS L., MENDREK A., BOURQUE J., POTVIN S. "When there's smoke, there's fire: brain reactivity of smokers in responses to anti-smoking images compared to appetitive stimuli." *Progress in Neuropsychopharmacology & Biological Psychiatry* 2014; 50: 66-73.



Do you go for Chocolate when Stressed?

This article is for you!

By **Julien Ayotte**, B.Sc., Master's student at the Centre for Studies on Human Stress

Your ego has just been put to the test by your boss in front of your work colleagues. This is a situation which will undoubtedly stress you a lot. Following this onslaught, you find yourself back at your desk eating a delicious chocolate bar. How can we explain this? Why do we feel the need to eat following a stressor? In this article, we will look at how stress influences our appetite and the reason why we are so very interested by food rich in carbohydrates and fat in these stressful situations. We will take a look at “food addiction”, a very controversial phenomenon in scientific research. Finally, we will give you some tips on how you can satisfy your appetites without remorse during stressful situations.

How does stress impact appetite?

Appetite as well as the total amount of food we consume is controlled by a gland in the center of the brain called the hypothalamus. By means of many bodily signals that it receives, the hypothalamus will decide to increase or decrease appetite. However, some environmental factors will modulate its activity. Among other things, the presence of a stressor in the environment will modulate appetite by raising or lowering it. But how can we explain appetite sometimes going up or sometimes going down at different times? Researchers think that part of this phenomenon is attributable to the manner we perceive stressful situations.

Animal studies have allowed us to distinguish between two types of reactions to stressors and to demystify their impact on feeding behavior. On one side, a stressful situation perceived as “threatening” (a situation where we do not think we have the resources to get over the threat) elevates our cortisol levels, an important stress hormone. This elevation would lead to increased appetite. This can be explained because when we face a threat, we must use our caloric reserves to “fight or flee”. Afterwards, we must then refuel our energy stores. On the other side, a stressful situation perceived as “challenging” (a situation we see as a challenge that we can get over) will rather increase the levels of adrenaline, another important stress hormone that has very different effects. Meanwhile, this elevation will lower appetite.

Among other things, the presence of a stressor in the environment will modulate appetite by raising or lowering it.

Why a chocolate bar?

Rapid rewinding of the reward circuit

When faced with a “threatening” stressful situation, we are often attracted to “comfort” food (rich in fat or sugar). Until recently, researchers could not precisely explain why this is so. However, one hypothesis proposes that this kind of food activates the reward circuit of the brain, thus making its consumption enjoyable. Once associated with pleasure, this would make us more prone to eat this kind of food in a similar situation. If we are stressed and overeat from time to time, our body will accommodate over indulgence without trouble. However, when living with chronic stress, our brain is constantly receiving messages telling us to eat more and this contributes to weight gain. Moreover, when we repeatedly eat comfort food, the body develops a tolerance to the signals telling it to eat less. Unfortunately, in the long term, diets full of fat or sweet food can lead to unpleasant effects on the body such as obesity and the diseases related to it.

Can we become “addicted” to food?

Can stress lead to the development of a food addiction and explain health problems such as obesity? Historically, obesity was considered a metabolic disorder (how nutrients are stored and used by the body to produce energy). In 1956, a re-

searcher first proposed that food could create addiction in a manner similar to alcohol and other substances. With this theory, we considered the problem of obesity to be “motivational” rather than metabolic. However, to this day, there is no clear scientific consensus on this question. Indeed, some researchers argue that it is not possible to become addicted to food since it is necessary for survival. Beyond stress hormones and addiction to food, obesity seems to have many causes, leading to many subtypes of obesity. Because of this, the problem is a lot more complex than it seems. This growing field of research attracts many ideas. Interdisciplinary research might give us a better understanding of this phenomenon and as a result put forth new prevention and intervention methods.

Tips and tricks to keep the chocolate bar away in stressful situations

To conclude, here are some tips and tricks to implement to minimize the effects of stress on your physiology:

1. Use the energy you mobilized in a stressful situation and move! For example, you can go for a walk, use the stairs instead of the elevator, dance, etc. By engaging in these activities, you will spend the energy you mobilized mounting a stress response.
2. If you have a tendency to eat food rich in sugar or fat during stressful situations and you know that you will be facing stressful situations during the day, prepare a healthy snack. This will allow you to lower your appetite all the while limiting overconsumption.
 - Favor foods rich in proteins, such as cheese and nuts, and fruits and vegetables.
 - For those with a sweet tooth, prefer chocolate with high cocoa content (at least 50%), and do not be afraid to try out dried fruits.
 - If you prefer chips and crackers, opt for “oven baked” types which often contain less fat. Take a look at the ingredients and choose foods with more fiber and less salt.

This way, next time you will have a craving following a stressful situation, you will be able to treat yourself without guilt! 🍫



Can we become dependant on technology?

By Julie Katia Morin-Major, B.Sc., Master's Student at the Center for Studies on Human Stress

When you read the title of the current edition of *Mammoth Magazine*, the first thing that may have come to your mind is that we were going to talk about addiction to drugs and alcohol. Indeed, when we talk about addiction, we are often referring to dependence to a particular substance. Years of research have focused on this subject and we now understand the mechanism underlying many types of addictions better than in the past. But what about dependence that is not related to a substance? Can we develop addictions to technology? For example, can we become dependent to the Internet, video games, social networks and mobile phones? This is a legitimate question: can we become hooked on mediums like our cell phones? Unfortunately, the answer is not that simple!

Here is a fictional story that will help illustrate the purpose of this article. Ocean loves social media. At first, she would only spend a couple of minutes per day on Facebook. But for the past week, she was spending more and more time on Facebook and on other social networks. She does not want to miss a single thing! Last week, she went on a romantic getaway, in a paradisiac location where she did not have access to Internet. Result: she was anxious all weekend and this caused many arguments with her boyfriend. Monday morning when arriving at work, she spent most of the morning on her cellphone catching up on what she had missed. Even though her boss warned her not to be on her cellphone at work, Ocean was just unable to follow the rules. Because this was not the first time that Ocean did not follow the rules, her boss asked her to leave. In line with this story, do you think that Ocean suffers from dependence? Does the anxiety and impact on her daily functioning when deprived of her cellphone relate to the addictive symptoms that were discussed in the previous articles?

A growing number of research is trying to shed the light on this question. Not surprisingly,

For some researchers, addiction must inevitably implicate a substance (ex: drug, alcohol, tobacco). For other researchers, addiction is characterised by a repetitive behaviour that enhances the chances of developing health related disorders or personal and social problems.

there is still a lot of controversy on this subject. For some researchers, addiction must inevitably implicate a substance (ex: drug, alcohol, tobacco). For other researchers, addiction is characterised by a repetitive behaviour that enhances the chances of developing health related disorders or personal and social problems. These behaviours are often characterised by an immediate gratification followed by long-term consequences (Marlatt, Baer, Donovan et Kivlahan, 1988). In light of the second definition, Ocean's behaviour qualifies as an addictive behaviour.

According to Griffith, an expert in the field of addiction to videogames and Internet, Ocean presents many symptoms in accordance with the biopsychosocial model of addiction including symptoms related to salience, mood modification, tolerance, withdrawal, conflict and relapse. First, social networks are taking over Ocean's life and she needs to spend more and more time on them to attain satisfaction, which relates to salience and tolerance. Second, when Ocean did not have access to Internet, she developed symptoms of anxiety, which relates to withdrawal symptoms. Finally Ocean, put her relationship and her work in jeopardy because social media took up too much place in her life, which relates to conflict in Griffith's model.

Recently, the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V) was published. This Manuel serves as a diagnostic tool to help identify various mental health disorders and is heavily used throughout North America. In the fifth edition, a new diagnosis that is named

"Internet Gaming Disorder" has been added, a specific addiction to Internet games. According to experts on the DSM-V committee, there is now sufficient evidence for this behaviour to be classified as a mental health problem. This being said, experts highlight that further studies are needed in order to include problematic Internet use without gaming as a diagnosis. Including this diagnosis in the DSM-V challenges one of the definitions of addiction, which emphasizes that addiction is only included in specific reference to a substance.

Unfortunately, it is currently not possible for mental health professionals to confirm whether Ocean suffers from addiction to social networks. Indeed, there is an insufficient number of studies focusing on Internet, mobile phone and social media addiction to come to any conclusions. However, there are more and more studies on this subject, suggesting that we should be more aware of these behaviours that can have a negative impact on mental health. Certain studies have shown that addiction to Internet games – mainly during adolescence – is especially problematic for boys. Furthermore, people who have unlimited access to games and Internet connections are more at risk of developing these kinds of problems.

While awaiting further research on this subject, here is a list of certain behaviours that you should be aware of:

1. The object of dependence takes up a lot of your time
2. You are spending an increasing amount of time with the object of dependence
3. The use of the medium has an impact on your mood: it is positive when you are in contact with the medium and negative when you are away from it
4. When you do not have access to the source of dependence, you experience symptoms such as anxiety
5. The use of the medium has an impact on your relations and your daily life activities.

Be aware: It is not because a person spends a lot of time on the Internet or social media that they are at risk of developing addiction. The object of dependence must have an impact on their daily life. If this is the case, it is important to identify the cause of the behaviour. Talking with friends and family can help you find a solution. However, if this does not help, it is possible to get some help from experts (see the "Resources" section in this edition of the *Mammoth Magazine*).

In summary, even though it is not possible to define clinically whether Ocean suffers from addiction, we can deduce that her behaviour has a major impact on her life and causes her a lot of stress. Hence, while awaiting further studies to understand the impact of these technologies on mental health, we lose nothing by being vigilant and by taking a little time away from technology to spend quality time with the people we love. 🐘



Do you need help? Here is a list of references at your fingertips!

By **Catherine Raymond**, B.Sc., Ph.D. student at the Center for Studies on Human Stress and **Nathalie Wan**, M.Sc., research assistant at the Center for Studies on Human Stress

You will find here a list of resources that you can refer to if you or a member of your entourage are seeking help. These resources are located in the greater Montreal area. If you would like more information about the services offered throughout the province of Quebec or to have access to more resources, we invite you to consult the following website: <http://www.toxquebec.com/ressources>

If you know or suspect that a loved one is suffering from addiction and would like more information about this disorder, we invite you to consult the “dependencies” tab of the *Quebec Association of Parents and Friends of persons with mental illness* website. You can also access their website via this link: <http://www.aqpamm.ca/ressources/fiches-maladies/les-dependances>



EDITORS-IN-CHIEF
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 Julie-Katia Morin-Major, B.Sc.
 Robert-Paul Juster, B.A., M.Sc.

EDITORS
 Jean LePage, B.A., Assistant to the Exec. Director
 Stéphane Potvin, Ph.D.
 Sonia Lupien, Ph.D.

EDITORIAL TEAM
 Olivier L. Bourdon, B.A.
 Sophia Cayer-Falardeau, B.A.
 Anne-Laure Dubé, B.Sc. Candidate
 Stéphane Potvin, Ph.D.
 Julien Ayotte, B.A.
 Julie-Katia Morin-Major, B.Sc.
 Nathalie Wan, M.Sc.
 Catherine Raymond, B.Sc.

DESIGN
 Marcel Béliste, Graphic Artist

TYPE OF PROBLEM	RESSOURCES	
Treatment centers (alcool, drugs and Pharmaceuticals)	<p>PUBLIC RESSOURCES</p> <p>Le Centre de réadaptation en dépendance de Montréal dependancemontreal.ca</p> <p>Le Cran www.cran.qc.ca</p> <p>Le Grand Chemin - Montréal www.legrandchemin.qc.ca</p> <p>Le Portage www.portage.ca</p> <p>Pavillon Foster www.crdfoster.org</p> <p>J'arrête (gouvernement du Québec) www.jarrete.qc.ca</p>	
	<p>PRIVATE RESOURCES</p> <p>Bonsecours inc. www.bonsecours.info</p> <p>La Maison du pharillon www.pharillon.org</p> <p>L'Escale Notre-Dame www.escalenotredame.com</p> <p>Maison de réhabilitation L'Exode inc. – Pavillon Émilie-Gamelin www.maison-exode.org</p> <p>Maison Jean Lapointe www.maisonjeanlapointe.com</p> <p>Maison L'Exode – Pavillon André-Dumont (Siège social) www.maison-exode.org</p> <p>Maison L'Exode inc. – Pavillon Alpha www.maison-exode.org</p> <p>Résidences Mission Bon Accueil www.missionbonaccueil.com</p> <p>The Foundation Centre of Addington House www.addingtonhouse.com</p> <p>Le Centre de réadaptation en dépendance de Montréal www.joueur-excessif.com</p> <p>Alcooliques Anonymes www.aa-quebec.org</p>	
	More general resources	<p>Centre antipoison du Québec For all regions of Quebec: 1 (800) 463-5060</p> <p>Centre de prévention du suicide For all regions of Quebec: 1 (866) 277-3553</p> <p>Info-Santé Montreal: (514) 934-0354</p> <p>Tel-Jeunes Montreal: (514) 288-2266 Other regions: 1 (800) 263-2266</p> <p>Ligne Parents Montreal: (514) 288-5555 Other regions: 1 (800) 361-5085</p>