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PREVENTING TOXICOMANIA AND ADDICTIVE BEHAVIOUR IN ADOLESCENCE

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SUMMARY

Objectives: *Drug addicts are more and more stigmatized in our society. Recent data show a connection between substance abuse and other behaviors considered normal, such as passionate love. Adolescence is characterized by a biopsychosocial, cognitive and neurodevelopmental immaturity. This article aims to understand if these subjects are more likely to develop addictions to certain products or addictive behaviors such as passionate love. It also offers a better understanding of the current models for prevention of substance abuse during adolescence.*

Methods: *After defining the roles played, in the brain, by dopamine and by the reward circuit, as well as the different stages of development of the human brain, we compared neurobiological data and imaging studies both in cases of passionate love and substance addiction during adolescence.*

Results: *The brain imaging studies highlight the role of the prefrontal cortex in the cognitive and behavioral aspects of the addictive phenomenon. Now, the maturation of the prefrontal cortex occurs during adolescence, as do significant peaks in the expression of dopamine.*

These studies also suggest an increase in cortical activation (nucleus accumbens and amygdala) when processing emotional information, which is also increased during adolescence.

Conclusion: *Taken together, the results show a parallel between addiction and love relations, both at the level of neuroscience and imaging. A greater emotional lability and sensitivity may play a role in the higher incidence of substance abuse and dependence in love observed at this age.*

Preventing the use of illegal substances among young people therefore requires a very specific approach.

Key words: *adolescence - love passion – prevention - prefrontal cortex – amygdale - addictive disorder*

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INTRODUCTION

Modern society thinks more and more of drug addiction as a serious illness; medicine and psychiatry are therefore required to provide care for those patients. The difficulty of such an approach is that drug addiction is not easily classifiable. It's either considered a disorder adding up to a primary psychiatric disease or thought to be part of a different class of mental diseases: the behavioral disorders. Now, it has been proven that behavioral disorders are more frequent during adolescence. According to a recent study in the USA led by the national youth behavior center survey, 72% of the deaths of young people between 10 and 24 years of age are due to a violent death, connected to the use of drugs and alcohol (Eaton 2011).

This article tries, from a neurodevelopmental perspective, to have a better understanding of why the adolescents are more at risk for developing addictive behaviours, such as drug abuse or love dependency (which, although is not substance-related, is also frequently observed during adolescence).

Adolescence is, indeed, a time of vulnerability and adaptation (Steinberg 2005) but also of increase of emotional reactivity (Casey et al. 2008) because of a number of physical, social, hormonal and neurological changes.

This article focuses on this last item. In the last ten years, and thanks to the evolution of medical imaging, neurosciences and cerebral pharmacology, many articles have been published about the cerebral evolution through life, and especially on the brain's specificities during adolescence. This article does not intend to explore all the risk factors in this period (whether they are hormonal, psychosocial, behavioural, cognitive or psychoanalytic) but to give a clear idea of one of the reasons for the vulnerability of adolescence to drugs, or to other addictive behaviours, so we can imagine more adapted techniques for prevention.

METHODS AND MATERIALS

To write the present paper, we used the following databases: med line and psycINFO. Referenced papers have been selected using the following key words: adolescent brain, addiction, imaging, love, prevention, prefrontal cortex, amygdala, addictive disorder.

We'll open the discussion with two points:

- We will analyse the neurobiological and anatomical characteristics of addiction, including love dependency.
- We will then study the neurobiological and anatomical modifications of the adolescent brain, in parallel with the addicted brain.

The conclusions will allow us to discuss the impact of neuronal development in the onset of addictive behaviors, such as drug addiction or passionate love. With these elements in mind, we will be able to imagine and suggest new leads for prevention strategies adapted to adolescence.

RESULTS

Theorical anatomophysiological pathways of rewards and addiction.

The reward system, well known for its role in addiction disorders, consists of the ventral tegmental area (VTA), situated in the midbrain; of the nucleus accumbens or ventral striatum, in the septal area, and of the prefrontal cortex (in which we find the orbitofrontal cortex, which controls drive and impulse, and the dorsolateral prefrontal cortex, which plays a key role in the cognitive function) (Stahl 2010).

Thoses structures (VTA, ventralstriatum, nucleus accumbens) are used during the process leading to drug addiction or during an addictive behavior. Indeed, as it has long been well established, the brain's major reward neuropathway is the dopaminergic pathway. Both mating and addictions involve similar dopaminergic action in the reward circuitry of the brain: sex, orgasm, and all known drug abuses stimulate high levels of dopamine release in the nucleus accumbens. An abundance of studies have shown that the role of dopamine extends beyond addiction and is linked to a wide range of other processes associated with reward learning, including eating, drinking, having sexual intercourse, and love (Burkett et al. 2012).

Neurobiological and anatomical characteristics of addiction

Neurobiological aspects

There are many natural ways to stimulate dopamine release: intellectual success, sport, sexual orgasm... Drugs that lead to abuse bypass the brain's own neurotransmitters and stimulate directly their receptors, causing dopamine liberation (Stahl 2010).

However, unlike with natural pleasure, there is such a discharge of dopamine on the postsynaptic limbic receptors that, when the effects of the drug stop, the receptors crave for another dose that will release dopamine again (Stahl 2010).

It is now believed that the final and common pathway of reward and reinforcement circuits of the brain is the dopaminergic mesolimbic pathway. Some believe that this pathway is the pleasure center of the brain, with dopamine being its neurotransmitter (eg: Stahl 2010, Casey et al. 2008, Dayan et al. 2011).

A conditional learning takes place progressively in the amygdala, and as a consequence, not just the drug itself, but also environmental data alone can trigger an imperious need for drug.

The connections between the amygdala, the VTA and the nucleus accumbens lead the brain to act impulsively, immediately and without thinking, that is without the orbitofrontal cortex or the dorsolateral prefrontal cortex being able to control the impulse (Stahl 2010).

Anatomical aspects: The contribution of medical imaging

In the last ten years, medical imaging has allowed us to see the functional and morphological alterations that occur on subjects addicted to different substances. As a general pattern, we find in all addictions an over-stimulation of the tegmental ventral area, the ventral striatum (and particularly the nucleus accumbens), the anterior cingulum and the orbitofrontal and the prefrontal cortex (Ernst et al. 2005, Casey et al. 2008).

The addiction love?

Recent neuroscientific research suggests that romantic love can be literally addictive. Numerous are the superficial similarities between addictive substance use and love based interpersonal attachment, from exhalation, ecstasy, and craving. So a number of scientific theorists have begun to argue that both sorts of phenomena may rely upon similar or even identical psychological, chemical and neuroanatomical substrates (eg: Insel 2003, Fisher et al. 2010, Burkett et al. 2012).

Aron and colleagues (2005) also focused on the early stage passionate love, and found that when participants looked at the face of their partner and thought about pleasurable, non-sexual events involving the partner, activation was detected in the right caudate and the ventral tegmental area (VTA). Additionally, they found that the more passionately in love people reported feeling (Hatfield et al. 1986), the greater the activation in the caudate. The caudate and the VTA are the most consistent regions associated with romantic love (Acevedo et al. 2011, Aron et al. 2005, Bartels & Zeki 2000, Ortigue et al. 2007, Xu et al. 2010), consistent with the fact that these dopamine-rich regions are strongly associated with reward and goal-directed behavior, supporting the notion of romantic love as an intense motivational state.

These studies confirm the relation between the craving and natural states of need and motivation. They reinforce the hypothesis that there is a misappropriation of the endogenous circuits of reward by the addictive drugs.

The adolescent brain

The adolescent brain and in particular the prefrontal regions go through the most important modifications in the course of adolescence. The dorsolateral prefontal cortex is involved in the development of cognitive processes, the orbitofrontal cortex in emotional and motivational processes, and the anterior cingulum in the autoregulation of behaviour. The ventral striatum is also modified, both at the level of white and grey matter. The alterations are both anatomical and neurobiological.

Neurological aspects

A recent study analysed the concentration of dopamine and D2 receptors in the adolescent brain. It suggests an increase of these concentrations during adolescence, and therefore an increased use of dopamine (Kuei et al. 2006). Studies, however, are still underway.

Anatomical aspects: The contribution of medical imaging

Neuro-imaging studies show that a large reorganisation of the neuronal circuits takes place during adolescence, especially in the regions of the brain involved in executive functions and emotional regulation. There is, in particular, an increase of white matter and a reduction of grey matter, which makes the communication between regions easier and the encoding, more efficient. (Gogtay et al. 2004, Casey et al. 2005, 2008). These changes occur from the posterior to the anterior regions, so that there is a parietal loss of grey matter when the child becomes a teenager and a loss of frontal grey matter when the adolescent becomes an adult.

Adolescence and addiction

According to Spear (2000), Eshel (2007) and Diamond (2012), the functional signification of these changes results in an unbalance between cognitive and emotional processes, which is explained by a disproportionate presence of mesolimbic dopamine during adolescence. Indeed, adolescent behaviour suggests that there is an important use of limbic associated structures, while inhibitive cognitive structures are less effective. Besides, during adolescence, there could be an important use of «approach related structures» (ventral striatum) at the expense of «avoidance -related srutuctures» (amygdala).

All this results in a neurodevelopmental fragility and a higher risk of dependency during adolescence (Steinberg et al. 2005, Dayan et al. 2011).

DISCUSSION

When we analyse the different studies it becomes clear that, at a neurobiological level, there are similarities between substance addiction and love dependency (eg:Insel 2003, Fisher et al. 2010, Burkett & Young 2012, Aron et al. 2005, Acevedo et al. 2011, Aron et al. 2005).

Functional imagery indeed shows that similar structures are involved. It could also well be that these structures, as well as dopaminergic transmission, take part in the neurodevelopmental modifications occuring during adolescence (eg: Gogtay et al. 2004, Casey et al. 2005, 2008, Diamond 2012).

Could the teenager be more at risk of addiction because of these modifications?

We have to be careful here. Adolescence is a vulnerable period for many reasons involving physical, hormonal, social and cognitive changes and the need for self-development... (Zdanowicz et al. 1999, Steinberg et al. 2005, Dayan 2011). We cannot therefore reduce adolescence to an alteration of the neurological structure. Moreover, the dopaminergic modification is itself influenced not only by serotonergic, GABAergic, glutamatergic and noradrergenic impregnation, but also by the environment and hormonal or inflammatory processes.

CONCLUSION

Medicine sets up preventions by warning about the primary and secondary effects of substances. It describes their chemical composition, their physiological effects, their potential dangers. Preventive hope resides in dissuasion. Justice sets prevention up by punishment, to try to eradicate substances (Zdanowicz et al. 1999). Now, trying to eradicate them means thinking that, in its absence, there is no risk of dependence whereas this article highlights the relation between substance abuse and addictive behaviours, like passionate love.

Building a model for prevention based only on this neurobiological model would be simplistic, especially during adolescence. Physical, hormonal, social, environmental and neurodevelopmental changes all make adolescence a time of vulnerability. It is important to have this specificity in mind to imagine methods that would take all these factors into account.

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