Drug addiction and alteration of decision making process

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Nicotine addiction represents a serious social and public health problem. It is characterized by impulses, urges, lack of self-control towards cigarettes and perseveration despite important negative consequences. However, the behavioral changes induced by tobacco use go beyond the sole modifications of the way smokers consume cigarettes. These changes affect general cognitive functions and decision-making processes (Naudé et al., 2015), with for example, a tendency for smokers to prefer immediate small rewards over bigger, delayed ones.

Nicotine acts through nicotinic acetylcholine receptors (nAChRs), a pentameric receptors widely expressed in the brain. The binding of nicotine onto its receptor is sufficient to trigger a series of adaptations that lead to nicotine addiction and to modifications of the decision-making system. Numerous theories have been developed to model addiction, but an important framework states that addictive drugs modify the activity of dopamine (DA) neurons in reward signaling and in decision making. DA carries information related to beliefs and rewards, and consequently plays an important role in decision-making and learning (Caplin et al., 2010; Cohen et al., 2007). A powerful computational theory relies on unexpected reward for generating phasic DA release, which acts as teaching signals for appropriate learning and behavioral conditioning (Montague et al., 2004). Slower changes in the dynamic of DA cells have been associated with uncertainty detection, punishment, but also modifications in motor, cognitive, and motivational systems (Schultz, 2007).

The remarkable evolutionary conservation of DA function illustrates the prominent role of DA in behavior. Dopamine is one of the most studied and theorized biological entities in Personality Neuroscience and variations in DA function correlate with variability in a number of important traits that define personality (DeYoung, 2013). In our lab, we have developed approaches in mice to investigate, from the molecular to the cognitive level, the mechanisms underlying nicotine addiction and of the resulting modifications of the decision-making system and individual behaviors. We have dissected how nicotine, through its action on DA cells Faure et al. (2014), modifies different traits of an individual, from its reaction to stress, its social behavior or its exploration / exploitation balance (Naudé et al., 2016). Addiction can thus be viewed as the result of a maladaptive decision process, but may also be considered as a particular and extreme situation illustrating the impact of DA dynamics modifications on personality.

Acknowledgements

This work was supported by the Foundation for Medical Research (FRM, Equipe DEQ20130326488), the Institut National du Cancer (Tabac-16), ANR (ANR-16 Nicostress).

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Carole Knibbe et al, eds., Proceedings of the ECAL 2017, Lyon, France, 4-8 September 2017,
(Cambridge, MA: The MIT Press, ©2017 Massachusetts Institute of Technology).