Role of orexin and opioid dynorphin peptides in obesity behavioral dysregulation

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Orexin, feeding and foraging

Food-seeking behavior and uncertainty

Uncertainty can be understood as a measure of the expectation of the reward prediction error in given environment. This measure of difference between expected reward and current reward is encoded by dopamine neurons (Bayer and Glimcher 2005). Furthermore, this system can modify decision-making policies based on the reward-prediction error (Pessiglione et al. 2006). Food-seeking behavior, can be conceptualized as series of decision-making actions occurring in an environment with varying grades of uncertainty, where each feeding bout is evaluated by the reward prediction error, and over a history of bouts, uncertainty over environment rewards is obtained.

Under higher uncertainty levels of environment food disposition, animal food-seeking bouts are increased resulting in hoarding-type behavior, arguably as a mechanism to prevent possible starvation (Anselme and Güntürkün 2019). However, this behavior can also be explained by food scarcity or insufficient energetic supply by the environment. The latter case doesn't necessarily predict uncertainty as this can be high in average, but volatile from time to time. Nevertheless, when feeding environment is altered by constant changes in food position, an increased intake is observed (Forkman 1993), so food access variability can trigger, by itself, an increased food-seeking behavior. Sign-tracking also increases when uncertainty about reward probabilities also increases (Anselme, Robinson, and Berridge 2013), that is, motivation is increased under uncertainty of reward delivery. In addition to modifying intake, uncertainty levels, can affect energy expenditure (Bednekoff and Houston 1994), even when overall food levels are equated in predictable and unpredictable setting (Cuthill 2000).

If uncertainty can modulate food-seeking behavior in order to increase intake, and better sustain energetic reserves. It is expected to have, at least, to functional instances (1) a uncertainty sensing unit and (2) a reward processing unit, which can relay information to homeostatic-related and decision-making loci, to integrate such information a determine the next action to take. In humans such functional instances seems to be separated, where nucleus accumbens, thalamus and medial orbitofrontal cortex are more activated in unpredictable reward scenarios, and predictable scenarios with right superior temporal gyrus (Tanaka et al. 2006). Task-related brain activity is reduced in more predictable environments, likely by lowering mean prediction error, however, anterior cingulate cortex (ACC), shows augmented activation when predictability drops (Davis, Choi, and Benoit 2010). When situated in a learning task, ventral striatum has been related to short-term reward prediction, whereas dorsal striatum was related with long-term reward prediction (Tanaka et al. 2006). Short-term reward prediction is closely related with uncertain environment as immediate rewards don't provide any information about subsequent rewards, which is the opposite case of certain (or regular) environments, where each rewards provide all information to predict the next reward.

Obesogenic environments

Cafeteria diet and uncertainty

The decision making problem in obesity

Conclusions

HOLA

References

Anselme, Patrick, and Onur Güntürkün. 2019. "How Foraging Works: Uncertainty Magnifies Food-Seeking Motivation." *Behavioral and Brain Sciences* 42: e35. https://doi.org/10.1017/S0140525X18000948.

Anselme, Patrick, Mike J. F. Robinson, and Kent C. Berridge. 2013. "Reward Uncertainty Enhances Incentive Salience Attribution as Sign-Tracking." *Behavioural Brain Research* 238 (February): 53–61. https://doi.org/10.1016/j.bbr.2012.10.006.

Bayer, Hannah M., and Paul W. Glimcher. 2005. "Midbrain Dopamine Neurons Encode a Quantitative Reward Prediction Error Signal." *Neuron* 47 (1): 129–41. https://doi.org/10.1016/j.neuron.2005.05.020.

Bednekoff, Peter A., and Alasdair I. Houston. 1994. "Avian Daily Foraging Patterns: Effects of Digestive Constraints and Variability." *Evolutionary Ecology* 8 (1): 36–52. https://doi.org/10.1007/BF01237664.

Cuthill, I. C. 2000. "Body Mass Regulation in Response to Changes in Feeding Predictability and Overnight Energy Expenditure." *Behavioral Ecology* 11 (2): 189–95. https://doi.org/10.1093/beheco/11.2.189.

Davis, Jon F., Derrick L. Choi, and Stephen C. Benoit. 2010. "Insulin, Leptin and Reward." *Trends in Endocrinology & Metabolism* 21 (2): 68–74. https://doi.org/10.1016/j.tem.2009.08.004.

Forkman, B. A. 1993. "The Effect of Uncertainty on the Food Intake of the Mongolian Gerbil." *Behaviour* 124 (3-4): 197–206. https://doi.org/10.1163/156853993X00579.

Pessiglione, Mathias, Ben Seymour, Guillaume Flandin, Raymond J. Dolan, and Chris D. Frith. 2006. "Dopamine-Dependent Prediction Errors Underpin Reward-Seeking Behaviour in Humans." *Nature* 442 (7106): 1042–5. https://doi.org/10.1038/nature05051.

Tanaka, Saori C., Kazuyuki Samejima, Go Okada, Kazutaka Ueda, Yasumasa Okamoto, Shigeto Yamawaki, and Kenji Doya. 2006. "Brain Mechanism of Reward Prediction Under Predictable and Unpredictable Environmental Dynamics." *Neural Networks* 19 (8): 1233–41. https://doi.org/10.1016/j.neunet.2006.05.039.