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Multiscale Modeling of Human Addiction: a Computational Hypothesis for Allostasis and Healing

Yariv Z. Levy, *University of Massachusetts - Amherst*

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First Advisor
Andrew G. Barto

Second Advisor
Jerrold S. Meyer

Third Advisor
Sridhar Mahadevan

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Abstract
This dissertation presents a computational multiscale framework for predicting behavioral tendencies related to human addiction. The research encompasses three main contributions. The first contribution presents a formal, heuristic, and exploratory framework to conduct interdisciplinary investigations about the neuropsychological, cognitive, behavioral, and recovery constituents of addiction. The second contribution proposes a computational framework to account for real-life recoveries that are not dependent on pharmaceutical, clinical, and counseling support. This exploration relies upon a combination of current biological beliefs together with unorthodox rehabilitation practices, such as meditation, and proposes a conjecture regarding possible cognitive mechanisms involved in the recovery process. Further elaboration of this investigation leads on to the third contribution, which introduces a computational hypothesis for exploring the allostatic theory of addiction. A person engaging in drug

consumption is likely to encounter mood deterioration and eventually to suffer the loss of a reasonable functional state (e.g., experience depression). The allostatic theory describes how the consumption of abusive substances modifies the brain's reward system by means of two mechanisms which aim to viably maintain the functional state of an addict. The first mechanism is initiated in the reward system itself, whereas the second might originate in the endocrine system or elsewhere. The proposed computational hypothesis indicates that the first mechanism can explain the functional stabilization of the addict, whereas the second mechanism is a candidate for a source of possible recovery.

The formal arguments presented in this dissertation are illustrated by simulations which delineate archetypal patterns of human behavior toward drug consumption: escalation of use and influence of conventional and alternative rehabilitation treatments. Results obtained from this computational framework encourage an integrative approach to drug rehabilitation therapies which combine conventional therapies with alternative practices to achieve higher rates of consumption cessation and lower rates of relapse.