Chapter 8
Predictive Regulation in Affective and Adaptive Behaviour:
An Allostatic-Cybernetics Perspective

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ABSTRACT

In this chapter, different notions of allostasis (the process of achieving stability through change) as they apply to adaptive behavior are presented. The authors discuss how notions of allostasis can be usefully applied to Cybernetics-based homeostatic systems. Particular emphasis is placed upon affective states – motivational and emotional – and, above all, the notion of 'predictive' regulation, as distinct from forms of 'reactive' regulation, in homeostatic systems. The authors focus here on Ashby's ultrastability concept that entails behavior change for correcting homeostatic errors (deviations from the healthy range of essential, physiological, variables). The

DOI: 10.4018/978-1-5225-1947-8.ch008

authors consider how the ultrastability concept can be broadened to incorporate allostatic mechanisms and how they may enhance adaptive physiological and behavioral activity. Finally, this chapter references different Cybernetics frameworks that incorporate the notion of allostasis. The article then attempts to untangle how the given perspectives fit into the 'allostatic ultrastable systems' framework postulated.

INTRODUCTION

Mid-twentieth century ('first-wave') Cybernetics led by Ashby (1952) has had, at its core, the concept of adaptive behavior serving homeostatic control. Cybernetics has been considered a forerunner for modern Cognitive Science (cf. Pickering 2010, Staddon 2014) and has also provided strong input to the domain of Systems Biology (Froese & Stewart 2010). In this chapter, we will discuss the role of an emerging perspective of (second order) homeostasis known as 'allostasis' and how it may fit within a Cybernetics approach as it concerns adaptive behavior.

Ashby (1952), as a chief exponent of first-wave cybernetics, coined the term *ultrastability*, which refers to the requirement of multiple (at least two) feedback loops – behavioural and internal ('physiological') – in order to achieve equilibrium between an organism and its environment. This perspective has, ever since, been a source of inspiration for many artificial systems, and theoretical, conceptions of adaptive behavior. Such work has focused on the role of essential variable (or homeostatic) errors that signal the need for behavioural change in order to maintain an organism-environment equilibrium. Essential variables are those variables *most critical* to the viable functioning of the (biological or artificial) organism. Approaches that have emphasized the existence of double feedback loops have manifested in studies of activity cycles of both behavioural and internal states (e.g. McFarland & Spier 1997; Di Paolo 2000, 2003; McFarland 2008). According to these approaches, homeostatic processes typically amount to *reactive* (corrective) responses that are purely behavioural including those mediated by a proximal action selection process. In more recent years, Cybernetics- and Artificial Intelligence-based perspectives on homeostasis (and ultrastability) have considered the role of *prediction* in regulating organisms' behavioural and internal needs (Muntean & Wright 2007, Lowe & Ziemke 2011, Seth 2014).

While allostasis has many definitions (for example, McEwen and Wingfield 2003; Berridge 2004; Sterling 2004, 2012; Schulkin 2011), a common thread among them is a focus on the predictive regulatory nature of biological organisms (particularly humans). Homeostasis, by comparison, is more typically conceived as a reactive process. However, a number of commentators have pointed out that this perspective emanates from a misconception of Cannon's (1929) original detailing of homeostasis