Ritter, F. E., Dancy, C., & Berry, K. (2011). The case for including physiology in cognitive modeling. In *Biologically Inspired Cognitive Architectures*, 303. IOS Press: Amsterdam.

The case for including a physiology substrate in cognitive modeling

Frank E. Ritter (frank.ritter@psu.edu)
Chris Dancy (cld5070@psu.edu)
College of IST, Penn State

Keith Berry (keith.andrew.berry@us.army.mil)
Bioengineering Department, Penn State, and Medical Corps, US Army Reserves

23 June 2011

Cognitive architectures such as ACT-R allow us to simulate certain aspects of human behavior and cognition. Though these architectures are sufficient for simulating many aspects of cognition, there remain features of humans, human behavior, and cognition that have yet to be sufficiently realized through models within a cognitive architecture. We examine here features not yet realized that appear to be based on the physiology level, for example, circadian rhythms, the effects of caffeine, task appraisal, and a wide range of factors that cause fatigue. That is, there are models of the effect of caffeine on cognition, but not models of the effect of caffeine on energy use that then influences cognitive mechanisms. There are models of the effects of fatigue, but these do not represent the underlying mechanisms of fatigue but the effects on performance. There are other examples that include a physiological substrate, but not a unified one that is based on human physiology.

To move towards an architecture that encompasses a larger breadth of humans and human behavior, we propose to add a physiological substrate to architectures, and we explain what this will mean for an existing cognitive architecture, ACT-R, creating ACT-RΦ. A concrete physiological substrate will allow for more diverse theories and representations of human behavior and cognition, that is, theories that involve the mind and the body. Examples of such behaviors include certain emotions, fatigue due to exercise or sleep deprivation, and external affects caused due to the environments—effects on cognition arising from a lower, physiological level. ACT-RΦ will give users an opportunity to model both cognitive and physiological effects. We will demonstrate this ability by comparing the behavior of an existing ACT-R model to one developed with the addition of a physiological substrate such as HumMod.