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Modeling the Impact of Cognitive Moderators on Human Cognition and Performance

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Introduction (Kevin Gluck)

Cognitive moderators, such as emotions, personality, stress, and fatigue, represent an emerging area of research within the cognitive science community and are increasingly acknowledged as important and ubiquitous influences on cognitive processes. This symposium brings together scientists engaged in research to develop models that help us better understand the mechanisms through which these factors impact human cognition and performance. There are two unifying themes across the presentations. One theme is a commitment to developing computational models useful for simulating the processes that produce the effects and phenomena of interest. The second theme is a commitment to assessing the validity of the models by comparing their performance against empirical human data.

Jonathan Gratch

Spurred by a range of potential applications in psychotherapy, education, and entertainment, there has been a growing body of research in developing computational models that can simulate the cognitive and behavioral influences of human emotion. In this talk, I will discuss how appraisal theories of emotion can profitably inform the design of human-like autonomous agents that must convey these core aspects of human behavior. I will lay out a detailed computational framework inspired by Lazarus's conception of appraisal theory with appraisal and coping as a central organizing principle for such systems, and discuss an empirical evaluation that compares the behavior of the model against human behavior using a standard clinical instrument for assessing human emotion and coping.

Glenn Gunzelmann

Sleep-related fatigue is prevalent in human functioning, and has been implicated as a contributing factor in a number of disastrous events stemming from human error. To mitigate the potential for such disasters requires an understanding of the mechanisms of fatigue and how they impact human cognition & performance. In this talk I will discuss a theoretical account of these effects that has been developed with consideration of empirical, theoretical, and neurobehavioral research, including the incorporation of biomathematical models that characterize changes in alertness as a function of sleep/wake history and circadian rhythmicity. I will describe the implementation of computational mechanisms and models within the ACT-R cognitive architecture and compare model performance against human performance on a sustained attention task.

Eva Hudlicka

Emotions induce a range of biases in cognitive processes, including those mediating cognitive appraisal. My research aims to characterize the mechanisms of the cognitive-affective interactions underlying these biases. In this talk I describe a methodology for modeling the effects of affective factors on cognition, and a cognitive-affective architecture that implements it. The underlying assumption of this approach is that a broad range of affective influences can be represented in terms of alternative configurations of *architecture parameters*. These then induce distinct modes of processing in the architecture modules, in terms of speed, capacity and specific content biases. Evaluation studies demonstrate the architecture's ability to produce distinct observable behaviors arising from the parameter-controlled manipulations of the modules' processing, to generate behaviors characteristic of distinct affective profiles, and to generate more realistic agent behavior. The associated testbed environment facilitates the generation and testing of alternative hypotheses regarding specific mechanisms.

Frank Ritter

We (Klein, Schoelles, & Quigley) have been developing a range of theories of how stress influences cognition and a way to test them. We represent the theories as changes (overlays) to ACT-R's mechanisms. This approach integrates cognitive architecture and stress research. The stress theories provide suggestions for improving cognitive architectures. For instance, the assumption that extended time-on-task negatively influences performance is central to nearly all stress theories, but these effects are not predicted by most architectures. Similarly, implementations of verbal/conceptual theories of stress as computational models often reveal weaknesses. For example, many stress theories predict that attention narrows or vision becomes more focused under stress, but do not predict that repeated serial subtraction (part of the Trier Social Stressor Task) will be affected by stress. However, this task is impacted by stress, and a comprehensive computational of stress will require adequately explaining this, and other, effects.