In D. Reitter & F. E. Ritter (Eds.), Proceedings of the 14th International Conference on Cognitive Modeling (ICCM 2016). University Park, PA: Penn State.

Integrative Physiological Modeling: Looking at a Larger Picture

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One approach to modeling is the use of minimal models that portray only the elements believed to be most causative of a particular phenomenon. An alternate approach is to connect many such minimal models together through their inputs and outputs to generate an integrated model in which larger phenomena can emerge. These emergent features do not belong to the minimal models, but rather are characteristic of their interactions. By integrating well-understood mechanisms into a consistent whole, the role of the individual pieces can be more fully understood. If the simple models and their linkages are viewed as the hypothesis of a theory, the integrated model is the testable part of that hypothesis.

Such models have been used to great effect in physiology to create cohesive scientific theories where no single causative agent could be found. Examples of this are the role of the kidney in establishing hypertension, and the complex interplay between the left and right heart in determining cardiac output. These models have been appreciated for this value for nearly 50 years in physiology, but enormous gaps remain to be studied. Among these is the relationship between cognitive state and physiological function.

In this talk, I will summarize past and current efforts in integrative physiological modeling from groups around the world, with special attention paid to the knowledge that flowed from studying the emergent properties of such models. Additionally, I will discuss domains in physiology that we believe will require cognitive models for deeper understanding of the physiology.