One of John Bowlby's primary goals was to replace Freud's drive theory with an attachment motivation theory rooted in modern scientific methods, empirically accessible, and better able to account for the context sensitivity of observable infant behavior. To accomplish this, he turned to control systems theory. Control systems are logical structures that integrate information about the environment and the internal state of the organism, relate this information to a set goal, and engage behavior in order to establish and maintain an adaptive relation to the environment. Although the structure of an attachment control system is not directly accessible, hypotheses about its structure can be tested by building computer models with specific information processing architectures (modeling) and examining their behavior over time (simulation). The emergence of new high-level simulation languages is making this methodology increasingly accessible to cognitive and behavioral researchers.

This poster illustrates the uses of modeling and simulation to examine(1) alternative hypothesis about hypothetical infant attachment control systems and (2) the origins of individual differences. Specific examples of secure base architectures are provided and compared with actual behavior. These include simulations of infants at home, exploring a park, 'coy' infant responses to meeting unfamiliar adults, and Strange Situation behavior. An advance over previous simulation research is the use of autonomous agent architecture and the ability to implement interaction and information exchange (including affect) between the infant and caregiver agents. The models implemented here vary in complexity from reactive (with no capacity to learn) to active (able to learn by reinforcement), and deliberative (able to 'look-ahead' and consider the possible effects of possible actions).

Computational experiments undertaken with interacting infant and caregiver agents show the presence of interesting dynamic properties, such as positive feedback loops. These suggest new interpretations of secure versus insecure and avoidant versus ambivalent attachment patterns. For example, within the architectures that have so far been created, the avoidant versus ambivalent distinction seems arises more from the structure of social interactions and learning in general than from attachment-specific features of the models. In addition to revealing strengths and weaknesses of hypothesized attachment control system models and suggesting alternative interpretations of actual observed behavior, simulation experiments can be used to evaluate models of developmental change.

Work with computer models depends on good behavioral description of the phenomenon to be captured. Perhaps because ethological / observational study seems too open ended, it receives little priority in current attachment study. By providing concrete patterns of attachment behavior over time, modeling and simulation studies provide very specific guidance as to the types of observations that would be most useful for (1) evaluating the fit of models' behavior to actual attachment behavior, (2) evaluating "novel" behaviors that arise from specific models, and (3) increasing the depth to which specific functions are modeled. Thus "high tech" and "low tech" methods are shown to inform one another and both have implications for the kinds of hypotheses tested using emerging methods from neuroscience.