

# Attachment and Cognitive Architecture

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## Abstract

Humans are interesting combinations of mammalian drives such as feeding, child rearing, and group affiliation, with high level cognitive capabilities such as language and planning. In this position paper, I argue that the attachment behavior system is an interesting boundary case to examine because, while attachment in young children is extremely similar attachment behavior in other primates, it develops alongside high level cognition to quickly incorporate human-specific skills such as language. This makes it hard to fit cleanly into most agent architectures.

Most agent architectures are understandably designed on functionalist grounds. That is, starting from some general theory of rational activity, the designer breaks the problem of action into subproblems like sensory-motor control, planning, etc. in whatever manner seems most sensible. These systems tend to break the problem up into a sensory system, a set of sensory-motor primitives, and a relatively general purpose problem-solving system to control them (Bonasso et al. 1997, Arkin 1998).

The human system, by contrast, wasn't designed from scratch. It is the result of the evolution of phylogenetically earlier reptilian and mammalian systems to somehow support the more general problem-solving capabilities of humans. While it is unclear how general-purpose problem solving is implemented in humans, it is clear that most of the mammalian hardware is still present. Many of these systems, such as visual cortex, have clear analogs in AI-oriented agent architectures. However, mammals also have a number of special-purpose behavioral systems that don't fit neatly into a three-level architecture. The attachment behavior system (Bowlby 1969) provides an interesting example of a mammalian system that appears to still be present and active in humans, but which becomes interestingly intertwined with the general purpose system during development. Most interestingly, it is neither clearly superior to, nor subordinate to the general-purpose

cognitive system, so it doesn't fit cleanly into a classical three-level architecture or other tiered architecture.

## Attachment Theory

Attachment Theory is concerned with the mechanisms and development of a child's attachment to his or her caregivers. It was initially developed by Bowlby and Ainsworth to explain why children remain attached to parents who mistreat them while being unable to attach fully to surrogate caregivers who treat them better. In the 1940s, when Bowlby began his work, the dominant psychological theories— Freudian psychodynamic theory and behaviorist psychology — explained children's attachment to their parents in terms of secondary drives (Cassidy 1999). Children, so the theory went, have a primary drive to get food. Parents provide food, therefore the children learn their attachment to their parents out of a self-interested need for food. This predicts that children should attach to whoever happens to feed them, contradicting observed behavior. Children often remain resolutely attached to abusive parents, while refusing to attach to surrogate caregivers who treat them much better.

Bowlby looked to ethology (the study of animal behavior), cybernetics, and later cognitive science, for alternative models. In both his work and subsequent work, the Attachment Behavior System (the system responsible for the child's attempts to engage the caregiver) and Caregiving Behavior System (the system responsible for the caregiver's attempts to protect and console the child) are thought to be innate components of human behavior. They display both ontogenetic continuity over the course of an individual's life and phylogenetic continuity with child rearing behavior in non-human primates, and even imprinting behavior in birds. Rhesus monkeys, for example, display nearly identical attachment behavior to young human children (Suomi 1999).

Bowlby stressed that the attachment system involved the development of increasingly complex internal models. Thus, although the attachment system begins activity within the first year of life as a relatively simple collection of sensory-motor behaviors, it evolves along with a child's cognitive capabilities. The perceived non-availability of a

caregiver triggers both anxiety and attachment behavior (seeking out of the caregiver, desire to touch the caregiver, etc.). In infants the assessment of availability is based on relatively simple perceptual properties, such as physical proximity or the availability of line-of-sight to the caregiver. However, children quickly substitute other, more abstract, parental availability cues, allowing them to tolerate the (short term) perceptual absence of the parent. For example, older, securely attached, children are capable of tolerating parental absence provided the parent (1) first discusses their absence with the child, (2) explains they will return at a designated time, and (3) has demonstrated their reliability in the past with such promises (Cassidy, 1999). Attachment behavior also increasingly involves verbal interaction, particularly talk about feelings, rather than simple approach and contact behaviors. Thus, although attachment is still thought to be an innate system with its own internal representations, both its behaviors and its releasers (the stimuli that trigger it) develop to interact with higher level cognitive systems such as language.

The system is thought to continue to be active throughout adulthood; however, adults are able to tolerate their parents' absence until some serious threat to the parent occurs, such as illness or death, at which point many adults will still experience anxiety, a desire to hug the parent on reuniting, etc. Moreover, adult romantic love is although thought to involve the attachment system (Hanzan and Shaver 1987, Feeney 1999). And adult attachment style is an important predictor of stalking behavior (Kienlen 1998).

### Why model attachment?

Humans are an interesting combination of mammalian drives such as feeding, child rearing, and group affiliation, with high level cognitive capabilities such as language and planning. If one wants to simulate human behavior, e.g. for interactive drama, one needs to model both. Attachment is interesting because, while it seems to be an innate behavioral system we have in common with other species, it grows to interoperate in complicated ways with the higher-level systems that seem to be unique to humans. This suggests a different architecture from the typical tiered architectures, one in which the standard mammalian behavior systems, rather than being replaced or controlled by the deliberative system, instead run alongside it, sometimes generating behavior directly, but other times generating goals for the deliberative system to plan for. I say "suggests" because I have no compelling proof one way or the other. This is a position paper, and I find that when I mention this argument to colleagues, they generally respond either with something along the lines of "yes, obviously", or with deep skepticism. While this paper isn't likely to persuade the skeptics, I hope it will at least make the argument clear.

If one does believe the argument, then while we should continue to study high-level cognition, we should also model the behavioral systems we have in common with other animals. Petters, for example, has developed computational models of infant attachment behavior and shown that they correctly predict the dependency of individual differences in child attachment style on parental caregiving style (Petters 2006). The next step would be to see how to modify such a system to interact with the cognitive system, and whether the cognitive system might also need to be modified to interact with it.

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