The context of this talk

• Multi-disciplinary research with contributions to AI and Psychology

• Significance for autonomous agent research in AI:
  – A novel application
  – An example of the design based approach (requirement/design/evaluation)
  – Novel architectures produced

  • (summarised in a recent paper found at www.cs.bham.ac.uk/~ddp)

• What is its significance to Psychology?
Do explanations of attachment behaviour in one year olds need to include mechanisms of executive function?

might be rephrased as

When simulating attachment in autonomous agents mechanisms of action selection form the foundation of any explanation of the externally observable behaviour.

BUT how important are these considerations to Attachment Theory and other fields of Developmental Psychology?
Overview of the talk

• Setting the scene with reviews of:
  – the range of attachment phenomena observed in humans and in other mammals across the life-span
  – the range of information processing theories of attachment that explain these phenomena
  – the general development of human infants at one year of age and theories of executive function

• The main questions:
  – Is there a gap between the explanation given by low level physiological theories and high level representational theories? Should this gap be filled with details of how infants co-ordinate different types of actions, for example, how infants choose between ‘affective’ and ‘cognitive’ actions in different contexts? How might these ideas be empirically tested?
Review of attachment phenomena

• Responses to separation over days and weeks
  – Phases of - Distress, Anger and Detachment
• Strange Situation Experiment behaviour
• Animal studies that mirror human separation behaviours and individual difference groupings
• “A move to the level of representation”
  – response to photographs
  – drawing pictures of the family
• Teenage studies
• The Adult Attachment Interview
Review of attachment phenomena

• Responses to separation over days and weeks
  – If a child is older than six months and is separated from their main carer the child goes through three phases:
    • Protest/distress may begin immediately or be delayed and lasts for few hours to a week or more
    • Despair/withdrawal/hopelessness/less physical movement
    • Detachment/no longer rejects nurses/some smiling and sociability but unemotional reunion
  – These findings from a time before ‘modern’ hospital visiting
Review of attachment phenomena

• Strange Situation Experiment behaviour
  – eight episodes of three minute duration
    • mother, infant, experimenter (<1 minute)
    • mother, infant
    • mother, infant, stranger
    • infant, stranger
    • mother, infant
    • infant
    • infant, stranger
    • mother, infant
Review of attachment phenomena

• Animal studies
  – Kraemer (1992)
    • primates, neurophysiology study of isolation experiments
    • rats, neurophysiological study of isolation experiments
  – Suomi (1999)
    • rhesus monkeys, naturalistic studies of individual differences in behaviour comparable to Strange Situation studies
Review of attachment phenomena

• Main “A move to the level of representation”
  – testing of infant/carer at 1 year
  – retesting at 6 years
  – study dialogues concerned with prospective two week separation
  – short separation and response to photographs
  – drawing pictures of the family
  – AAI on parent of 6 year olds

• Kobak (1993)
  – Teenagers studied using AAI and Q sorts
  – Investigating how teenagers regulate their emotions
Review of attachment phenomena

• The Adult Attachment Interview
  – Discourse analysis
  – Grice’s Maxims - eg coherence
  – Four categories with 63% concordance
    • Autonomous - secure
    • Dismissing - avoidant
    • Preoccupied - resistant/ambivalent
    • Unresolved - disorganised
Review of information processing theories

• Bowlby
  – Behavioural systems
  – Internal Working Models
  – Language
  – under-specified and not up to date

• Kraemer (1992), Hofer (1995, 1999)
  – wrong timescale, ie hours and days not seconds and minutes and no clear route to linking with higher level theories (see next slide)
  – “image” not IWM (Kraemer)
  – hidden regulators (Hofer)
Review of information processing theories

• Main (et al 1985, 1991)
  – dual coding, coherence and meta-cognition

• Bretherton (1990, et al 1999)
  – scripts, event schemata etc

• Kobak et al (1993)
  – control theory, hyperactivation, hypervigilance, deactivation, (action selection BUT in teenagers)

• Crittenden (1995)
  – different mechanisms for infancy, pre-school
  – cognitive versus affective
Human infants at one year of age and mechanisms of executive function

- Bowlby
  - Phase 1 (up to 8 weeks of age) Orientation and Signals with Limited Discrimination of Figure
  - Phase 2 (from 4 weeks auditory/ 10 weeks visual to 6 months) Orientation and Signals Directed towards One (or More) Discriminated Figures
  - Phase 3 (Starts from approx 6 months to 1 year, Ends approx 18 months). Maintenance of Proximity to a Discriminated Figure by means of Locomotion as well as Signals. Uses Goal corrected mechanisms but does not represent the plans of others.
  - Phase 4 (18 months - ) Formation of a Goal-corrected Partnership
Human infants at one year of age and mechanisms of executive function

- Cole and Cole - Bio-social-behavioural shifts at:
  - 2-3 months
  - 7-9 months
  - 18-24 months

- Tomasello - Social-cognitive revolution/joint attention at 9 months
  - Distinctly human behaviours, agents as 'causes' of events

- Diamond - A not B error, performance changes between 9 months and 1 year, memory constraints and inhibition of prepotent response versus Barkley - ADD/inhibition of prepotent response in older children

- LeDoux (High road versus Low road fear response in rats) versus Contention Scheduling and the SAS

- H-cogaff versus Newell SOAR preparation-deliberation
Attachment and executive function - Looking again at Crittenden (1995)

• Three questions
  – how do A, B, C, D patterns develop?
  – why are there only three patterns?
  – how does maturation change attachment relationships

• Highlights different brain structures
  – brain stem - reflexive patterns
  – reptilian midbrain - associative learning
  – limbic system - affective responses
  – cortex - cognitive functioning
“When caregivers respond to infants’ reflexive, conditioned, and affective behaviour in ways that are comforting to infants, infants are reinforced and learn to display the behaviour more predictably. In Vygotskyan terms these mothers assist their children to learn both the communicative meaning of their behaviour and the predictability of its effect on others. In attachment terms they are securely attached.”
“When infants’ signals result in interference or rejection, the effect is to punish infants for their behaviour; consequently, they learn to inhibit the punished behaviour. Infants who become avoidant by one year of age typically experience maternal rejection when they display affective signals indicative of a desire for closeness to their mothers. If infants protest this unpleasant outcome, they often experience maternal anger. Inhibition of affective signals both has the predictable effect of reducing maternal rejection and anger and also teaches infants that expression of affect is counterproductive.”
“Other children have mothers who are clear in their affective communication but inconsistently responsive to infant signals. The inconsistency may involve either over- or underresponsiveness; in either case, infants find it difficult to learn to communicate effectively. When infants cannot predict their caregiver’s response, they become anxious and angry. Expression of this anger leads to mixed outcomes: inconsistent mothers are sometimes comforting, sometimes angry, and sometimes ineffective. In learning theory terms, infants of such mothers are on a schedule of unpredictable intermittent reinforcement.”
“It is well known that such a reinforcement schedule maintains behaviour at high rates, even in the context of intermittent negative outcomes. Because infants of inconsistent mothers are unable to make predictions, they are unable to organise their behaviour on the basis of them. Cognition, in other words, fails them. They do, however, experience the temporal association of desire and its satisfaction with anger, uncertainty, and fear...”

Cognition versus affect,
A = cognitive, B = integrated, C = affective
Attachment and executive function

• A flat Reinforcement Learning architecture? (implicit goals, just maximisation of reward)
• A multi-level (executive function/cogaff like) architecture? (with some RL lower level and ability to deliberate)
  – one explanation for Strange Situation behaviour might be that A, B and C infants all use the full range of architectural subsystems
  – another is that A type infants use higher ‘cognitive/deliberative’ subsystems that C type infants don’t use
• Alternative mechanisms?
• Empirically testable?