Designing Agents to Understand Infants

Problem: to understand infant behaviours linked to attachment (and in future work infant behaviours linked to use of executive functions)

Solution: to design information processing architectures for autonomous agents
The Design Based Approach:

Bowlby as a mind designer

Reverse engineering: evolution as a designer, the designs of evolved organisms possess a function

Synthetic versus analytic research: Braitenberg and simple theories, Uphill analysis and downhill synthesis

Complete agent architectures: Broad and shallow
Attachment and Modern Evolutionary Psychology

Hierarchy of theories:

Inclusive fitness

reciprocal altruism sexual selection attachment parent offspring conflict life history

normative individual difference
Adaptationism vs Adaptivism

Current adaptations

Exaptations

Past adaptations

Dysfunctional by product
The Environment of Evolutionary Adaptedness

EEA for an infant:

- evolutionary niche similar to a requirements specification, but not a fixed external specification as it depends on infants developing capabilities
- generalised over all habitats
Behaviours that involve switching goals

Park exploration, coy behaviour with a stranger, wary behaviour with strangers and objects - all normative

analysis of evolutionary function: trade-off between learning and safety
  Langur monkeys and protective strategy requirements of altriciality,

the goal switching (GS) architecture
The goal switching (GS) architecture

Explore

Anxiety
2xWariness

Socialise
Physical-need
Limitations of GS architecture

Only normative behaviours

No Learning

No joint attention, intentionality or means end reasoning
Security and exploration

Two meta studies - Strange Situation and Q sort

Security of attachment related to carer sensitivity

Evolutionary analysis: parent offspring conflict

Scenario - infants learn about the appropriate level of sensitivity from testing carer sensitivity

How to adapt GS architecture?
Computational experiments
Learning from responses to anxiety

At a carer’s response threshold of 29 the Safe-range values bifurcate to high and low, giving a high error.
Computational experiments
Learning from responses to anxiety

At a carer's response threshold of 29 the Safe-range values bifurcate to high and low, giving a high error

secure infant-carer pairs

insecure infant-carer pairs
Computational experiments
Learning from responses to socialising

[Graph showing data points for safe-range at 1000 cycles against threshold of crying at which carer responds. The graph includes labels for secure infant-carer pairs and insecure infant-carer pairs.]
Computational experiments
Learning from responses to socialising
Theoretical Implications

Fraley and Spieker (2003)

Taxometric analysis of categories versus causal analysis of categories

Dynamic systems constructs: sensitivity to initial conditions, positive feedback loops, emergence of categories
Limitations

Ignores the difference between two types of Insecure infants

Same criticisms of GS, regarding Joint Attention, Intentionality, etc
Avoidance versus Ambivalence

Behaviour in reunion episodes

Behaviour at home

Possible causes:
   close contact
   inconsistency of care

Evolutionary analysis
   carer as threat, infanticide in EEA

Conditional scenarios
Two solutions

Rich interpretation versus Deflationary accounts

OR

The high road versus the low road

hybrid-action-reasoning (HAR) versus reactive-action-learning (RAL)
Secure
Ambivalent
The RAL architecture
The RAL architecture: Avoidant
The RAL architecture: Secure
The RAL architecture: Ambivalent
The HAR architecture
The HAR architecture: Avoidant

Deliberative processing
Deliberate about outcome of reactive actions. Outcome is inhibition of old actions and proposal of new actions

Goal activation modules
- explor
- anx
- obj
- soc
- socialise
- physical

Reactive goal selection

Motor control
- move
- signal

comfort sensor
The HAR architecture: Secure
The HAR architecture: Ambivalent
Limitations

RAL only:
no intentionality, reasoning, joint attention, and ignores results on executive functions and inhibition in infancy (ie Diamond A not B)

HAR only:
too advanced, beyond ‘Core Knowledge’, multiple independent centres for selection, not based on Basal Ganglia

HAR and RAL:
Carer doesn’t adapt
No role for consistency, temporal constraints, low level constraints, deep theory of anger, representational change, culture
Future work

Simulating other examples of infant behaviour that require executive control

Developing an infant Basal Ganglia

Implementing architecture with a consistent level of temporal granularity

Introducing non-Fregean forms of deliberation

Exploring internal processes as a dynamic system
Thanks