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# **Attachment as Free-Energy Minimisation**

**David Cittern and Abbas Edalat  
Algorithmic Human Development  
Imperial College London**

**Tobias Nolte  
Anna Freud Centre  
UCL**

# Strange Situation Reunion

Infant Classification	Infant reunion behaviour	Home caregiver behaviour	Infants (US)
<b>Secure</b>	Seeks proximity, quickly returns to exploration	Consistently responsive and sensitive to infant stress	62%
<b>Avoidant</b>	Avoids caregiver, continues to explore	Rejecting, distant	15%
<b>Ambivalent</b>	Hyperactive or guarded (resistant) proximity seeking, slow to return to exploration	Inconsistent, affective communication errors	9%
<b>Disorganised</b>	Chaotic and inappropriate responses, e.g. freezing or stifled scream	Hostile (frightening) or helpless (frightened), affective communication errors	14%

“**Organised**” attachment types: Secure, Avoidant, Ambivalent

# Decision Theoretic Model

- “Mathematical Models of Mother/Child Attachment”, Buono et al., 2006

		Caregiver Action	
		Attend	Ignore
Infant Action	Seek	$q$	$1 - q$
	Guarded Seek	$g$	$-s$
	Avoid	$h$	$-t$
	Avoid	$0$	$0$

- Captures organised attachment in final reunion of strange situation

# Attachment as Free-Energy Minimisation

- “Active inference and epistemic value”, Friston et al., 2015
  - Free Energy Principle: brain minimises quantity called “**free energy**” that gives a measure of uncertainty
- **Actions (control states)** performed by the agent
  - Here: Seek, Guarded Seek, Avoid
- **Hidden states of the world**
  - Transitions between hidden states based on current hidden state and action
  - Here: pairs of actions and caregiving behaviours, capturing effect caregiver has on infant’s internal stress (parametrised by  $q$ )
- **Observations** that the agent sees
  - Depend on the current hidden state
  - Here: Relative stress increases/reductions parametrised by  $g, h, s, t$
- Agent’s **model** of hidden state and observation dynamics
  - Used to predict future consequences of behaviour

# Parameter Space Exploration

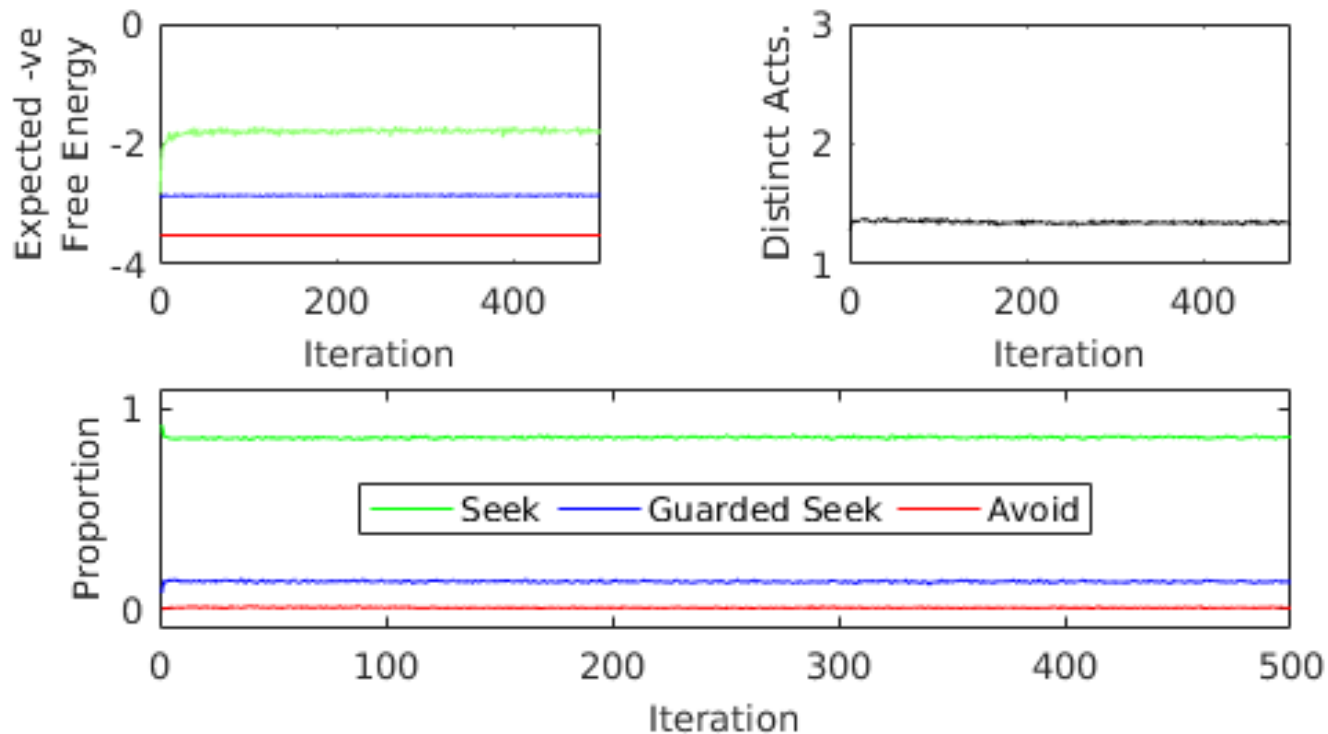
- Begin by assuming that infant has good model of how caregiver likely to behave
- Minimise free-energy:
  - **For large regions of parameter space, the three organised attachment types emerge for varied  $q$**

# Learning Caregiver Characteristics

- In reality, infant not born knowing how caregiver is likely to behave
  - **Must learn this**
- Now start with an infant who has an initial model that is uniform with respect to caregiving behaviour
  - Model gradually learned with experience as part of free-energy minimisation process

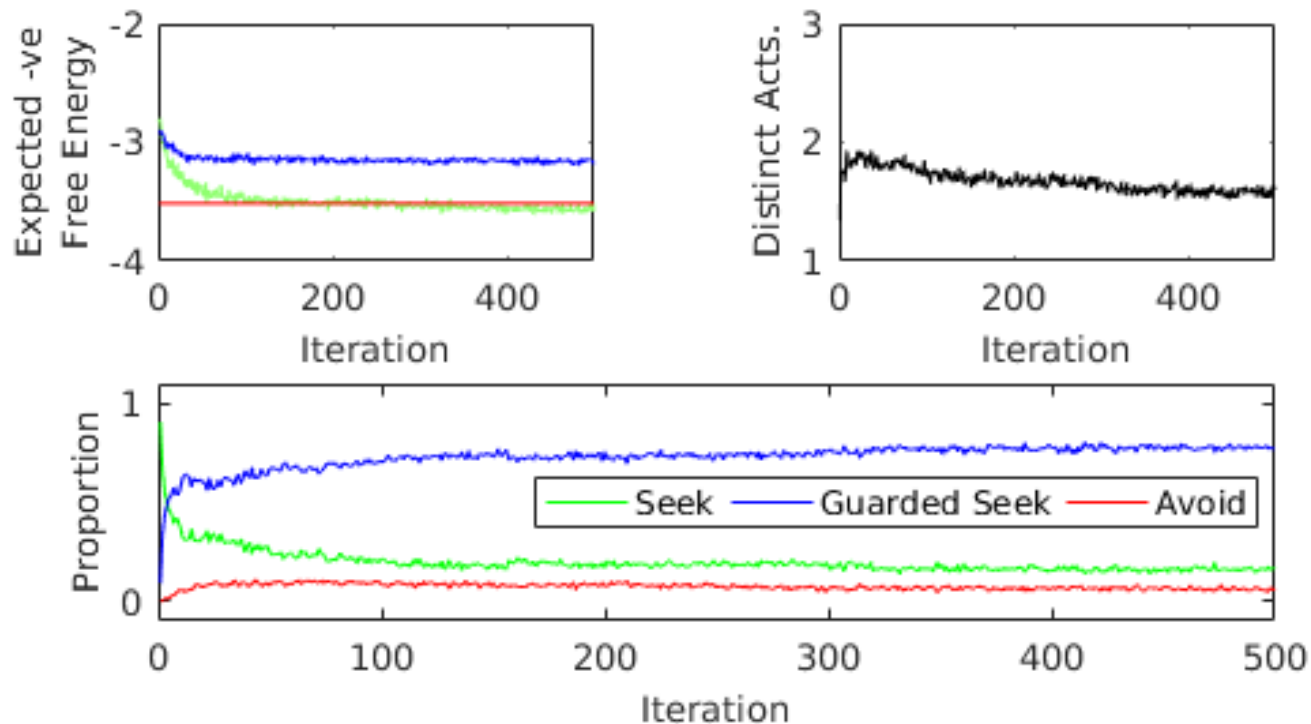
# Secure Attachment

- Consistently responsive caregiver ( $q=0.9$ )
- Top left: expected negative free-energies  
Top right: number distinct actions chosen per iteration  
Bottom: proportion action selections per iteration



# Ambivalent Attachment

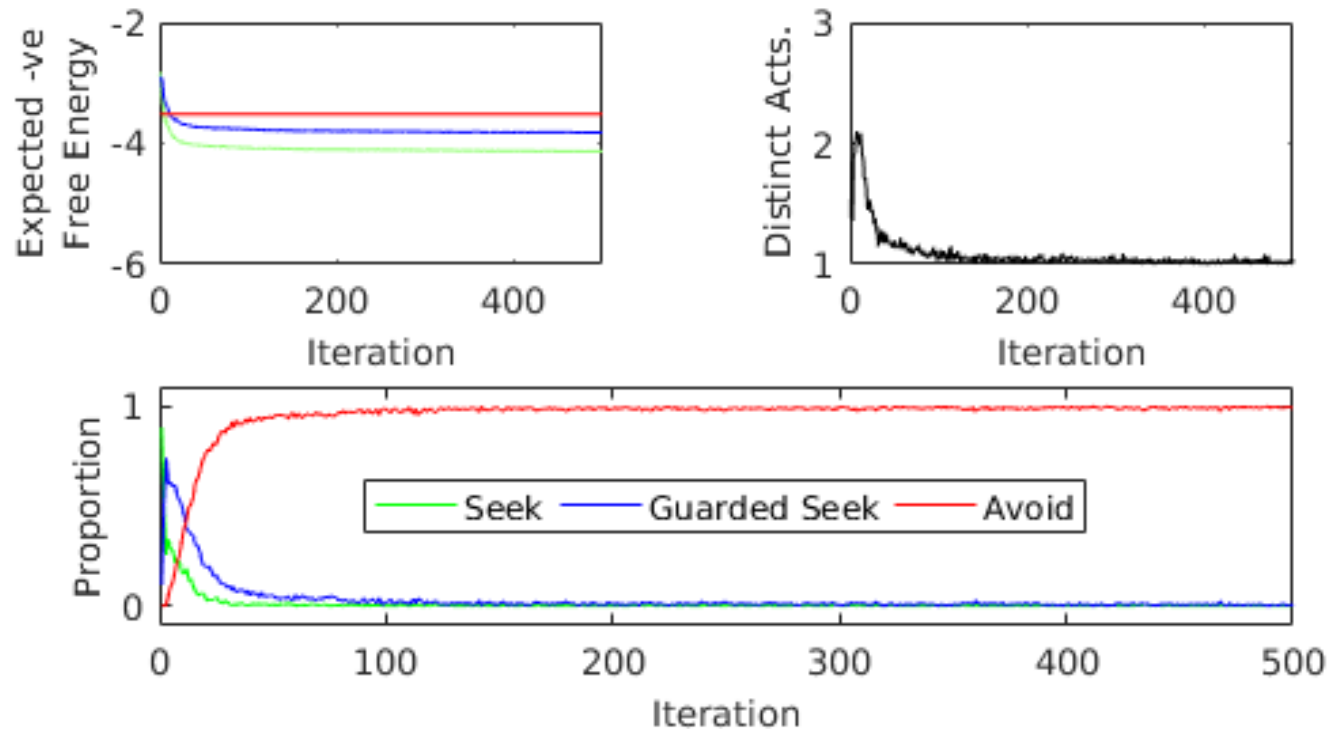
- Inconsistent caregiver ( $q=0.4$ )
- Top left: expected negative free-energies
- Top right: number distinct actions chosen per iteration
- Bottom: proportion action selections per iteration.





# Avoidant Attachment

- Consistently unresponsive caregiver ( $q=0.1$ )
- Top left: expected negative free-energies
- Top right: number distinct actions chosen per iteration
- Bottom: proportion action selections per iteration.

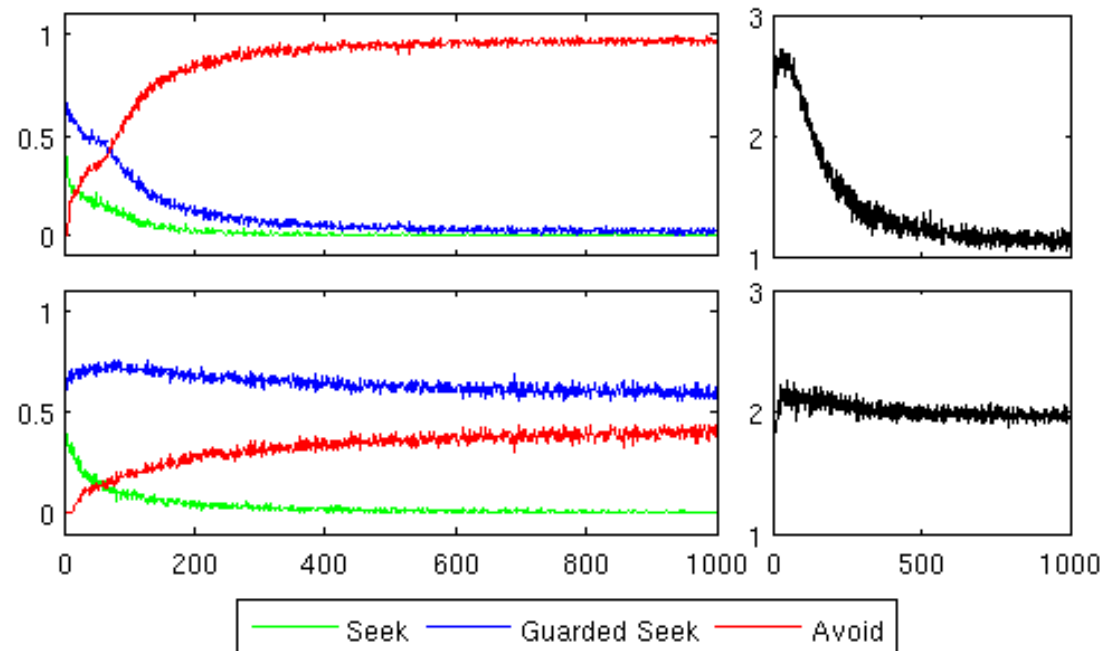


# Exteroceptive Cues

- **Disrupted Affective Communication (Karlen Lyons-Ruth and others)**
  - Research findings: Heightened disrupted affective communication, particularly **affective communication errors (ACEs)**, in Ambivalent and Disorganised caregivers
- ACEs include cues that are **misleading** or **ambiguous** with respect to subsequent caregiving behaviour
  - Example of misleading ACE (particularly linked to disorganisation): “Invites approach verbally then distances”

# ACEs and Disorganisation

- **Model: (misleading) ACEs disorganise behaviour for infants of caregivers who consistently increase stress on approach**
  - Broadly consistent with the current research
- Top row: low-q & no ACEs results in avoidance
- Bottom row: low-q & 50% chance of misleading ACE results in disorganisation



# Self-Attachment (Abbas Edalat)

- A new, self-administrable, attachment-based psychotherapy
- Aim: re-train attachment schema
- Method: create internal attachment relationship
  - Inner-child and adult-self
  - Techniques: self-directed bonding, re-parenting (including correction of memorised/experienced trauma) etc

# Self-Attachment

- **Hypothesis:** induces plasticity in key attachment-related neural circuitry
- Bonding:
  - Release dopamine and oxytocin, new OFC reward representations, strengthen OFC-amygdala inhibitory pathways
- **Self-Attachment as free-energy minimisation?**

# Questions?

- <http://humandevelopment.doc.ic.ac.uk>