Imitation, Goal-Attribution and the Mirror Neuron System

Why do we need it?

What is imitation?

"[T]he archetype of imitative learning . . . [is the] reproduction of both behaviour and its intended result." (Boesch & Tomasello, 1998, p.599)

- High fidelity behaviour copying skill present only in humans (Tennie, Call & Tomasello 2009).
- Imitation requires copying intentional actions in pursuit of same underlying goals as observed agent.

Goal attribution and imitation

… both fundamental to human development.

e.g. Language development

- Goal attribution → learn the meanings of others' words and gestures
- Imitation → produce words/gestures in pursuit of one's own goals

What mechanisms enable imitation and goal attribution?

In humans and primates sensorimotor neurons in the TFP (tempero-frontal-parietal) region fire both when an individual performs an action and observes that same or similar action performed by another (Gallese et al. 1996).

- → Mirror Neuron System (MNS)

MNS across species (Tramacere, Pievani, & Ferrari, 2017)

- Humans possess MNS for observation and execution of goal-directed manual and vocal actions.
- MNS for vocal perception and reproduction is not present in primates.
- MNS for perception and execution of hand and tool actions present only in less developed form in primates.

Origin of the MNs

Adaptive Hypothesis (Rizzolatti & Arbib 1998)

- MNS are an adaptation for matching behaviour
- Map sensory information to motor knowledge
- Underlying intentions inferred via simulation

  → action understanding

  → knowledge of others minds
- Facilitates goal attribution and imitation
- Operant hours after birth (Meltzoff & Moore 1997)

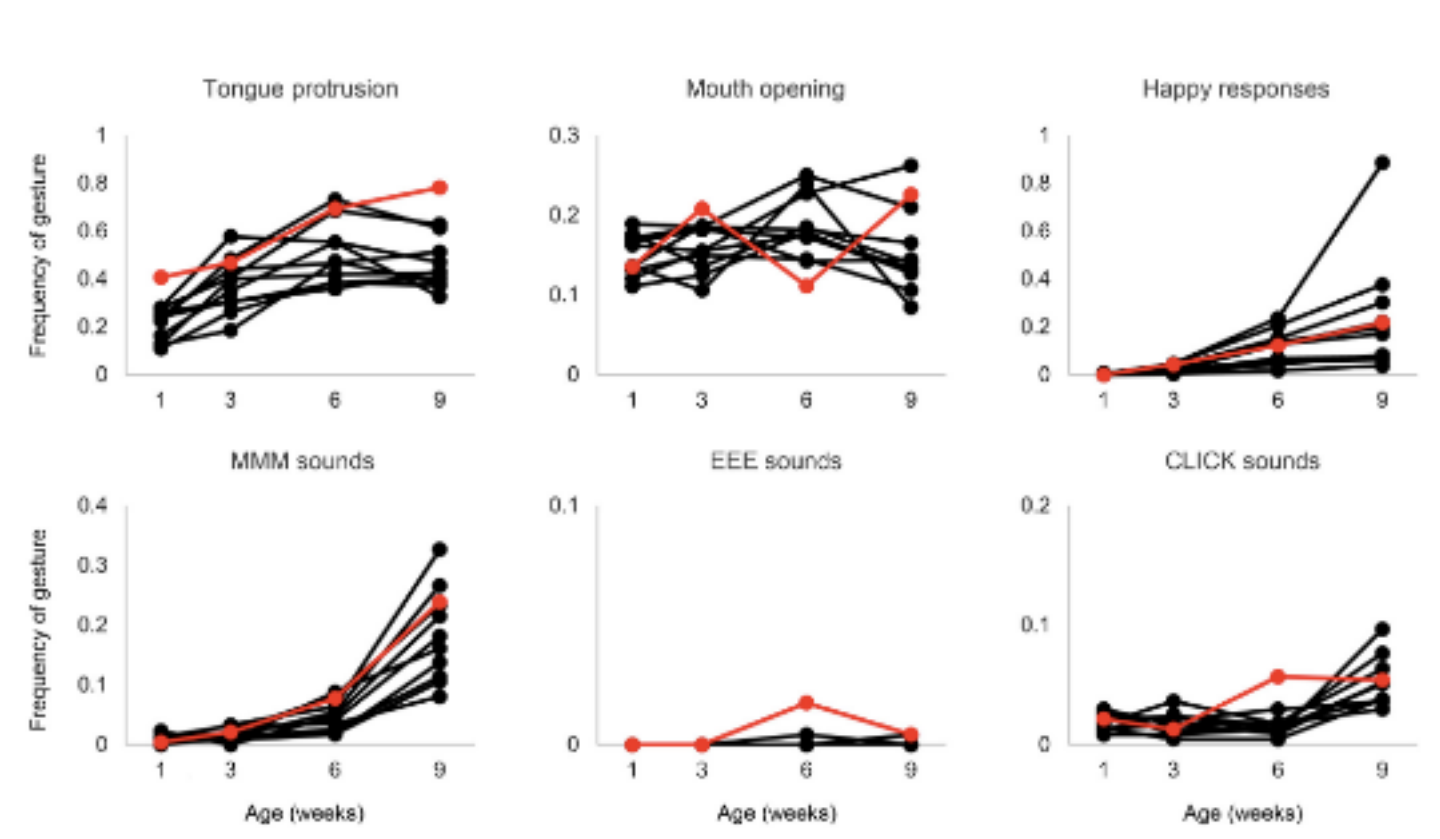
An alternative explanation

Associative Learning Hypothesis (e.g. Cook et al. 2014; Heyes 2018)

"Neurons that fire together wire together" (Hebb 1949)

- MNS is forged via domain general associative learning
- Neurons acquire mirroring properties because of repeated, everyday co-activation of sensory and motor representations
- MNS is trained by cultural practices like looking at ourselves in mirrors and positive reinforcement

Neonate imitation discredited (Oostenbroek et al. 2016)



Red lines show mean response frequencies to matching stimuli; controls are indicated in black

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