

Newborn imitation and cognitive development

J. Oostenbroek, M. Nielsen, V. Slaughter & T. Suddendorf

School of Psychology

University of Queensland

Australia

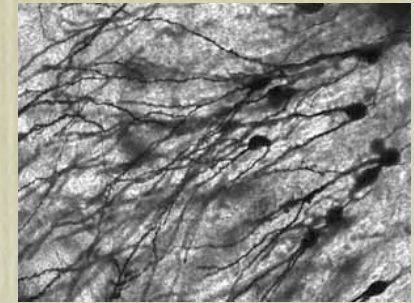


Neonatal imitation and cognitive development



- **Meltzoff and Moore (1977) first reported facial imitation in newborns**
 - inborn capacity to code observation and execution of motor acts in a supramodal framework? (e.g., Meltzoff and Moore, 1994)
 - “like-me” mechanism allows for intentional social interaction? (e.g., Meltzoff, 2005)
 - claimed to be foundation of later developments in social learning and cognition (e.g., Lepage and Theoret, 2007; Sommerville and Decety, 2006; Trevarthan and Aitken, 2001)
 - e.g., theory of mind (e.g., Meltzoff, 2005):
 - innate link between observed and experienced act
 - through first person experience acts are associated with internal mental states
 - like-me projection then enables children to link observed acts in others with likely mental states in others
 - others argue that neonatal imitation is not the basis for more advanced cognitive functions (e.g., Bjorklund, 1985)
- **homology with later imitation, mental simulation, and other social-cognitive capacities?**

Mirror neurons



- mirror neurons in macaques fire when seeing or performing the same specific goal-directed acts (e.g., di Pellegrino et al., 1992; Gallese et al., 1996; Rizzolatti et al., 1996)
 - could be the neurological basis for imitation (e.g., Iacoboni, 2005)
- MN have been implicated in
 - understanding of intention (e.g., Iacoboni et al., 2005)
 - in language (e.g., Arbib, 2005)
 - empathy (e.g., Leslie et al., 2004)
 - theory of mind (e.g., Meltzoff and Decety, 2003)
 - dysfunction of MN system may lead to imitation problems and this has been proposed to lead to a cascade of subsequent difficulties that are typical of autism (Williams et al., 2001)
- neonatal imitation proposed to be first sign of an innate mirror neuron system functional at birth (Lepage and Theoret, 2007; Meltzoff and Decety, 2003; Nagy and Molnar, 2004)
 - some evidence for neonatal imitation in rhesus monkeys (Ferrari et al., 2009) and chimpanzees (e.g., Bard, 2007)

But...

- **no direct evidence for the fundamental roles that have been attributed to MN**
 - there remains some debate about the very existence of MN in humans
 - MN fire in response to visual and motor events, but this does not necessarily mean they can transform a perceived input into the equivalent motor output (e.g., Jones, 2005).
- **goal-directed vs neonatal imitation**
 - single cell recording in monkeys revealed mirror neurons fire in response to goal-directed action such as reaching for objects (Rizzolatti et al., 2001)
 - but neonatal imitation is not goal-directed (mouth opening, tongue protrusion etc)
- **MN recorded in the premotor cortex, but simple imitation may be governed sub-cortically**
 - patients with severely impaired cortical function can show mouth-opening imitation (Go & Konishi, 2008)
 - these patients show little voluntary movement, but do show reflexes typically found in newborns.
- **in sum, the discovery of MN may not necessarily strengthen the case for the foundational role of neonatal imitation**

Behavioral evidence

- **some 29 studies have reported neonatal imitation of facial gestures, hand movements, emotional expressions and sounds**
- **none have produced direct evidence linking neonatal imitation to later social cognition**
 - some scholars even question the very existence of neonatal imitation (e.g., Jones, 2006 - arousal hypothesis)
- **literature reviews differ vastly in their conclusions from the available data**
 - **Anisfeld (1996)**
 - disputes most findings and argues that only tongue protrusion is reliably being copied
 - suggests that tongue protrusion imitation is best explained as a specific, directly elicited response - akin to a reflex
 - in line with data from cortically impaired patients who show reflexes and basic imitation (Go & Konishi, 2008)
 - **Meltzoff and Moore (1997)**
 - however, maintain that the literature provides ample evidence for imitation of a wide variety of gestures
 - and that neonatal imitation is evidently innate and demonstrates active intermodal mapping
- **unclear what the nature and prevalence of neonatal imitation really is**
 - the latest review, Ray and Heyes (2011), found only more positive than negative evidence for copying facial emotions, lateral head movement and tongue protrusion

Why inconsistent conclusions?



- **different coding schemes**
 - e.g., partial imitation, forced choice, absolute acts vs relative to diverse range of control conditions etc.
- **reliance on single testing events**
 - problems of newborn state regulation, experimenter effects etc.
- **lack of longitudinal data**
 - Heimann (1989) tested 32 infants at 3 days, 3 weeks and 3 months
 - TP imitation had disappeared at 3 months
 - two further longitudinal studies with very small N or t
 - Jones (1996) tested 2 children from week 1 to week 30
 - Meltzoff & Moore (1994) tested 6 week olds on three consecutive days
 - the rest are cross-sectional data

Need for longitudinal data

- **what is the actual range of gestures newborns are capable of imitating?**
 - only tongue protrusion vs many types of gestures? Comparison of different coding schemes
- **what is the prevalence and developmental path of such imitative responses?**
 - does it follow similar trajectory as other reflexes? (Anisfeld)
- **and are there individual differences that could be informative?**
 - if it is a deliberate social act (Meltzoff), then infants with a more social temperament may display more imitation than others
 - if it is the basis of later imitation (Meltzoff), then infants who show more neonatal imitation may also imitate better in later object-directed imitation tasks
- **we need such data to establish the nature of neonatal imitation and its role in cognitive development**

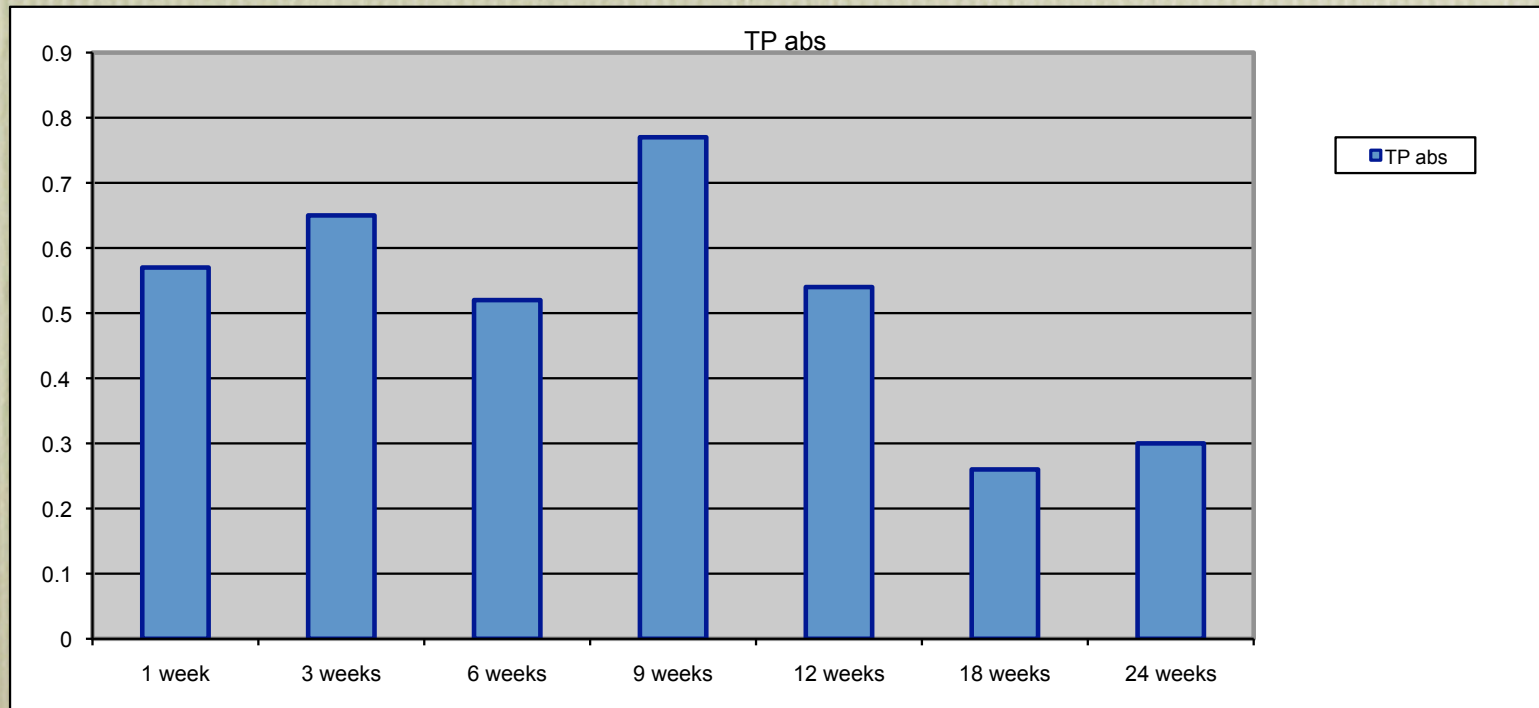
Our study



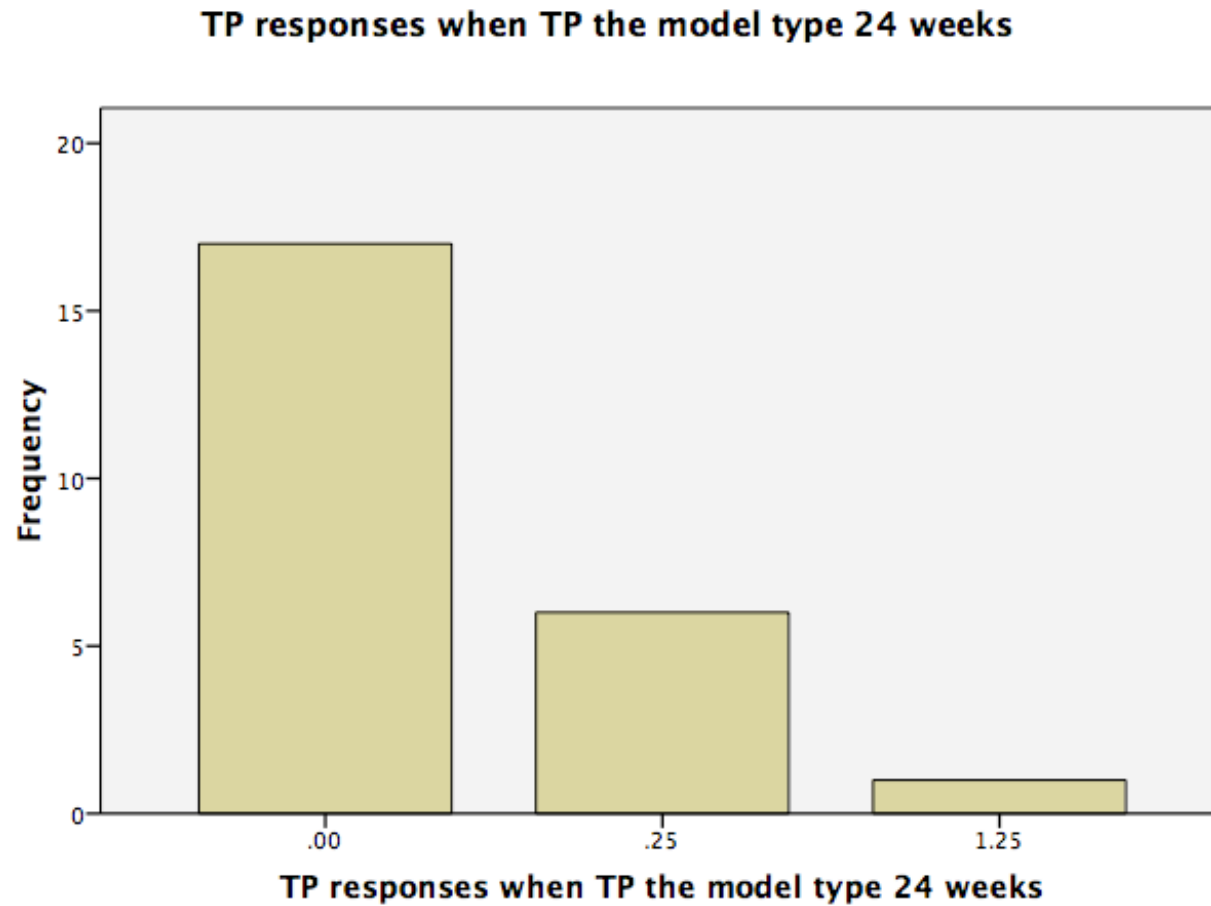
- **longitudinal study of neonatal imitation with N=100**
 - tested at 1, 3, 6, 9, 12, 18 weeks and at 6, 9, 12, and 18 months
 - (a) two facial gestures: tongue poking, mouth opening
 - (b) two facial expressions: happy and sad
 - (c) two manual gestures: opening and closing of the hand (grasping movement) and index finger pointing
 - (d) two vocal gestures “EEE,” “MMM”
 - (as well as tongue clicks & responses to inanimate objects etc)
 - many other measures are included at various stages, including
 - Brazelton Neonatal Assessment Scale (reflexes), short temperament scale for infants (Sanson et al., 1986), standard protocol scales of infant motor development (Bayley), preferential looking for social/non-social stimuli (Baron-Cohen, 2003), joint attention (Slaughter & Mc Connell, 2003), McArthur communicative development inventory, mirror-self-recognition and measures of imitation (object-directed and synchronic)

Very preliminary results

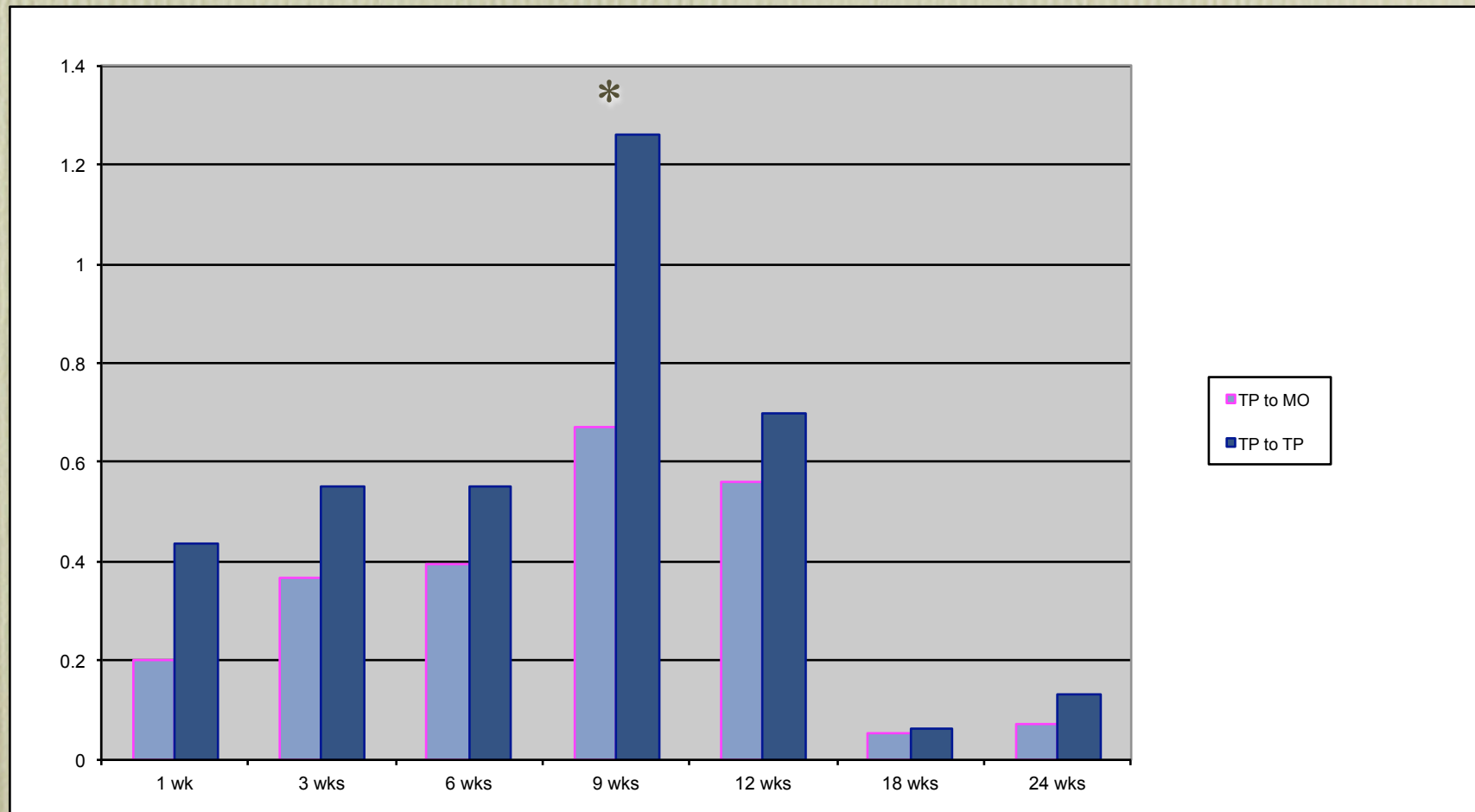
- ▣ first 6 months and $N=25$
- ▣ proportion of infants displaying at least one tongue protrusion in response to model TP (over 4 x 15 second bouts)



Frequency distributions



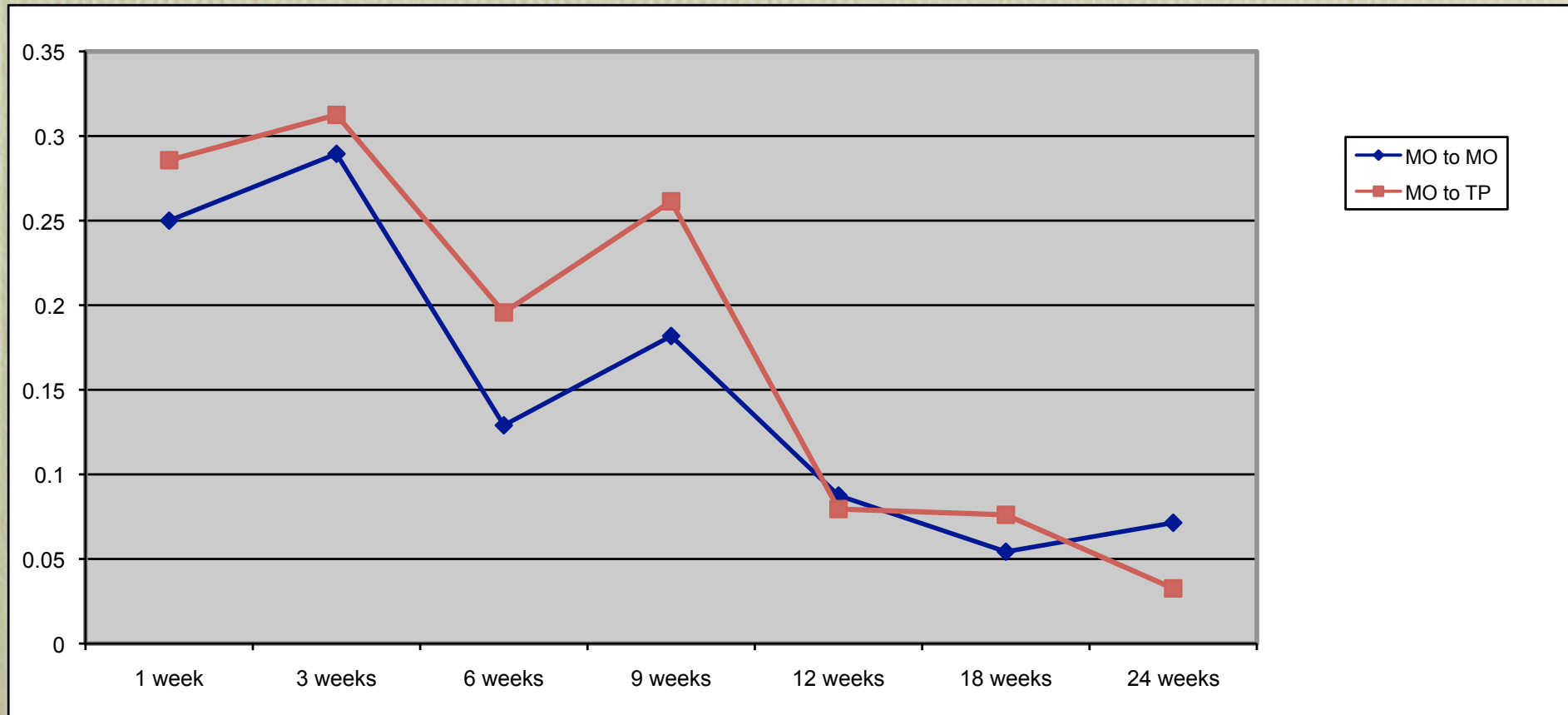
Average TP in response to TP model and mouth opening model



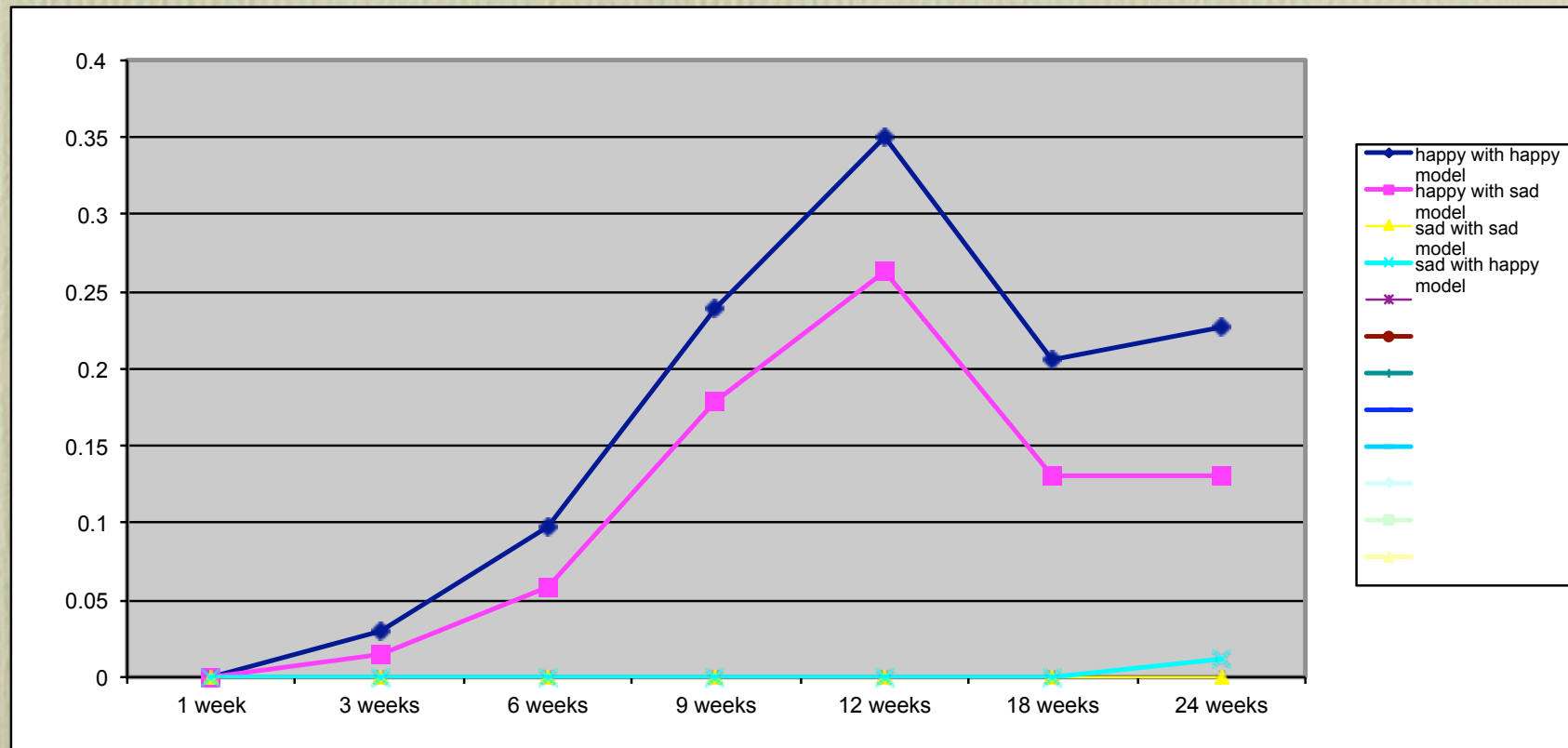
Preliminary pattern

- strongest evidence at 9 weeks
 - rather than the typically reported 1,3 or 6 weeks (not even significant yet - but power)
- disappears after 12 weeks
 - rather than the typically reported 2 months
- full longitudinal data set will give us a clearer view of the actual trajectory
 - what about the other actions?

Mouth opening

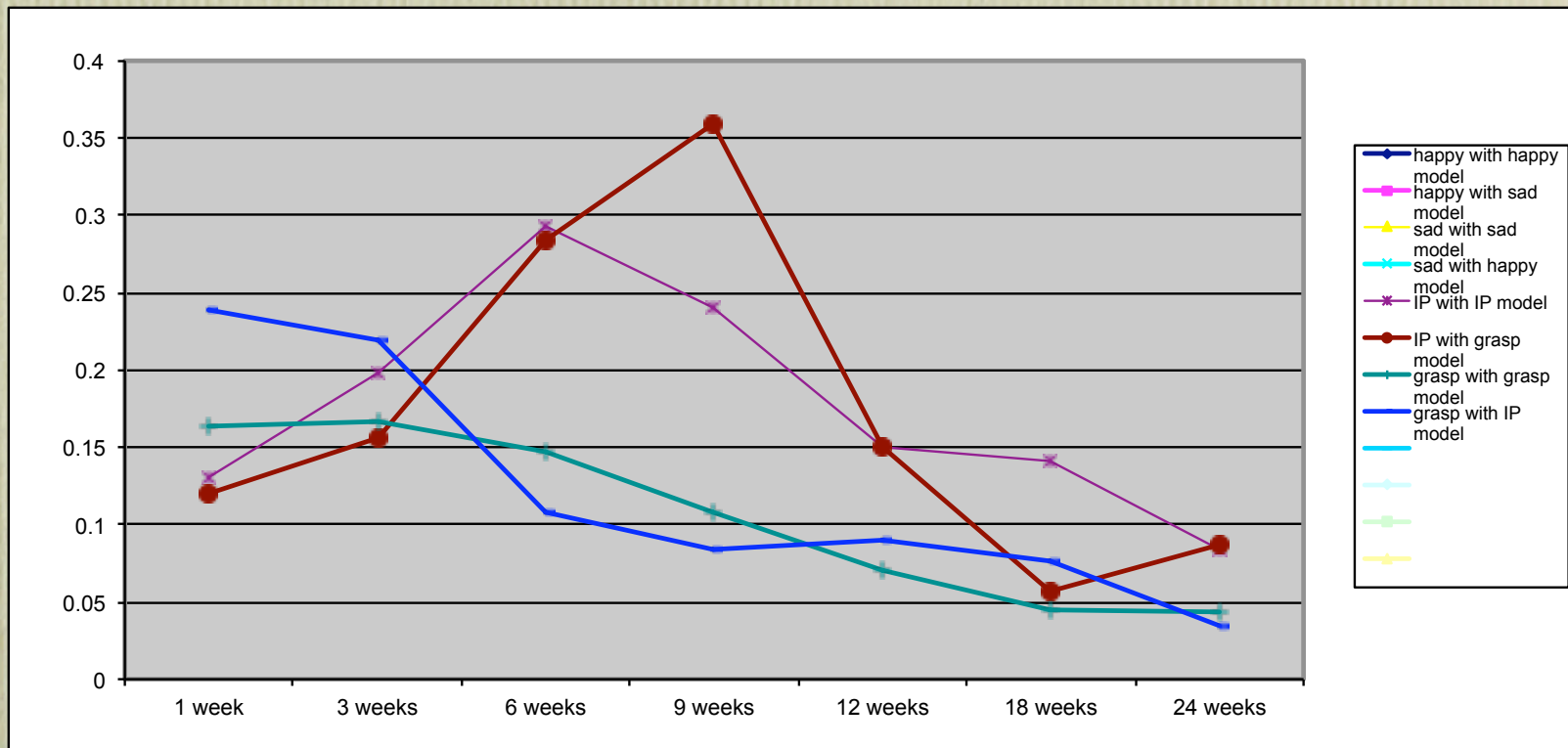


Happy and sad



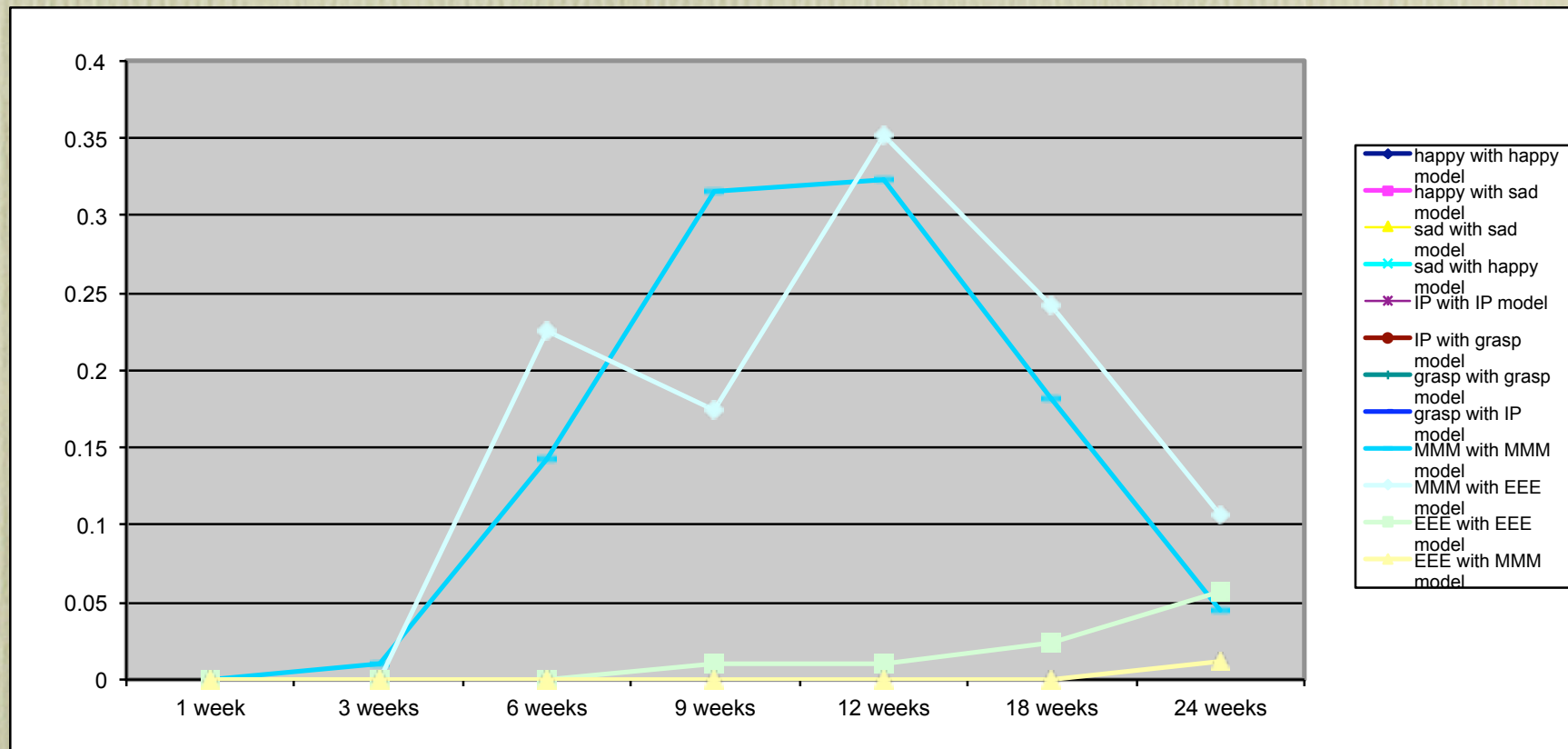
- no significant differences

Grasp and point



- no significant differences

EEE and MMM

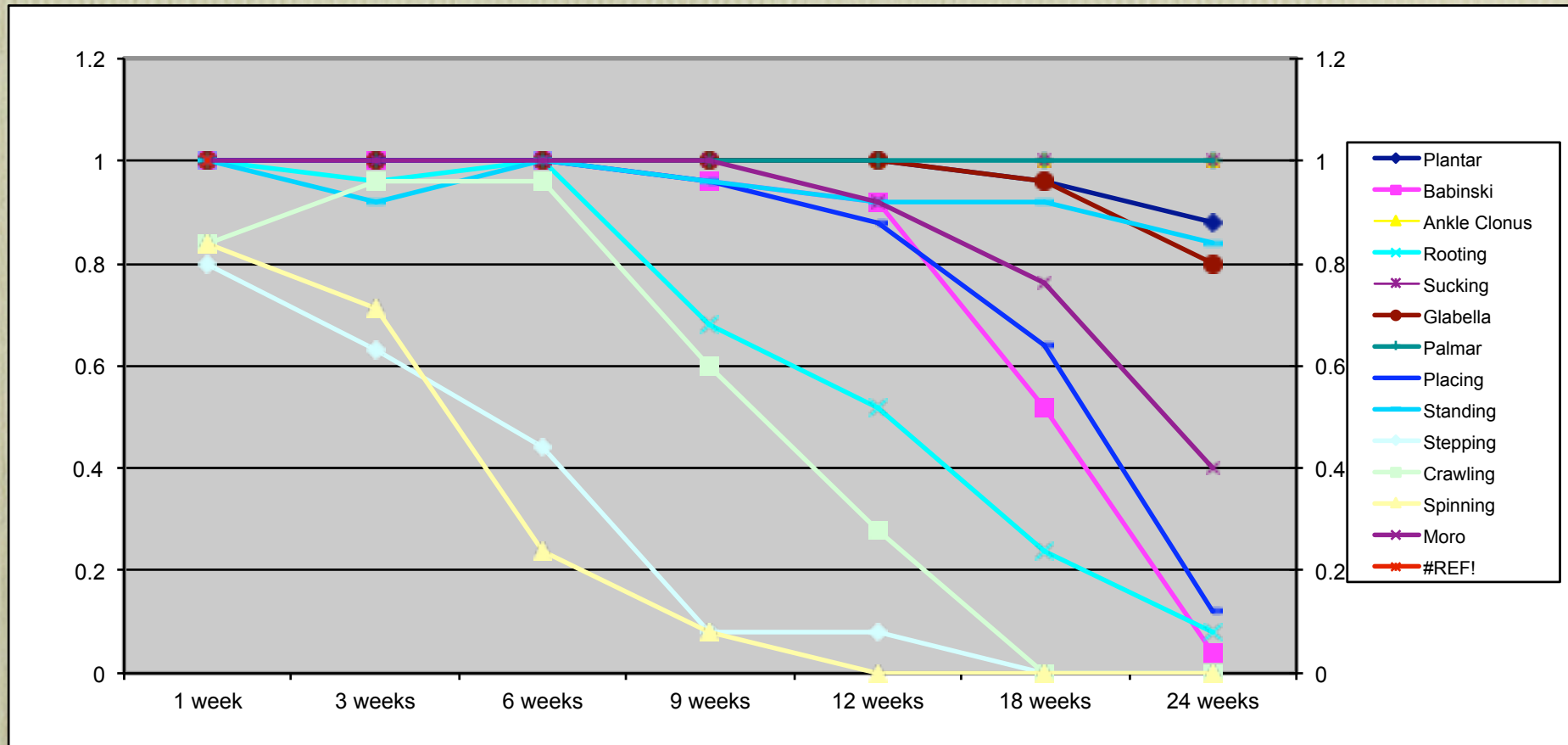


- no significant differences

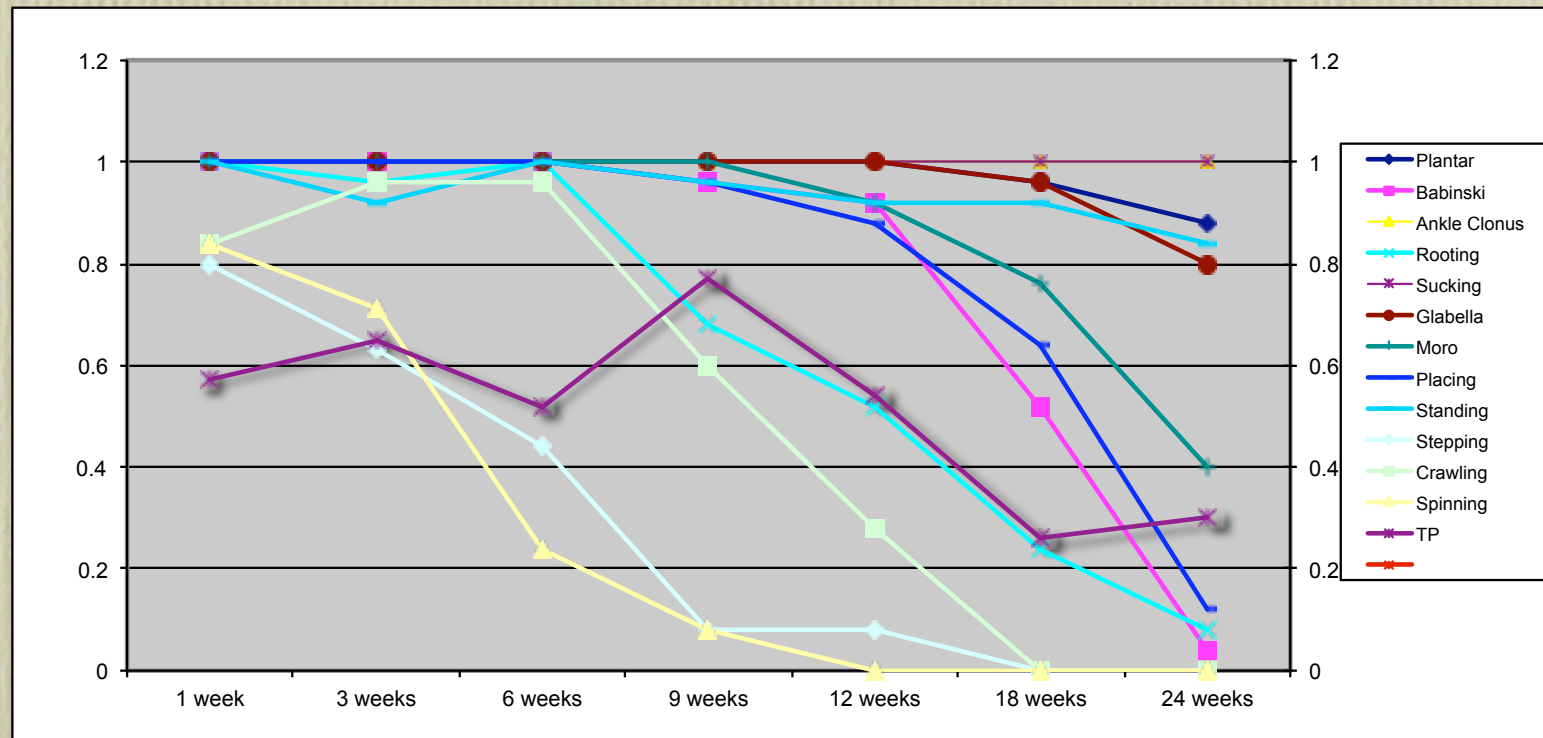
So...

- only tongue protrusion modeling appears to be copied
 - so far no evidence of neonatal imitation of other acts
 - and hence no support for the view that newborns have a flexible “like me” mechanism
- supports Anisfeld’s view rather than Meltzoff’s
 - is neonatal imitation, then, a reflex restricted to tongue protrusion as Anisfeld suggests?

Reflex data



Reflex vs imitation of TP



- TP is not as universal as other reflexes to begin with, but also drops in first months
- standard reflexes are all triggered through touch whereas imitation is mediated visually (ie., requires cross modal integration)

Individual differences in sociality



- **temperament**
 - do more social children show more imitative responding?
 - approach sub-scale of the Short Temperament Scale for Infants (Sanson et al., 1986) measured at 6 and 18 weeks
 - neither significantly associated with any TP imitation scores
 - only two trends (and those are in the opposite direction of prediction; i.e., more difficult babies show more tongue protrusion)

Is early imitation predictive of later imitative capacities?

- **measures of object-directed imitation at 6 and 9 months**
 - open toy door, shake rattle, putting toy into box
- **predictors**
 - TP imitation absolute and relative at week 1 to 24 and averages
- **no associations with scores at 6 nor 9 months**
 - a couple of trends, but again both in wrong direction (more neonatal imitation -> less object directed imitation)
- **no evidence yet of individual differences in neonatal imitation predicting later object-related imitation**

Conclusion



- **preliminary results suggest**
 - only tongue protrusion produces reliable neonatal imitation
 - phenomenon declines later than previously thought (around 18 weeks)
 - individual differences in temperament are not related to differential imitation
- **no support for the idea that neonatal imitation is the deliberate social capacity envisioned by Meltzoff as the foundation of later social cognition**
- **instead results are in line with critiques that see**
 - TP imitation as a reflex (Anisfeld) or as a mere exploratory response to interesting distal stimuli (Jones) (we'll explore the latter with tests that have not yet been analyzed)
- **no support for the notion of a homology**
 - individual differences in TP imitation are not related to later object-directed imitation
 - but this does, of course, not rule out the possibility of underlying homologies. How else to examine the possibility?
- **please remember all this is very preliminary (N=25)**
 - the full data set should help answer many vexing questions about the nature of neonatal imitation and claims about developmental homologies

Thanks



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