Newborn imitation and cognitive development

Thomas Suddendorf, Janine Oostenbroek, Mark Nielsen, Virginia Slaughter

Early Cognitive Development Centre, School of Psychology, The University of Queensland, St Lucia, 4072, Queensland, Australia

ph: +617 3365 8341 fax: +617 3365 4466 t.suddendorf@psy.uq.edu.au

It has been argued that neonatal imitation is the foundation of many later developments in social cognition (Lepage & Theoret, 2007; Sommerville & Decety, 2006; Trevarthen & Aitken, 2001). To properly assess such purported developmental homologies we need longitudinal data. In the absence of such data, scholars can only base their argument on inferences and conjectures.

The perhaps most influential line of conjecture supporting the foundational role of neonatal imitation, is based on the discovery of mirror neurons in the premotor cortex of macaques (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Mirror neurons fire when the monkey performs a goal-directed action (such as grasping an object) as well as when it observes the same action performed by another. The discovery of these neurological links between specific action and their perception has caused great excitement and theories have since implicated mirror neurons in understanding of intention (Iacoboni et al., 2005), in language (e.g., Arbib, 2005), empathy (Leslie, Johnson-Frey, & Grafton, 2004), theory of mind (e.g., Meltzoff & Decety, 2003) and imitation (Iacoboni, 2005). Neonatal imitation, it has been argued, involves cross-modal matching of equivalent visual and motor information and may thus represent the first sign of a human mirror neuron system that is innate and functional at birth (Lepage & Theoret, 2007; Meltzoff & Decety, 2003; Nagy & Molnar, 2004). Given the range of capacities that mirror neurons are purported to be crucially involved in, it would not appear far-fetched to consider neonatal imitation a fundamental building block of human social cognition.

However, although these proposals may be plausible and appealing, there are fundamental problems with the empirical bases of the major arguments. First, we do

not as yet have any direct evidence that mirror neurons even exist in humans, let alone play the fundamental roles that have been ascribed to them. Only single cell recordings in monkeys have produced unequivocal evidence for mirror neurons. Second, neonatal imitation is not equivalent to the goal-directed action that is associated with mirror neuron activity in studies with macaques (Rizzolatti & Craighero, 2004). Third, patients with severely impaired cortical function and little voluntary movement have been shown to display mouth-opening imitation and reflexes typically found in newborns (Go & Konishi, 2008). This suggests that sub-cortical, rather than cortical, processes are governing this imitation. Finally, we do not have any compelling evidence linking newborn imitation to later social cognitions. At present, there are only cross-sectional and two short-term longitudinal studies of the phenomenon. And even these studies have resulted in conflicting evidence and radically different interpretations.

Here I will introduce the first large scale and long-term longitudinal study that traces the development of neonatal imitation and related developments.

Studies on neonatal imitation

Meltzoff and Moore (1977) originally presented 30 newborns with a modelled gesture, such as mouth opening and tongue protrusion, and found that they produced significantly more responses matching these gestures than when viewing a different modelled gesture. Since then dozens of studies have tested newborns with a myriad of model gestures (e.g., emotional expressions, index finger protrusion, chin tapping, ear touching, waving, blinking and so on). In a recent review Ray and Heyes (2011) conclude that only three of these – facial expressions of emotion, tongue protrusion and lateral head movement – have produced more positive than negative results.

Earlier reviews by Anisfeld (1991; 1996) even found only the evidence for matching of tongue protrusion compelling. Meltzoff and Moore (1997), however, disagree and report in their own review that their original study had been replicated and extended to include a wide range of gestures in 25 independent studies from 13 different laboratories.

In the handful of more recent studies, Anisfeld et al. (2001) again found evidence for neonatal imitation only in the context of tongue protrusion. Chen, Striano and Rakoczy (2004) report that newborns were able to differentially imitate two vocal sounds by imitating the mouth shape needed to produce these sounds. Nagy et al. (2005) and Nagy et al. (2007) found that newborns could imitate index finger protrusion. Curiously Soussignan et al. (2011) report that neonates significantly increased their tongue protrusion when viewing a disembodied human mouth and tongue and a robotic artificial tongue, but not when viewing a whole human face protruding its tongue. These studies, like those of the previous 30 years, fail to provide compelling evidence that newborns reliably imitate other people.

The nature of neonatal imitation, its prevalence, time course and role in subsequent development remains controversial. Indeed, some researchers even refuse to acknowledge that neonatal imitation exists at all, arguing instead that general arousal is responsible for what appear to be imitative responses (Hayes & Watson, 1981; Jones, 1996; 2006).

Even if one grants that neonatal imitation does exist, there are competing theories that do not involve claims about mirror neurons and foundations of subsequent socio-cognitive development. An alternative view is that the phenomenon is a simple reflex (Abravanel & Sigafoos, 1984; Anisfeld, 1996; Jacobson, 1979; Kaitz, Meschulach-Sarfaty, Auerbach, & Eidelman, 1988). This view suggests that

seeing a modelled gesture such as a pocked out tongue (or an inanimate equivalent) triggers an involuntary, reflexive motor response or fixed-action pattern. As such, it is argued to belong to a suite of other inborn, inflexible temporary starting-state action schemas. Cross-sectional studies of early imitation indicate that most infants fail to show any imitative responses by 3 months or so (e.g., Abravanel & Sigafoos, 1984). This may be taken as evidence that an imitative reflex disappears like other neonatal reflexes that are subsumed by maturation of the motor cortex. Reflexes such as stepping, moro, tonic neck, palmar grasp and plantar grasp are suppressed as motor tracts develop. Indeed, infants progress from stereotyped and reflexive behaviour to increasingly goal-corrected and skilful movement as the motor cortex matures and muscle tone, muscle mass and body composition increases (Thelen, Fisher, & Ridley-Johnson, 2002). With our longitudinal data we can compare the developmental trends of these standard reflexes and those of neonatal imitation. We can also examine the relationship between neonatal imitation and later developments including goal-directed imitation.

The current study

This is an ambitious project in which we aim to test up to 100 infants in the first week after birth and then repeatedly up to 18 months of age: at 1, 3, 6, 9, 12, 18 weeks and at 6, 9, 12, and 18 months. At each test infants are presented with the following models (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. Furthermore, we assess reflexes with the Brazelton Neonatal Assessment Scale standard protocol. Other measures at various stages

include Bayley scales of infant motor development, a short temperament scale for infants (Sanson et al., 1986), preferential looking for social/non-social stimuli (Baron-Cohen, 2003), joint attention (Slaughter & Mc Connell, 2003), the MacArthur Communicative Development Inventory, mirror -self-recognition, and measures of imitation (object-directed and synchronic). We are in the middle of this time consuming testing and coding.

At the workshop I plan to report preliminary data of the first 25 infants that we have tested at 1, 3, 6, 9, 12, 18 and 24 weeks of age. I will focus on documenting the time course of neonatal imitation with an emphasis on tongue protrusion - the most commonly reported imitative gesture. I will compare this to the developmental data on reflexes over this period. I will also report on the relation between social temperament and neonatal imitation. Most importantly for the purposes of this meeting, I will present initial data on the relationship between individual differences in neonatal imitation and object-directed imitation at 6 months and 9 months of age.

Once we have obtained the full longitudinal data set, we should be able to answer some of the vexing questions about the nature of neonatal imitation and its role in later cognitive development.

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