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Toward a neuroscience of interactive parent–infant dyad empathy

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Abstract

In accord with social neuroscience's progression to include interactive experimental paradigms, parents' brains have been activated by emotionally charged infant stimuli – especially of their own infant –including baby cry and picture. More recent research includes the use of brief video clips and opportunities for maternal response. Among brain systems important to parenting are those involved in empathy. This research may inform recent studies of decreased societal empathy, offer mechanisms and solutions.

Within the field of social neuroscience, investigators are now studying the brain basis of human parenting, using paradigms in accord with the ideas of Schilbach et al. in the target article. Recent neuroimaging studies, in which mothers respond to infant stimuli, have demonstrated the functional significance of many parental care-giving-related brain regions – building on rodent neuroscience. In summary, a broad array of brain regions activate to baby-cries (Swain, Mayes, & Leckman 2004) and pictures (Swain & Ho 2010) and according to measures of parent–infant interaction, thoughts, and behaviors – highlighted by parts of the amygdala (alarm), striatum/nucleus accumbens (NA; motivation and reward). In humans, cortical response circuits are added, including the anterior cingulate for decision-making, inferior frontal gyrus for theory of mind, as well as orbitofrontal cortex, insula, periaqueductal grey, and dorsomedial prefrontal cortex that regulate complex social-cognitive functions currently under study. (For reviews, see Barrett & Fleming 2011; Mayes et al. 2005, Swain 2011a; 2011b; Swain et al. 2011.)

One of the key conceptualizations in the neuroscience of parenting has been that of empathy, which has been a central topic in social neuroscience highlighting the insula (Decety & Jackson 2004, Lamm et al. 2007). Among parents, the insula was activated while reacting to own baby cry (Kim et al. 2010) and more among breast-feeding versus formula-feeding mothers (Kim et al. 2011). Furthermore, observing and actually imitating faces of their own child activated in the insula and other cortical motor imitation and mirror neuron systems (Lenzi et al. 2009), which correlated positively with levels of maternal empathy assessed with independent validated interviews. Support for the insula being part of a general system of empathy includes responses of non-parents to baby-pictures (Schechter et al. 2012) –

which also involves premotor cortex activation in preparation for appropriate behavioral responses (Caria et al. 2012).

Direct studies of reciprocal baby brain function in response to their parents are yet to be done; however, a recent neuroimaging study of mothers showed how perceived maternal care (a proxy for animal models' licking and grooming behaviors) affects both brain structures and functional response to own-baby cries in adult mothers (Kim et al. 2010). In this study, mothers who reported higher maternal care in their own childhood showed higher gray matter density, proportional to the number of neurons, in a range of higher cortical areas and executive function areas, including the insula, superior and middle frontal gyri, orbital gyrus, superior temporal gyrus, and fusiform gyrus. There were also increased functional responses in a number of frontal brain regions and the insula in response to own-baby cries. This may reflect long-term effects in humans of early-life mother-child interactions affecting adult maternal mother-infant interactions.

Three recent studies of maternal interactions with brief video clips come closest to second-person neuroscience. (Atzil, Hendler, & Feldman 2011, Atzil, Hendler, Zagoory-Sharon, Winetraub, & Feldman 2012, Schechter et al. 2012). In Atzil et al. (2011; 2012), mothers were scanned while observing several own and standard infant-related vignettes. Beyond basic motivation/reward nucleus accumbens (NA) responses, functional NA and amygdala were functionally correlated with emotion modulation, theory-of-mind, and empathy networks including the insula. In studies by Schechter et al. (2012) mothers with post-traumatic stress disorder (PTSD) and controls, epochs of play and separation from their own and unfamiliar children were processed by regions including the insula. Extensions of this work might be to ask mothers to respond to the visual stimuli as if they were actually there with a push-button device to attempt parenting responses. Other experimental approaches on the horizon include direct electroencephalography (EEG) or functional near-infrared spectroscopy (fNIRS) studies of simultaneous interacting mother-infant dyads.

The neuroscience of maternal-infant dyadic interaction and empathy leads to a concern regarding apparent societal declines in other-orientation in the United States. For example, Americans are less likely than ever to participate in many types of social experiences, from sharing dinner to attending religious services (Putnam 1995; 2000). Moreover, dispositional empathy has declined among American college students from the 1980s onward (Konrath et al. 2011), suggesting that young people today find it difficult to experience others' emotional worlds (O'Brien et al. 2013). Finally, there has been a recent change in attachment style. Today's college students increasingly report having a predominantly avoidant attachment style (Chopik et al. 2011; Konrath et al., under review), which is characterized by having positive views of the self but negative views of others (Bartholomew & Horowitz 1991). It has been suggested that these trends may be related to modern electronic "social" interactions, many of which are at the level of mere observation (e.g., email, social networking sites) instead of dynamic interaction (discussed in the target article), and many of them are also lower in emotional engagement. Even tools that are more socially interactive (like Skype) do not currently allow eye contact. In fact, the "virtual" characters described in the target article have more properties of actual social interaction

(i.e., eye contact, real-time responsiveness) than many social interactions commonly experienced today.

These considerations beg many broad social policy questions regarding the effects of different media environments on mother–child interactions. Parents may be continually distracted by their social media from caring for their infant – effectively simulating a still-face paradigm to their own infant (Tronick et al. 1978), which encourages infants to first try harder to engage their parent, and then to withdraw and become distressed (Mesman et al. 2009). Could some of the social changes described above be partially explained by an increase in still-face-like parent–infant interactions? Moreover, it is not just parents who are increasing their screen time in recent years. Children are now watching more television than ever and it is now common for toddlers to be proficient iPhone users (Konrath 2013). Does this affect the development of fundamental social cognitive capacities?

We recommend that future research take into account parental and child media use when examining neural signatures of attachment and bonding. Excessive media use may be a relatively unexplored risk factor, or a marker, for poor parent–infant attachment, with concerning implications for social-cognitive development. Second-person neuroscience used to optimize dyadic interventions may offer a solution (Swain et al. 2012).

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