could be acting in a similar manner, forcing mitochondria to switch from microtubule tracks to actin. The gross differences in the observed effects of GFP–Myo19 overexpression in cultured epithelial cells versus neurons may reflect differences in the distribution of actin and/or microtubules that would lead to the anchoring of mitochondria in one case and Myo19-driven motility in another.

Studies of myosin family members and other molecular motors continue to surprise us. There is a breathtaking diversity of eukaryotic myosins and, while the majority have been identified on the basis of the sequence homology of the motor domains [7,10], it remains an open question how many actually act as motors. In fact, after 30 years of unconventional myosin research, it has become clear that these motors have defied our expectations — and, daresay, prejudices — every step of the way. There is now good reason to consider that many members of this family of motors can act as unusual actin-binding proteins or crosslinkers [11], employing the motor activity solely to generate tension locally, orient actin structures or have the ability to make fine adjustments of position within a structure. It may be tempting to think that Myo19 acts in a familiar way and that it is *the* higher eukaryotic mitochondrial myosin motor, but it is too soon to tell at the moment. The late appearance of Myo19 in evolution should now compel the field to search for other myosins that serve similar functions in other organisms. Undoubtedly, there's a good chance that future work on Myo19 and functionally related motors has some interesting surprises in store for us.

References

1. Hirokawa, N. (1982). Cross-linker system between neurofilaments, microtubules, membranous organelles in frog axons revealed by the quick-freeze, deep-etching method. J. Cell Biol. *94*, 129–142.
2. Morris, R.L., and Hollenbeck, P.J. (1995). Axonal transport of mitochondria along microtubules and F-actin in living vertebrate neurons. J. Cell Biol. *131*, 1315–1326.
3. Chada, S.R., and Hollenbeck, P.J. (2004). Nerve growth factor signaling regulates motility and docking of axonal mitochondria. Curr. Biol. *14*, 1272–1276.
4. Itoh, T., Watabe, A., Toh, E.A., and Matsui, Y. (2002). Complex formation with Ypt11p, a rab-type small GTPase, Is essential to facilitate the function of Myo2p, a class V myosin, in mitochondrial distribution in *Saccharomyces cerevisiae*. Mol. Cell. Biol. *22*, 7744–7757.
5. Quintero, O., DiVito, M.M., Adikes, R.C., Kortan, M.B., Case, L.B., Lier, A.J., Panaretos, N.S., Slater, S.Q., Rengarajan, M., Feliu, M., *et al*. (2009). Human Myo19 is a novel myosin that associates with mitochondria. Curr. Biol. *19*, 2008–2013.
6. Berg, J.C., Powell, B.C., and Cheney, R.E. (2001). A millenial myosin census. Mol. Biol. Cell *12*, 780–794.
7. Odronitz, F., and Kollmar, M. (2007). Drawing the tree of eukaryotic life based on the analysis of 2269 manually annotated myosins from 328 species. Genome Biol. *8*, R196.
8. Lechler, T., Shevchenko, A., and Li, R. (2000). Direct involvement of yeast type I myosins in Cdc42-dependent actin polymerization. J. Cell Biol. *148*, 363–373.
9. Gross, S.P., Tuma, M.C., Deacon, S.W., Serpinskaya, A.S., Reilein, A.R., and Gelfand, V.I. (2002). Interaction and regulation of molecular motors in *Xenopus* melanophores. J. Cell Biol. *156*, 855–865.
10. Foth, B.J., Goedecke, M.C., and Soldati, D. (2006). New insights into myosin evolution and classification. Proc. Natl. Acad. Sci. USA *103*, 3681–3686.
11. Woolner, S., and Bement, W.M. (2009). Unconventional myosins acting unconventionally. Trends Cell Biol. *19*, 245–252.

Department of Genetics, Cell Biology and Genetics, University of Minnesota, Minneapolis, MN 55455, USA.
E-mail: titus004@umn.edu

DOI: 10.1016/j.cub.2009.10.053

Communicative Development: Neonate Crying Reflects Patterns of Native-Language Speech

The crying behaviours of newborn infants are shown to be surprisingly sophisticated, reflecting generic prosodic features of their native languages.

Ian Cross

Human infants are profoundly altricial; they can neither move about nor feed themselves, and are wholly dependent on their caregivers for survival. But there is mounting evidence that infants have some precocious perceptual capacities even as neonates. Neonates are sensitive to prosodic cues in language, a capacity present even in sleep [1]; they are sensitive to acoustical differences in voices [2]; and they can distinguish between prosodically different languages [3]. This last capacity — which, on the surface, seems intensely human — turns out to be shared by cotton-top tamarins, which suggests that the auditory capacities of both species are likely to rely on common processes. Hence, the apparent perceptual precocity of human neonates may simply reflect the workings of a common primate perceptual system. Such an interpretation is called into question by the findings of Mampe *et al.* [4], reported in this issue of *Current Biology*, which demonstrate that human newborns incorporate generic features of adult native-language prosody into their crying behaviours.

The developmental trajectories of human infants differ significantly from those of other primates. Over the first two years of life, human infants show clear indications of a capacity for, and motivation towards, shared intentionality. Their ability to follow gaze direction develops into a capacity for joint attention and action. Their early vocalisations (reflecting immediate bodily needs), and their early gestures (aimed at manipulating the behaviours of others) develop into a complex coordinated system that enables co-operative communication [5]. It is of considerable interest to identify any possible developmental antecedents of such communicative behaviour. On the face of it, crying behaviours do not seem to offer a particularly good platform for the emergence of articulate communicative capacities, but Mampe *et al.* [4] have shown that neonate crying is not simply reflexive, but exhibits features that indicate extremely early and seemingly quite sophisticated vocal learning.

Precisely why newborn crying might display such complex characteristics is not clear. Crying, particularly non-distress crying, is generally thought to have the function of signalling either vigour or need [6]. It has been conceptualised as functioning in analogy to begging signals in avian and other species [7], and like such signals has been analysed in terms of honest signalling theory. But this incorporation of features of native-language prosody seems unnecessarily elaborate if 'prosodically well-formed crying' is directly related to the efficacy of the crying — begging — signal. Begging signal efficacy in other species has been found to correlate simply with increased call frequency and intensity [8], and likelihood of caregiver intervention has been found to relate to the intensity of the crying signal in human infants.

A more parsimonious interpretation could be that this behaviour enhances the likelihood of mutual caregiver-infant affiliation, perhaps by helping align affective states; prosody can be interpreted as affective or linguistic in function, though the two functions have been shown to interact [9]. But the particular prosodic features manifested here cannot be interpreted simply as affective; as the evidence presented by Mampe *et al.* [4] is derived from spontaneous, non-distress cries, and averages across infants within different language groups, it cannot be linked unambiguously to any specific affective state. The appearance of native-language generic prosodic structure in human neonates' vocal productions can only be tied to an assimilation and exploitation of generic, affective (and prospectively pragmatic), prosodic constancies of the natal language environment. The precocity of this behaviour, however, does suggest that human infants are primed from the outset to pick up and exploit all the communicative tools and strategies that they can access, though the mechanisms whereby neonates are able to bind perception to action are not at all clear.

Other work reported recently in *Current Biology* [10] suggests that there appear to be some evolutionary precursors of several features of human caregiver–infant communicative interaction amongst primate mother–infant units (in the form of mutual gaze and imitative lipsmacking between rhesus macaque mothers and neonates). But do the neonates of other primate species (or indeed any other species) reflect, in their early vocalisations, differentiation in the acoustical structure of their calls that might be regarded as shaped by the acoustical features of their local, social environments (perhaps those that might be specific to their kin-groups)? Certainly, there is evidence that some avian signals reflect kin-group characteristics (*Aegithalos caudatus*), and that this kin-specificity develops in the nest [11], as well as evidence that variability of begging calls is a precursor of effective vocal learning [12].

Is neonate native-language prosody production a precursor of language? It seems highly likely that this is the case, although from other evidence it could equally well be interpreted as a precursor of musicality; neonates recognise not only native-language prosody but also features of music to which they have been exposed *in utero* [13,14]. And neonates have been shown, highly precociously, to have expectations about the downbeat — the first beat — of rhythmic cycles, even when these are not marked out by acoustical cues [15], as well as being capable of discriminating between musical intervals [16]. Moreover, it has been shown that aspects of the prosodic features of particular languages appear to be evident in the musics of the countries in which those languages are spoken [17] — or *vice versa*, as what has been found are correlations rather than any causally directional relationships. The new findings of Mampe *et al.* [4] could be interpreted as reinforcing the idea that for human neonates, linguistic and musical channels are likely to be equally accessible and not discrete; overall, they are probably best thought of as indicating that the altriciality of human infants is more apparent than real; humans are born highly adapted to exploit the full range of communicative resources that they will require in adult life. The extent to which this represents a step-change from neonate communicative capacities in other species remains to be explored.

References

1. Sambeth, A., Ruohio, K., Alku, P., Fellman, V., and Huotilainen, M. (2008). Sleeping newborns extract prosody from continuous speech. Clin. Neurophysiol. *119*, 332–341.
2. Floccia, C., Nazzi, T., and Bertoncini, J. (2000). Unfamiliar voice discrimination for short stimuli in newborns. Dev. Science *3*, 333–343.
3. Ramus, F., Hauser, M.D., Miller, C., Morris, D., and Mehler, J. (2000). Language discrimination by human newborns and by cotton-top tamarin monkeys. Science *288*, 349–351.
4. Mampe, B., Friederici, A.D., Christophe, A., and Wermke, K. (2009). Newborns' cry melody is shaped by their native language. Curr. Biol. *19*, 1994–1997.
5. Tomasello, M., and Carpenter, M. (2007). Shared intentionality. Dev. Sci. *10*, 121–125.
6. Soltis, J. (2004). The signal functions of early infant crying. Behav. Brain Sci. *27*, 443–490.
7. Zeifman, D.M. (2001). An ethological analysis of human infant crying: Answering Tinbergen's four questions. Dev. Psychobiol. *39*, 265–285.
8. Leonard, M.L., and Horn, A.G. (2005). Ambient noise and the design of begging signals. Proc. R. Soc. Lond. B *272*, 651–656.
9. Pihan, H., Tabert, M., Assuras, S., and Borod, J. (2008). Unattended emotional intonations modulate linguistic prosody processing. Brain Lang. *105*, 141–147.
10. Ferrari, P.F., Paukner, A., Ionica, C., and Suomi, S.J. (2009). Reciprocal face-to-face communication between rhesus macaque mothers and their newborn infants. Curr. Biol. *19*, 1768–1772.
11. Sharp, S.P., and Hatchwell, B.J. (2006). Development of family specific contact calls in the long-tailed tit *Aegithalos caudatus*. Ibis *148*, 649–656.
12. Liu, W.-C., Wada, K., and Nottebohm, F. (2009). Variable food begging calls are harbingers of vocal learning. PLoS One *4*, e5929.
13. Kisilevsky, B.S., Hains, S.M.J., Jacquet, A.Y., Granier-Deferre, C., and Lecanuet, J.P. (2004). Maturation of fetal responses to music. Dev. Science *7*, 550–559.
14. Hepper, P. (1988). Fetal 'soap' addiction. The Lancet *331*, 1347–1348.
15. Winkler, I., Háden, G.P., Ladinig, O., Sziller, I., and Honing, H. (2009). Newborn infants detect the beat in music. Proc. Natl. Acad. Sci. USA *106*, 2468–2471.
16. Stefanics, G., Haden, G.P., Sziller, I., Balazs, L., Beke, A., and Winkler, I. (2009). Newborn infants process pitch intervals. Clin. Neurophysiol. *120*, 304–308.
17. Patel, A.D., Iversen, J.R., and Rosenberg, J.C. (2006). Comparing the rhythm and melody of speech and music: The case of British English and French. J. Acoust. Soc. Am. *119*, 3034–3047.

Centre for Music and Science, Faculty of Music, West Road, University of Cambridge, Cambridge CB3 9DP, UK.
E-mail: ic108@hermes.cam.ac.uk

DOI: 10.1016/j.cub.2009.10.035