time of the outcome were both represented in the amygdala [2]. Amygdala activity was also shown to correlate with choices of risky gambles framed as losses and sure outcomes framed as gains [3]. Moreover, the anterior insula, involved in the affective recognition of noxious stimuli [11], has been linked to anticipation of monetary loss, pain and emotionally aversive pictures [12], and to anticipation of riskless choices as well as risk-aversion mistakes (in which people do not take risks when they should) [4]. This brain region is also more responsive when unfair offers are rejected during the ultimatum game in which two players split a sum of money, one player proposing a division and the other accepting or rejecting it [5].

Concluding remarks

This study provides important new insights into the functional properties of decision making in humans. The reduced neural sensitivity to losses among individuals who were less loss averse is particularly relevant for several neuropsychiatric and behavioural disorders, such as substance abuse and pathological gambling, associated with increased risk taking and impulsive behaviour. These individual differences in behavioural and neural loss aversion might be related to naturally occurring differences in dopamine function. Future studies could test how hormonal and genetic individual variations influence brain response to loss aversion, as recently investigated during anticipation and receipt of monetary rewards [13]. Multivoxel pattern analysis should also test whether the activation of common brain regions for gain and loss reflect engagement of a common neural population or whether these overlapping brain regions reflect functionally independent neural populations engaging the same brain regions [14]. Finally, this study should open up new lines of research in neuroeconomics that could help uncover further the nature of processes involved in social cognition, for example, by comparing financial loss and the perception of sanctions in the context of social interaction (social exclusion).

Acknowledgements

J-C.D. is partially supported by a European reintegration grant from the 6th Framework Program, the Fyssen and the Medical Research foundations. I thank G. Coricelli, P. Domenech and G. Sescousse for comments on an early version of the manuscript.

References

1 Kahneman, D. and Tversky, A. (1979) Prospect theory: an analysis of decision under risk. *Econometrica* 4, 263–291
2 Yacubian, J. *et al.* (2006) Dissociable systems for gain- and loss-related value predictions and errors of prediction in the human brain. *J. Neurosci.* 26, 9530–9537
3 De Martino, B. *et al.* (2006) Frames, biases, and rational decision-making in the human brain. *Science* 313, 684–687
4 Kuhnen, C.M. and Knutson, B. (2005) The neural basis of financial risk taking. *Neuron* 47, 763–770
5 Sanfey, A.G. *et al.* (2003) The neural basis of economic decision-making in the Ultimatum Game. *Science* 300, 1755–1758
6 Tom, S.M. *et al.* (2007) The neural basis of loss aversion in decision-making under risk. *Science* 315, 515–518
7 Breiter, H.C. *et al.* (2001) Functional imaging of neural responses to expectancy and experience of monetary gains and losses. *Neuron* 30, 619–639
8 Knutson, B. *et al.* (2003) A region of mesial prefrontal cortex tracks monetarily rewarding outcomes: characterization with rapid event-related fMRI. *Neuroimage* 18, 263–272
9 Dreher, J.C. *et al.* (2006) Neural coding of distinct statistical properties of reward information in humans. *Cereb. Cortex* 16, 561–573
10 O'Doherty, J.P. *et al.* (2002) Neural responses during anticipation of a primary taste reward. *Neuron* 33, 815–826
11 Frot, M. and Mauguiere, F. (2003) Dual representation of pain in the operculo-insular cortex in humans. *Brain* 126, 438–450
12 Paulus, M.P. and Stein, M.B. (2006) An insular view of anxiety. *Biol. Psychiatry* 60, 383–387
13 Dreher, J.C. *et al.* (2007) Menstrual cycle phase modulates reward-related neural function in women. *Proc. Natl. Acad. Sci. U. S. A.* 104, 2465–2470
14 Peelen, M.V. and Downing, P.E. (2007) Using multi-voxel pattern analysis of fMRI data to interpret overlapping functional activations. *Trends Cogn. Sci.* 11, 4–5
15 Trepel, C. *et al.* (2005) Prospect theory on the brain? Toward a cognitive neuroscience of decision under risk. *Brain Res. Cogn. Brain Res.* 23, 34–50

doi:10.1016/j.tics.2007.05.006

Letters

Teachers in the wild: some clarification

Alex Thornton[1], **Nichola J. Raihani**[1] **and Andrew N. Radford**[2]

[1] Department of Zoology, University of Cambridge, Downing Street, Cambridge, CB2 3EJ, UK
[2] School of Biological Sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG, UK

In a Research Focus article published in the March 2007 issue of *Trends in Cognitive Sciences*, Csibra [1] highlights recent work on teaching in non-human animals [2,3] and examines its role in the transfer of cultural information. We welcome a greater integration between human and non-human research and feel that more open discussion between the two fields would be highly productive. However, we would like to clarify three issues. First, Csibra begins by reviewing work on pied babblers, *Turdoides bicolor*, by Radford and Ridley [4], noting that Rapaport [5] has interpreted it as providing evidence for teaching. The babbler study is mentioned before the two established examples of animal teaching (tandem running ants, *Temnothorax albipennis* [2], and meerkats, *Suricata suricatta* [3]) and in place of other studies that have explicitly exam-

---

Corresponding author: Jensen, O. (ole.jensen@fcdonders.ru.nl).

ined teaching and provide some supportive evidence [6,7]. Csibra goes on to state that the babbler study 'describe[s] phenomena that fulfil the accepted criteria for teaching'. This is not true. For behaviour to be meaningfully classed as teaching it must fulfil three strict criteria, and the behaviour must function to promote learning [6]. Radford and Ridley [4] show that adult babblers give recruitment calls that attract juveniles to divisible food sources. They present no evidence that the juveniles learn anything, as required by the third criterion [6]. Moreover, they show that the function of the adult behaviour is to increase the food intake of juveniles, whose own foraging efficiency has not yet reached adult levels, rather than to promote learning, and they deliberately never use the word 'teaching' in the article.

Our second issue concerns the concept of 'prototypical' human teaching. Csibra argues that this entails the 'transmission of generalizable knowledge from the teacher to the pupil through communication', rather than the acquisition of knowledge or skills by pupils through experience in a 'learning environment' supported by the teacher. We agree that the use of communication (particularly language) in humans enables more complex and flexible teaching than that seen in animals. However, we feel that the notion of 'prototypical teaching' is too vague to be of much use and risks arbitrarily excluding many forms of teaching found in humans. For example, human parents promote infant learning of motor skills by encouraging and supporting them ('scaffolding'), and babies clearly learn by performing activities in an adult-supported learning environment [8], just as meerkat pups do [3]. Forms of teaching that involve language and could promote cultural transmission might also be excluded. For example, an algebra teacher might describe techniques and provide demonstrations but pupils ultimately learn through attempting problems themselves.

Finally, although we agree that the forms of teaching found in ants and meerkats are unlikely to support 'the transmission of cultural knowledge with opaque content', we do not feel that it would be productive to generate new definitions for certain subsets of teaching. Rather, the field would benefit from retaining a broad, inclusive definition based on evolutionary function. Research might then investigate how the complex cognitive and linguistic abilities that humans sometimes incorporate into teaching might facilitate the spread of culture.

References

1 Csibra, G. (2007) Teachers in the wild. *Trends Cogn. Sci.* 11, 95–96
2 Franks, N.R. and Richardson, T. (2006) Teaching in tandem-running ants. *Nature* 439, 153
3 Thornton, A. and McAuliffe, K. (2006) Teaching in wild meerkats. *Science* 313, 227–229
4 Radford, A.N. and Ridley, A.R. (2006) Recruitment calling: a novel form of extended parental care in an altricial species. *Curr. Biol.* 16, 1700–1704
5 Rapaport, L.G. (2006) Parenting behaviour: babbling bird teachers? *Curr. Biol.* 16, R675–R677
6 Caro, T.M. and Hauser, M.D. (1992) Is there teaching in nonhuman animals? *Q. Rev. Biol.* 67, 151–174
7 Maestripieri, D. (1995) Maternal encouragement in nonhuman primates and the question of animal teaching. *Hum. Nat.* 6, 361–378
8 Whiten, A. and Milner, P. (1984) The educational experiences of Nigerian infants. In *Nigerian Children: Developmental Perspectives* (Curran, H.V., ed.), pp. 34–73, Routledge and Kegan Paul

1364-6613/$ – see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tics.2007.05.002