What Bees can *really* tell us about the face processing system in Humans? A response to Dyer et al. (2005).

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Cognitive abilities present in humans, such as face processing, are likely to have evolved under various ecological pressures. A comparable and specialized face processing system observed in sheep and non-human primates suggests a possible common origin in evolution (Pascalis et al., 1999; Kendrick et al., 2001; Parr, 2003). However, it is important to determine when this system emerged during evolution if we are to fully understand it. Studies conducted with honeybees (*Apis mellifera*) and wasps (*Polistes fuscatus*) could potentially contribute to our understanding of this ability.

Dyer et al. (2005) have demonstrated that bees are able to learn and recognise the picture of a human face when paired with a novel face, which is consistent with our existing knowledge of the bees' visual ability. However, we believe Dyer's extrapolations about how recognition is achieved and whether it is facilitated or not by specialised brain regions are misleading.

Face recognition is carried out by an automated and specific process in humans, which is known as configural processing (perceiving metrical relations between face features). Contrary to Dyer's argument and to earlier research findings (Diamond & Carey, 1977), it is now debatable whether such processing develops late in childhood (Schwarzer et al., 2005). Furthermore, studies that have created 'visual experts' who develop configural processing for non-face objects required many more hours of intensive training than reported in Dyer et al. In their study, there is no clear

evidence of configural processing and it is likely that the bees' recognition relied on specific features.

In human adults, functional neuroimaging studies have identified a network of areas within the ventral temporal cortex that are highly responsive to faces (Haxby et al., 2000) with maximum selectivity in the right middle fusiform gyrus: the so-called 'Fusiform Face Area' (FFA) (Kanwisher et al., 1997). A comparable functional specialization supports face processing in the primate brain (Tsao et al., 2006). Critically, however, normal face identification relies on the integrity of this complex network, as prosopagnosic patients with lesions sparing the FFA show impaired use of optimal information for face identification (Caldara et al., 2005, Schiltz et al., 2006).

It is too speculative to conclude with data collected from just five bees' that specialised brain regions are not necessary for face processing in humans. Humans and bees have not shared a common ancestor for roughly 600 million years and have evolved very differently since this separation. We can therefore expect them to process faces differently. Clearly, more studies are required to determine *how* the honeybee succeeds in simple face matching tasks before attempting to establish potential similarities between its visual recognition abilities and those of different species. It is first necessary to establish whether bees are able to recognise or categorise conspecifics in a similar way to the wasp (Tibbetts, 2002; Tibbetts & Dale, 2004). Given that humans appear capable of only processing faces confined to human and non-human primate categories, it would be somewhat paradoxical if the bee demonstrated recognition with human faces but not with conspecifics. Finally, artificial computing systems without a neural substrate also demonstrate an optimal

ability in recognizing individual faces. Does such evidence question the neural specificity of face processing in humans?

References:

Caldara, R., Schyns. P., Mayer, E., Smith, M., Gosselin, F., and Rossion, B. (2005). Does prosopagnosia take the eyes out of face representations? Evidence for a defect in representing diagnostic facial information following brain damage. *J. of Cog. Neuro., 17,* 1652-1666.

Diamond, R. and Carey, S. (1977). Developmental changes in the representation of faces. *J. of Exp. Child Psy., 23,* 1-22.

Dyer, A.G., Neumeyer, C. and Chittka, L. (2005). Honeybee (*Apis mellifera*) vision can discriminate between and recognise images of human faces. J of Exp. Biol. 208, 4709-4714.

Haxby, J.V., Hoffman, E.A., Gobbini, M.I., 2000. The distributed human neural system for face perception. *Trends Cogn. Sci.* 4, 223– 233.

Kanwisher, N., McDermott, J., and Chun, M.M. (1997). The fusiform face area: a module in human extrastriate cortex specialized for face perception. *J. Neurosci*. 17, 4302–4311.

Kendrick, K.N. da Costa, A.P., Leigh, A.E. Hinton, M.R. and Pierce, J.W., 2001. Sheep don't forget a face. *Nature*. 441: 165–6.

Parr, L., 2003. The discrimination of faces and their emotional contents by chimpanzees (Pan troglodytes). *Ann. New. York. Acad. Sci*., 1000: 56-78.

Pascalis, O., Petit, O., Kim, J.H., and Campbell, R. (1999). Picture perception in primate: the case of face perception. *Picture Perception in Animals*, Special issue of *Current Psychology of Cognition, 18,* 889-922.

Schiltz, C., Sorger, B., Caldara, R., Ahmed, F., Mayer, E., Goebel, R., and Rossion, B. (2006). Impaired face discrimination in acquired prosopagnosia is associated with abnormal response to individual faces in the right middle fusiform gyrus. *Cerebral Cortex*, 16, 574-586.

Schwarzer, G., Huber, S. and Dümmler, T.(2005). Gaze behavior in analytical and holistic face processing. *Mem. & Cog*. , 33, 344-354.

Tibbetts, E. A. (2002). Visual signals of individual identity in the wasp Polistes fuscatus. *Proc. R. Soc. Lond. B* 269, 1423-1428.

Tibbetts, E. A. and Dale, J. (2004). A socially enforced signal of quality in a paper wasp. *Nature* 432, 218-222.

Tsao, D.Y., Winrich A. Freiwald, W.A., Tootell, R.B.H. and Livingstone, M.S. (2006). A Cortical Region Consisting Entirelyof Face-Selective Cells. *Science*, 311, 670-674.