

Selective Impairment of Social Inference Abilities Following Orbitofrontal Cortex Damage

Valerie Stone* (vestone@ucdavis.edu)

Simon Baron-Cohen[†], Leda Cosmides[‡], John Tooby[‡], Robert T. Knight*

* Center for Neuroscience, U.C. Davis, Davis, CA 95616

[†] Departments of Experimental Psychology and Psychiatry, University of Cambridge, Cambridge, England

[‡] Center for Evolutionary Psychology, U.C. Santa Barbara, Santa Barbara, CA 93101

Patients with damage to orbitofrontal cortex (OFC) and to the amygdala often have great difficulties engaging in appropriate social behavior, though they have few cognitive deficits (Mattson & Levin, 1990; Adolphs, Tranel, Damasio & Damasio, 1995). We tested patients with OFC damage on several tasks designed to test their abilities to make inferences in social situations. In the first study, we tested 5 patients on a developmentally graded series of tasks designed to measure "theory of mind," the ability to make inferences about other people's mental states. Normal adult control subjects performed at ceiling on all tasks, and 5 patients with dorsolateral frontal damage also showed no deficits on any of the theory of mind tasks.

The OFC patients made no errors on first and second order false belief, but one of them, R.M., had difficulty recognizing mental state terms, and as a group, the OFC patients showed significant deficits on the most developmentally advanced task, recognizing faux pas. This task requires not only mental state inferences, but also an empathic understanding of others' affective states. The OFC patients' performance on these tasks was parallel to that of individuals with Asperger syndrome, a mild form of autism, who can pass first and second order false belief tasks, but have difficulty with more subtle mentalistic inferences (O'Riordan et al., 1997).

In the second study, we tested some of these same patients on a set of 41 reasoning problems, some of which were about social situations, and were hypothesized to depend on theory of mind. The social problems (n=18) involved reasoning about social contracts, conditional rules of the form "If you take the benefit, then you must pay the cost." The non-social problems (n=23) were precaution rules of the form "If you are in hazardous situation X, then you must take precaution Y." The two types of problems are logically equivalent. Both types of problems have an affective component. Norm data on both sets of problems shows that normal control subjects (N=37) performed identically on both sets, though not at ceiling (71% correct on social contracts, 72% on precaution rules).

One patient, R.M., who demonstrated the most severe theory of mind impairment in the first study, was selectively impaired in reasoning about social contract

problems (38% correct) while performing normally on precaution problems (71% correct). R.M.'s damage includes bilateral damage to OFC and anterior temporal cortex, including part of the left amygdala. Two other patients, one with bilateral OFC and anterior temporal damage but no damage to the amygdala, and one with bilateral anterior temporal damage but no damage to the amygdala, performed equally well on both types of problems.

Because the performance of controls indicates that the two sets of problems are of equal difficulty, we conclude from R.M.'s selective deficit that different neural resources and therefore slightly different psychological mechanisms are used in reasoning about each type of problem. We speculate that R.M.'s difficulty with the social contract rules may be due to his theory of mind deficits, because previous research shows that social contract reasoning depends on an understanding of intentionality, whereas precaution reasoning does not (Fiddick, 1996). Orbitofrontal cortex, anterior temporal cortex and the amygdala may be involved in social inferences requiring theory of mind, particularly those involving affect. (Funded by the McDonnell Pew Foundation and NINDS grant F32 NS09977-01 to the first author.)

References

- Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. *Nature*, 372, 669-672.
- Fiddick, L. (1996). Domain-specificity in moral reasoning. Paper presented at the Seventh Annual Meeting of the Human Behavior and Evolution Society, Northwestern University, June, 1996.
- Mattson, A. & Levin, H.S. (1990). Frontal lobe dysfunction following closed head injury. *Journal of Nervous and Mental Disease*, 178, 282-291.
- O'Riordan, M., Baron-Cohen, S., Jones, R., Stone, V.E., & Plaisted, K. (1997). Recognition of faux pas by children with autism and Asperger Syndrome. Unpublished manuscript, Department of Experimental Psychology, University of Cambridge, Cambridge, England.