

Neuroimaging, auditory hallucinations, and the bicameral mind

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Just as we cannot step in the same river twice, we will never again see the world of neuroscience as we did before the recent advancements in neuroimaging techniques. For example, functional magnetic resonance imaging can suggest brain regions for cellular analyses, provide in vivo data regarding effective connectivity, provide a means to model the effects of various drug challenge paradigms, and characterize phenotypes in the search for the genes underlying mental illness.¹ The data obtained from neuroimaging studies are used to study the pathogenesis of psychiatric disorders, generate new hypotheses, and test and discuss old hypotheses.

In 1976 Julian Jaynes proposed in his book *The Origin of Consciousness in the Breakdown of the Bicameral Mind* that man had no consciousness until 1000 BC.² According to the Jaynes' hypothesis, between 10 000 and 1000 BC the bicameral mind operated in humans. The left hemisphere was the site for speech, and the right hemisphere was the site for hallucinations that expressed voices and commands of gods and demons. Hallucinations were a normal phenomenon. The end of the dominance of the bicameral mind and the beginning of modern consciousness were caused by "the weakening of the auditory by the advent of writing, the inherent fragility of hallucinating control, the unworkable-

ness of gods in the chaos of historic upheaval, the positing of internal cause in the observation of differences in others ... and a modicum of natural selection." Contemporary regressions to the bicameral mind include schizophrenia, possession states, religious prophecy, hypnosis and some other phenomena. In other words, Jaynes proposed that there are 3 forms of human awareness: the bicameral or god-run man; the modern or problem-solving man; and contemporary forms of throwbacks to bicamerality (e.g., hypnotism, and schizophrenia). Jaynes' hypothesis was based on psycho-historical analysis, observations of schizophrenic patients and neurobiological knowledge available around 1970.

This hypothesis has been criticized. Asaad and Shapiro³ stated in 1987 that "the difficulty which we find with Jaynes' hypothesis is that the conclusions he draws have a questionable basis in neuropsychiatric fact" and "if Jaynes' hypothesis were to coincide more accurately with anatomic fact, the right temporal area in question would more likely coincide with Broca's expressive area — a notion that does not conveniently fit Jaynes' theoretical constructs." They suggested that lesions of the right-sided areas corresponding to Broca's and Wernicke's areas seem more related to the negative symptoms of schizophrenia (such as restricted affect)

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Medical subject headings: auditory cortex; brain; consciousness; hallucinations; magnetic resonance imaging

J Psychiatry Neurosci 2000;25(3):239-40.

Submitted Dec. 6, 1999

Accepted Jan. 27, 2000

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than to the positive hallucinatory symptoms. Assad and Shapiro also suggested that Jaynes oversimplified the diverse and complex nature of hallucinatory phenomena. More recently, another author⁴ wrote, "After many years of psychophysiological studies, mainly carried out in the field of evoked neurocognitive bioelectrical events ... I feel I can ... safely state that the concepts of mind/brain and brain/behavior dualisms with their ancient, widespread and persistent philosophy are now all outdated, as are those of the bicameral mind or the double brain."

However, a few months ago, Olin⁵ suggested that recent neuroimaging studies "have illuminated and confirmed the importance of Jaynes' hypothesis." Olin believes that recent reports by Lennox et al⁶ and Dierks et al⁷ support the bicameral mind. Lennox et al⁶ reported a case of a right-handed subject with schizophrenia who experienced a stable pattern of hallucinations. The authors obtained images of repeated episodes of hallucination and observed its functional anatomy and time course. The patient's auditory hallucination occurred in his right hemisphere but not in his left hemisphere. Lennox et al suggested that their results demonstrated the strong association of the right middle temporal gyrus with the experience of auditory hallucination in this patient, supporting the hypothesis that auditory hallucinations reflect abnormal activation of auditory cortex. Dierks et al⁷ described experiments with 3 patients with paranoid schizophrenia in whom the onset and offset of auditory hallucinations could be monitored during a single session of functional magnetic resonance imaging. The authors found that the area in the transverse temporal gyrus that was activated during auditory hallucinations included the transverse gyrus of Heschl in the dominant hemisphere and

matched the location of primary auditory cortex. Their results provided direct evidence of the involvement of primary auditory areas in auditory hallucinations.

I find it very interesting that contemporary neuroimaging data have been used to revive and support the old, controversial hypothesis. I believe that neuroimaging studies will lead to new, exciting findings and discussions regarding various scientific hypotheses and ideas. I would like to conclude this commentary with the words from the well-known book *Mapping the Mind*⁸: "As we enter the twenty-first century functional brain scanning machines are opening up the territory of the mind just as the first ocean-going ships once opened up the globe."

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