Phineas Gage and the beginnings of neuropsychology

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1848 was a year of political revolutions in Europe. In the same year, in the field of neuroscience, a freak occurrence would also prove - eventually - to have a revolutionary impact. Few neurologists will be unfamiliar with the name of Phineas P Gage, nor with the extraordinary work-related accident which befell him on the afternoon of 13 September 1848 in Burlington, Vermont, USA.[1,2] Excavating rock with blasting powder, in his capacity as a railroad foreman, an accidental ignition caused a tamping iron approximately 1.1 m (43 inches) long, 3 cm thick at its widest point, and weighing 13 pounds, to smash through the left side of Gage's face, entering just below the cheekbone, and emerge from the top of his skull, landing some 25-30 yards away smeared with brain. Gage was thrown back, a few convulsive movements of the extremities were observed, but he was able to speak within a few minutes.

Fewer neurologists may be familiar with Dr John Martin Harlow, the railway physician who attended Gage within two hours of the accident. Harlow continued to treat Gage in the following days when death from infection seemed imminent. He then continued to observe the changes in Gage's personality, up to the time of his death from status epilepticus in 1861. Moreover, it was Harlow who persuaded the family to permit exhumation of Gage's skull five years after his death (no post mortem was performed). Harlow published his findings in two papers,[3,4] without which record Gage might not be remembered at all.

Gage's skull was subsequently donated to the Warren Anatomical Museum at Harvard University School of Medicine. Modern neuroimaging techniques have been used to study Gage's skull and reconstruct the probable path of injury caused by the tamping iron.[5] This has permitted more precise definition of the lesion location, and suggests that both left and right prefrontal cortices were injured. As Harlow's account records in detail the behavioural changes manifested by Gage after the accident,[4] and is still regarded as one of the best accounts of behavioural disorder following prefrontal damage, clinical-anatomical correlation is possible. From an efficient and capable work foreman, Gage became irreverent, capricious, profane and irresponsible, and showed defects in rational decision making and the processing of emotion, such that his employers refused to return him to his former position. Harlow argued that the frontal lobe lesion had caused a loss of planning skills.[4] These neurobehavioural changes, sometimes labelled "pseudopsychopathic" or "sociopathic", are now regarded as typical of orbitofrontal injury, having been observed in other patients with selective lesions of this area.[6] However, other case histories indicate the need to differentiate this clinical picture from that following injury to other parts of the frontal lobes. For example, a more recent report, with prolonged follow up, of a patient with frontal lobe injury due to an iron bar penetrating the skull documented prominent apathy, difficulties with planning, and lack of drive, yet stability of function within the domestic, professional and social setting (cf. Gage), associated with dorsolateral prefrontal injury.[7] Disinhibited, apathetic, and akinetic types of frontal lobe syndrome are described, associated respectively with orbitofrontal, frontal convexity and medial frontal lesions.

Although we accept the landmark status of Gage in the development of ideas relating to cortical localisation,[2] the contemporary response to Harlow's reports was, to say the least, muted.[1] However, the account did appear at a propitious time. Broca was publishing his observations correlating aphasic syndromes with focal brain injury (1861), and Fritsch & Hitzig's electrical stimulation studies of the exposed cortex were soon to follow (1870). Ferrier's experimental observations in monkeys (1878) largely confirmed Harlow's clinical findings in Gage.

Gage is unquestionably one of the most famous patients in neurological history, a fixture in neurological textbooks and the subject of many papers. (Regrettably these often err in their assertions about him, principally because they neglect the original Harlow reports.[8]) A cursory study of the history of medicine indicates that it is unusual for the names of patients, rather than their doctors, to be recorded for posterity (one eponymous exception which immediately springs to mind is Christmas disease). Why should it be, then, that Gage is remembered, and not Dr Harlow? Many speculations might be advanced: perhaps the extraordinary "truth-stranger-than-fiction" nature of the accident Gage suffered, the very fact that he survived, his memorable name, the fact that he was written up. More significant, however, may be the possibility, evident with the benefit of hindsight, that this case represents part of a paradigm shift, a "natural experiment" which demonstrated the possibilities of correlating particular personality and behavioural changes with injury to focal brain regions, and hence the correlation of function with location. This practice continues in modern neuropsychology, where detailed case histories may be compared with structural and functional neuroimaging findings to help elucidate the workings of the brain.[9]

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