



## Neuropsychological Rehabilitation: An International Journal

Publication details, including instructions for authors  
and subscription information:

<http://www.tandfonline.com/loi/pnrh20>

### Rehabilitating Phineas Gage

Malcolm Macmillan<sup>a</sup> & Matthew L. Lena<sup>b</sup>

<sup>a</sup> Psychological Sciences , University of Melbourne ,  
Victoria , Australia

<sup>b</sup> Elysium Digital LLC , Cambridge , Massachusetts ,  
USA

Published online: 17 May 2010.

To cite this article: Malcolm Macmillan & Matthew L. Lena (2010) Rehabilitating Phineas Gage, Neuropsychological Rehabilitation: An International Journal, 20:5, 641-658, DOI: [10.1080/09602011003760527](https://doi.org/10.1080/09602011003760527)

To link to this article: <http://dx.doi.org/10.1080/09602011003760527>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-

licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

## Rehabilitating Phineas Gage

Malcolm Macmillan<sup>1</sup> and Matthew L. Lena<sup>2</sup>

<sup>1</sup>*Psychological Sciences, University of Melbourne, Victoria, Australia;*

<sup>2</sup>*Elysium Digital LLC, Cambridge, Massachusetts, USA*

The view that Phineas Gage's accident made him permanently "no longer Gage" is scrutinised critically. Re-examination of the well-known older evidence together with a consideration of new material strongly implies that Gage eventually made a surprisingly good psychosocial adaptation to his injury. It is argued that the structure provided by the external circumstances of his work facilitated this result. Parallels are drawn with the theory and practice of modern rehabilitation which began with Luria.

**Keywords:** Phineas Gage; Aleksandr Romanovich Luria; Dysexecutive function; Psychosocial adaptation; Rehabilitation.

### INTRODUCTION

*In this regard his mind was radically changed, so decidedly that his friends and acquaintances said he was "no longer Gage".* (Harlow, 1868, p. 340)

---

Correspondence should be sent to Malcolm Macmillan, Psychological Sciences, University of Melbourne, Victoria 3010, Australia. E-mail: malcolm.macmillan@unimelb.edu.au

For help and co-operation in finding and providing copies of many of the items on which we rely, we are very grateful to: Dominic Hall, Warren Anatomical Museum, Francis A. Countway Library of Medicine, Harvard Medical School, Boston, Massachusetts; Jack and Beverly Wilgus of Bright Bytes Studio, Austin, Texas; Tara Gage Miller, Texas, and Mrs. Phyllis Gage Hartley, New Jersey, for their photographs of Gage; Bill Copeley, Librarian, New Hampshire Historical Society, Concord; Professor Edith Bavin, Latrobe University, Melbourne. Thomas Bruno, Edward Doctoroff, and Joshua Parker of the Harvard University Libraries, Cambridge, Massachusetts, extended important courtesies. Mr. Roberto Carvalho Fernandes helped in many ways.

This, John Martyn Harlow's famous sentence summarising the changes in Phineas Gage, is familiar to every neuropsychologist. Although Phineas was definitely no longer himself, our question is, how long did his alienation last?

Phineas Gage suffered a major injury to his brain (Harlow, 1848, 1868). His tamping iron, a small crowbar-like instrument weighing  $13\frac{1}{4}$  pounds, 3 foot 7 inches long, and  $1\frac{1}{4}$  inches in diameter tapering to a  $\frac{1}{4}$  inch point, was blown completely through his head destroying his left frontal lobe (Ratiu & Talos, 2004; Ratiu, Talos, Haker, Lieberman, & Everett, 2004). Before the accident, Phineas was a quiet man, of temperate habits, a great favourite with his men, energetic in executing his plans, a shrewd, smart, businessman, and the best foreman employed in the construction of the Rutland and Burlington Railroad. After it, also in Harlow's equally famous but fuller description:

The equilibrium or balance, so to speak, between his intellectual faculties and his animal propensities, seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operation, which are no sooner arranged than they are abandoned in turn for others appearing more feasible. A child in his intellectual capacity and manifestations, he has the animal passions of a strong man. Previous to his injury, although untrained in the schools, he possessed a well-balanced mind, and was looked upon by those who knew him as a shrewd, smart business man, very energetic and persistent in executing all his plans of operation. In this regard his mind was radically changed, so decidedly that his friends and acquaintances said he was "no longer Gage". (Harlow, 1868, pp. 339–340)

In the commonly presented post-accident view, this alteration was permanent, and it was this Gage, no longer the man he had once been, who went to his death 11 years later.

Our purpose in contrast is to raise the possibility that not long after his accident, Phineas Gage started to make a reasonably good social recovery. Confirmation of our thesis would place him among those who have made, almost by themselves, successful psychosocial adaptations to the effects of traumatic brain injury.

We begin by stressing that until 2008 there were only four primary and four supplementary sources of detailed information about Phineas: the reports by Harlow of 1848, 1849, and 1868; of 1850 by Henry Jacob Bigelow; the 1849 case notes and 1870 museum catalogue entries of

Dr. J. B. S. Jackson; and anonymous 1850 medical and 1851 phrenological reports (all reproduced in Macmillan, 2000, Appendix A and pp. 93–94). Careful re-reading of these in the light of new evidence we have gathered, reinforces the earlier questioning by one of us of another common view: Phineas as an unstable, impatient, foul-mouthed, work-shy drunken wastrel, who drifted around circuses and fairgrounds, unable to look after himself, and dying penniless in an institution (for an evaluation of this grossly distorted picture, see Macmillan, 2000, pp. 307–337).

## PHINEAS GAGE 1823–1860

### Pre-accident 1823–1848

The base from which to judge the changes in Phineas remains uncertain. Apart from confirmation of his literacy, nothing new has been found about his education or date of birth (Macmillan, 2000, pp. 16, 31n.4, 375–376). Some evidence has been found about the work he did before his accident. Late in life, Dr Edward Higginson Williams, who had attended Phineas with Harlow, said that Phineas worked on the Hudson River Railroad (HRRR) early in 1848 (Rutland Railroad Company, 1897, pp. 41–42). On 18th July 1848, the *Hudson River Chronicle* (Sing-Sing, NY) advised there was a letter awaiting a Phineas P. Gage at the Cortlandt Town Post Office. Cortlandt Town is on the Hudson about 15 miles south east of Sing-Sing. The HRRR was then still under construction and Phineas may there have added to his farm-based rock-blasting skills by developing his ability to organise the work of others.

### Post-accident 1849–1852

When *An Odd Kind of Fame* (Macmillan, 2000) was written, there was nothing to confirm Harlow's statement that Gage exhibited himself and his tamping iron in the "larger New England towns" and at Barnum's Museum in New York City.

Three pieces of relevant evidence have since been found: a letter by Bigelow stating that Phineas appeared at Barnum's Museum; a broadside (poster) advertising an exhibition by Phineas at Concord, New Hampshire; and a newspaper announcement of Phineas' exhibition in Montpelier, Vermont. Bigelow wrote that Phineas was willing to so exhibit himself in order to earn "an honest penny" but that he abandoned doing so because that "sort of thing has not much interest for the general public" (a point foreshadowed in Macmillan, 2000, p. 98). The Concord broadside has Phineas appearing alone (possibly managing his exhibitions by himself) and with no implication of a "freak-show". However, in the otherwise similar

Montpelier announcement, Phineas was in the company of a “General Washburn, the living Dwarf Skeleton”. Even so, he was not in a troupe or circus, or on a fairground.

Recently Jack and Beverly Wilgus (2009) identified the subject of one of their daguerreotypes as Phineas Gage holding his tamping iron—probably looking as his audiences would have seen him. It must have been made after the January 6<sup>th</sup> 1850 date inscribed on the tamping iron. Emotions are difficult to judge from static images but, despite his obvious though surprisingly limited disfigurement, Phineas looks self-assured, even proud—certainly not withdrawing from public view. Descendents of Phineas’ brother, Roswell Rockwell Gage, own a second, similar image. Phineas’ touring and sitting for at least two images suggests he had accommodated to his post-accident appearance and was not, as Kotowicz (2007) has recently implied, ashamed to display it.

Harlow (1868, p. 340) reported that Phineas worked in the livery stable of Jonathan Currier’s Dartmouth Hotel in Hanover NH, “for nearly or quite a year and a half” probably beginning in early 1851. Harlow next tells us that in August 1852 Phineas “engaged with a man who was going Chili [sic]...to establish a line of coaches in Valparaiso”.

What were Phineas’ qualifications for such a position in Chile? The answer is threefold: Phineas knew about horses; he had the opportunity to learn coach driving skills in Hanover; and there he could also have re-acquired the personal skills for dealing with passengers and the public. First, we know that as a farmer’s son, Phineas had cared for and worked with horses before the accident, and Jackson’s case notes record his continuing to do so after it. Second, we know Currier ran a coaching business and owned the *Allen Horse* (Linsley, 1857, p. 262), at the time one of the most valuable of the Morgan horses, the breed commonly used to draw stagecoaches. Phineas was thus in a position to learn and practice the complex cognitive-motor skills required of a coach driver (discussed below). Third, had Phineas driven for Currier, he would have had to adapt to the challenges of the routes travelled while at the same time dealing politely with passengers’ demands. It seems unlikely that a Phineas still disinhibited by his accident would have qualified.

### In Chile 1852–1860

Precisely when Phineas departed for Chile is uncertain. Harlow says it was in August 1852 but the Warren Museum has a note apparently dated 1854, and apparently signed by Phineas, requesting the return of his tamping iron (Records of the Warren Anatomical Museum (AA 192.5), Francis A. Countway Library of Medicine, Box 1).

In Chile, Harlow says, Phineas often drove heavily laden, six-horse coaches. These were likely to have been stagecoaches rather than goods

wagons, because heavy wagons in Chile were then drawn by ox-teams, whilst only two passengers could fit in the light, two-wheeled, two-horse carriages known locally as *birlochos*. Jackson (1870, p. 147) wrote that Phineas drove a “six-horse stage-coach” and he is confirmed by Dr Henry Trevitt’s statement (cited below) that Phineas drove a stage in Valparaíso.

According to those travelling through Santiago in the late 1850s, that city was full of New England coach drivers and Concord coaches. These could be hired for either way of the Santiago–Valparaíso run and there were also scheduled services. The 1860 daily service was probably typical of the earlier ones, leaving Valparaíso at 4 a.m. for the 100-mile, 12–13 hour journey to Santiago (*New York Times*, 1<sup>st</sup> March, 1860). To meet that starting time, we infer that Phineas rose even earlier—much earlier if his duties included feeding, grooming, and harnessing the horses. He would have had to load the passengers’ luggage (50 lb. allowance), possibly handle the fares (at \$10.00 then a good deal of money), and see to the passengers’ comfort throughout the journey. We particularly note how these external requirements provided a structure regulating Phineas’ daily work.

The Hollywood caricature of stagecoaches at full gallop escaping Indian pursuers by reaching the bosom of the US Cavalry grossly misrepresents the complex skills actually demanded of real drivers. Travel was generally at a fast walk with an occasional trot. Each horse in each pole or span (“row”) of usually two horses, in up to three such poles, had to be controlled separately. For this drivers used the “Concord grip” or “Concord reining”: the reins for each pair of horses in a span being draped over each of the separated fingers of the left hand. Commands to each horse could thus be given delicately and individually, leaving the right hand free for signalling with the whip (Moody, 1967, pp. 23–24; Macmillan, 2000, pp. 104–106).

Much foresight was required. Drivers had to plan for turns well in advance, and sometimes react quickly to manoeuvre around other coaches, wagons, and *birlochos* travelling at various speeds on what Claudio Gay portrayed as a very crowded Valparaíso–Santiago road (Villalobos, 1967). Adaptation had also to be made to the physical condition of the route: although some sections were well-made, others were dangerously steep and very rough.

Phineas had arrived a stranger to Chile and its ways; he would have had to learn something of the local language and customs. He had also to deal with political upheavals that frequently spilled into everyday life.

### Last years 1859–1860

After Phineas left South America, Harlow (1868, p. 341) says he lost trace of him but in 1866 somehow obtained Phineas’ mother’s address. From her he learned that Phineas was dead. Failing health, and a long illness beginning in 1859, caused him to go to his family, then in San Francisco. His mother

said he arrived in “a feeble condition, having failed very much since leaving New Hampshire”, had had “many ill turns”, and suffered much from “hardship and exposure” (Harlow, 1868, pp. 340–341).

Nevertheless, his mother said, Phineas “was anxious to work” after recovering, and did so on farms. The day before his first convulsion, in February 1860, he was actually ploughing. He resumed work “a few days after” but now, *for the first time*, he became unsettled, changing employers frequently yet “always finding something which did not suit him” (Harlow, 1868, p. 341). This late development, in Phineas’ final months, is the only suggestion of his *ever* being unstable in his employment.

Phineas died on 21<sup>st</sup> May 1860 and was buried in Lone Mountain Cemetery (N.B. Harlow’s “1861” is incorrect and we have accordingly silently corrected certain of his other dates—see Macmillan, 2000, p. 108).

### PHINEAS GAGE’S SKULL 1860–1868

Some seven years after his death Phineas’ body was exhumed, the skull removed and taken, with the tamping iron, to Harlow, then living in Woburn just outside Boston. *An Odd Kind of Fame* contained a circumstantial argument that the exhumation took place in late 1867 and that it was Phineas’ brother-in-law, David Dustin Shattuck, who delivered the skull to Harlow (Macmillan, 2000, pp. 110–111). Although the exhumation date is still unknown, the travels of Phineas’ skull are now documented: we have a ship’s manifest listing Shattuck, and all of Phineas’ San Francisco relatives, arriving in New York early in 1868. Harlow thus had the opportunity of meeting the family, and what he writes strongly suggests that he spoke to some of them.

Harlow’s (1868) post-accident history of Gage consists, we believe, of two groups of statements distinguished by how he learned of them. The first, written mainly in the present tense, and as if from Harlow’s own notes, narrates the accident and initial treatment, the 10-week period of immediate recovery, and Phineas’ return visit several months later (Harlow, 1868, pp. 330–340). During this visit Harlow observed Gage’s maladaptive behaviour, famously epitomised by Gage’s friends’ lament that he was “no longer Gage”. Harlow saw these things for himself, or heard of them directly from eyewitnesses, soon after they occurred and therefore, we argue, can only describe Phineas before his departure for Chile in 1852. *All* of the maladaptive changes Harlow reported fall into this period.

In the second group, Harlow (1868, pp. 340–342), repeats things learned from others, probably in large part from the family’s correspondence with him or during their visit to New England in 1868: “His mother...informs me that...” “He took to travelling ...”; “his health began to fail...”; “These convulsions were unquestionably epileptic”. We argue these statements



date from about the time Gage began work for Currier in 1851, or later, and note that nothing in them suggests behavioural pathology of any kind.

### Phineas' tamping iron

One relatively unimportant matter is whether Phineas' tamping iron was recovered from the grave. A common story has it that he was buried with it; *ergo*, it must have been dug up with his body. There is no account of the burial. Only Harlow writes of the exhumation and he does not say the tamping iron was recovered then. Although what he says may be slightly ambiguous, it does not warrant the contrary and undocumented account of Damasio, Grabowski, Frank, Galaburda, and Damasio (1994)—since followed by Damasio (1994) among others—that Gage's tamping iron was recovered from his grave.

### PHINEAS GAGE'S MENTAL AND PHYSICAL HEALTH 1849–1860

Interpretation of the few reliable direct accounts we have of Phineas' mental and physical health after the accident must take into account mid-1800s standards of judgement. When applied to brain-injured patients, phrases like restored “in health” or “in body and mind” are ambiguous at best. According to the then-current physiology the brain controlled movements evoked by incoming sensations. Physicians looked for the effects of damage to the brain on the ability to sense things through touch, sight, hearing, smell, etc., and to control the muscles, including those of the limbs and the vocal apparatus. Regaining one's health usually meant only that there was no, or no substantial, sensory impairment or paralysis.

A similarly limited sensory-motor psychology accompanied this sensory-motor physiology. According to it, several potential movements might be stimulated by incoming sensations (or ideas) but selection among them was made by the mind inhibiting those less adapted to current circumstances. Willing was explained by the inhibition of unwanted responses, but how inhibition took place was a complete mystery. Nor, until the 1860s, was there any theory relating psychological function to brain activity apart from the mistaken views of the phrenologists.

Thus, except for sensory-motor impairment and effects on vital functions such as circulation and breathing, the significance of damage to the brain itself was often overlooked. When Harlow noted in November 1848 that Phineas was “in a way of recovering if he can be controlled”, he almost excepted the mental changes, although he hinted he would communicate some in the future (Harlow, 1848, p. 393). About a month later Phineas was “walking about the house, and riding out, improving both mentally and physically” (Harlow, 1849, p. 507). Bigelow's (1850, p. 14) phrase that

Phineas had “quite recovered in his faculties of body and mind” possibly comes from the sensory-motor framework, magnified by his opposition to phrenology. Even Harlow had not completely escaped that framework 20 years later when he did report the mental manifestations. Before giving details, he endorsed his original 1848 impression, “I am inclined to say he has recovered” (Harlow, 1868, p. 339).

To be sure about what they mean statements about Phineas’ mental or psychological health must be specific. Unfortunately what is available is equivocal. Although we may wish to disregard the March 1849 letter of “C”, presumably a non-physician, who reported that Phineas was “restored to perfect health and soundness” and had “gone back to resume his post” (Macmillan, 2000, pp. 40–41), we need to give more credence to Jackson’s report of what Phineas’ family told him in August 1849: Phineas had been “weak and childish on getting home” (presumably in November 1848) but now appeared “well in mind”. Apart from his memory being “somewhat impaired,” they said “a stranger w[oul]d notice nothing peculiar” (cited in Macmillan, 2000, p. 93).

Very much the contrary of these sanguine accounts is an April 1850 report of the American Medical Association’s *Standing Committee on Surgery*. Claiming to be based on information from the family, it said “his mental powers are greatly impaired. . . and . . . the degenerating process is still going on”, and that “the deficiency of his mental faculties” was much clearer than his loss “of bodily powers”. More specific was the *American Phrenological Journal*’s 1851 dismissal of a newspaper account of Bigelow’s 1850 conclusion that Phineas showed “no difference in mental perceptions and power”. It counterposed a Phineas having many of the characteristics found in Harlow’s 1868 report of what he was like immediately after the accident (compare Macmillan, 2000, pp. 93–94, 347–351).

We have found another report of Phineas’ mental and physical state and it may be an important one. Some time before November 1860, in a medical discussion in Ohio, the question of whether Phineas had recovered was raised. Prof. J. W. Hamilton of Starling Medical College, an editor of the *Ohio Medical and Surgical Journal*, recorded that:

Dr. Henry Trevitt, of Valparaiso, South America, who was present, at once replied to our remark that he knew Gage well; that he lived in Chili [sic], where he was engaged in stage driving; and that he was in the enjoyment of good health, with no impairment whatever of his mental faculties. (H[amilton], 1860, p. 174)

Trevitt was in Valparaiso from mid-1858 until about mid-1859. Although unequivocal that Phineas was physically healthy and working, Trevitt’s evaluation of his psychological state may also be from the sensory-motor

context. If not (and unfortunately we have no more detail from him) Trevitt points strongly to the possibility that Phineas had made a good psychological recovery.

Harlow himself provides some support for Trevitt's conclusion. In the fourth last paragraph of his 1868 paper Harlow said that "physically, the recovery was quite complete during the first four years immediately succeeding the injury". He then went on:

Mentally the recovery certainly was only partial, his intellectual faculties being decidedly impaired, but not totally lost; nothing like dementia, but they were enfeebled in their manifestations, his mental operations being perfect in kind, but not in degree or quantity. (Harlow, 1868, p. 345)

Drawing on phrenological theory giving both hemispheres equal responsibilities, Harlow added that the outcome may have been due to the intact right hemisphere (which he had seen and felt while examining Phineas) being able to conduct "its operations singly and feebly".

## EXPLAINING THE EFFECTS OF DAMAGE TO THE FRONTAL LOBES

Various explanations have been offered for changes like those shown by Phineas. All propose a weakening of control over the brain's psychological functions, originating from either a defect in *a single process* or from defects in *a system of processes*.

### Single-process explanations

The main single-process explanations derive from Ferrier's 1876 experimentally-based conclusion that a pre-frontally located inhibitory-motor mechanism controlled actions by regulating the relation between the brain's sensory and motor parts. Two years after first formulating the mechanism, Ferrier used this failure of inhibition to explain Phineas' symptoms (Ferrier, 1878).

Ferrier's arguments for this inhibitory mechanism were, however, essentially speculative and possibly for that reason, he replaced it 10 years later with a different (though still frontally located) single controlling mechanism, that of attention (Ferrier, 1886; Macmillan, 2000, pp. 185–188, 267–268).

The speculative basis of Ferrier's two mechanisms aside, there was also the problem of the tremendous variety of behaviours for which they were pressed into explanatory service. Ferrier followed the physiological arguments of Müller and Bain in proposing his inhibitory function as a physiological basis for willing and the control of thinking generally (Ferrier, 1873, 1876; Macmillan, 2000, pp. 162–168, 181–188). The behaviours to be explained

included lack of will, impaired judgement and reasoning, inability to follow a line of thought, want of attention, complete dementia, mental slowness, indisposition to talk, intellectual stupidity, listlessness, emotionality, querulousness, and disinhibition. Despite Ferrier's later disavowal of the inhibitory-motor concept, others continued with its wider use, and Aron (2007) has recently shown that many modern applications of it are similarly too broad. Although by the 1930s "inhibition" had acquired so many meanings that Brickner deliberately chose an atheoretical concept, "restraint", as a substitute, this equally vague concept never became popular (Macmillan, 2000, pp. 213–226, 237–239).

Conceptually it seems impossible to separate the effects of inhibition or restraint from attention. If we execute an action, do we not simultaneously inhibit or not attend to others? Which process is at work? Is it their vague characterisation that allows each to be so easily applied to such a variety of behaviours?

### Systems explanations

Most modern theories explain the effects of damage to the frontal lobes through damage to frontally localised *systems* of psychological and/or brain functions. The most dominant of these theories attributes executive functions to the frontal lobes, so that damage to them results in the *dysexecutive syndrome*. The thesis of Hitch and Baddeley (1976), and Baddeley (1986), that memory functions could be explained by a central executive system having processing links to phonological and visuospatial memory systems, was the basis for the Supervisory Attentional System proposed by Norman and Shallice (2000), and Shallice (1982), which had access to representations of the external world and to the organism's intentions and cognitive capacities. This supervisory system selectively activates or inhibits internally stored schemas of routine actions as well as generating new, non-routine ones. Shallice's (1982, 1988, 2002, 2004) original model and its later amendments explained many differences in experimental findings between patients with frontal damage and normal subjects, as well as much everyday behaviour of such patients.

## LURIA AND FRONTAL LOBE FUNCTIONS

Norman and Shallice explicitly formulated their systems approach "to anchor the overall theory Luria applied to the 'frontal functions' within a cognitive science conceptual framework" (Shallice, 1988, p. 332). Aleksandr Romanovich Luria, a pioneer Soviet neuropsychologist, based his theory on the 1920s Marxist conceptualisations of Lev Vygotsky (Eilam, 2003). A recurrent theme in Luria's work—which ranged from cultural historical fieldwork to

studies of twins, the intellectually handicapped, and the aphasias—was that complex systems of psychological functions developed from simple interactive brain functions during a historical and cultural developmental process mediated by human activity. For Luria, human nature could not be abstracted from this cultural–historical mediated context.

The regulation of behaviour by language, and especially its self-regulation by internalised language, was central to Luria's thinking. By the time World War II began, Luria had completed medical and specialist neurological training and was commissioned to establish a 400-bed hospital focusing on developing methods for the rehabilitation of the many Red Army soldiers with head injuries. There he applied his Marxist psychological concepts in a unique way by attempting to re-establish the regulatory function of internal language (Luria, 1963, 1966, 1979, 1980).

In Luria's view, frontal lobe damage caused failures in the ability to use internal language to programme or plan actions, to regulate them, and to verify their consequences. In rehabilitation, goals were re-established toward which the patient would work, and these goals guided the sequence of actions required to realise them. A supervisor would use his language to regulate the patient's behaviour, continuing to do so until the patient had relearned the external regulatory use of his own. In many cases the internal role of language was also re-established. With massive frontal damage (usually bi-lateral) complete success was infrequent: fewer than 5% of such patients seem to have regained full independence. For the remainder, working in structured environments in which external conditions regulated the tasks brought limited success (Luria, 1963, pp. 244–246, 255–256, 261–262).

## REHABILITATION: FROM THE EXTERNAL TO THE INTERNAL

Moving the control of action to internal self-regulation is central to many modern rehabilitation programmes, some of which are based on Luria's conceptualisation, and all of which are consistent with it (Burgess & Robertson, 2002; High, Sander, Struchen, & Hart 2005; Tyerman & King, 2008; Wilson, Evans, & Williams, 2008; Wilson, Gracey, Evans, & Bateman 2009). Learning to monitor one's behaviour, or to slow one's thinking while planning, rehearsing, and checking sequences of actions, for example, are important aspects of contemporary treatment programmes for executive dysfunction (Alderman, 2003; Evans, 2003, 2008; Rees, 2005, pp. 168–188); auditory alerts are used to help in sequencing actions (Manly, Hawkins, Evans, Woldt, & Robertson, 2002); and paging systems and reminder notes are used when memory is impaired (Wilson, 2003). One thing stressed in these programmes is that rehabilitation should take place in an environment that is consistent, relevant to the patient, and for many patients, highly structured.

Outside formal rehabilitation programmes, there is also a number of reports of good psychosocial adaptation, some many years after injury, in which structured environments played a significant part. Thomsen, Waldemar, and Thomsen (1990), for example, report a female patient who made a good psychosocial adaptation many years after suffering severe bilateral fronto-orbital damage when she was 17. She showed typical uninhibited behaviour until, 10 years post-accident, she began living with a man (not sexually involved with her) who drew up a simple written programme of personal and household tasks that she had to perform in exactly the same order every day. Although she remained childish, exhibited mild irritability and temper, and her memory was still impaired, two years of this routine enabled her—then 19 years post-accident—to care for herself and do housework and shopping.

The circumstances and outcome for the 81-year-old man studied 60 years after injury by Mataró et al. (2001) are not dissimilar to Thomsen et al.'s patient. He had fallen on a large metal spike that had massively damaged both frontal lobes. Although gross cognitive functioning was unimpaired, his planning and execution were extremely poor and he had moderate to severe symptoms of agitation, inattention, memory deficit, and decreased initiative and motivation. About two years after his accident he was able to marry, father two children, and support himself by working in the family factory, although his family had to maintain supervision of his everyday activities.

Neither patient was “cured” but each had made a remarkable psychosocial adaptation. Thomsen and colleagues credit the outcome of their patient to the orderly, steadfast, and patient partner who “did not mind the rigidity and monotony of a very highly structured life” (Thomsen et al., 1990, p. 10); Mataró credits “the protected and structured family and work environment” (Mataró et al., 2001, p. 1142). The regimens for both patients are consistent with Luria's principles and we propose a comparable regimen was present in Phineas Gage's post-accident life.

## A PSYCHOSOCIALLY ADAPTED PHINEAS?

In considering whether Phineas may have made some kind of psychosocial adaptation, we list here, with some modern explication, those behaviours reported by Harlow (1868) which would have been obstacles:

1. Planning:
  - λ Capricious and vacillating in devising plans for the future and soon abandoning them for apparently more feasible ones.
  - λ Fitful (irregular and spasmodic activity).
2. Regulation:

- λ A child in his intellectual capacity and manifestations, yet with the animal passions of a strong man.
- λ Gross profanity.
- λ Impatient of restraint or advice conflicting with his desires.
- 3. Social interaction:
  - λ Irreverent (lacking respect for others, especially those in authority).
  - λ Lacking deference toward others (impolite).

Although the behaviours comprising dysexecutive function are not especially clear, nor the criteria for diagnosing it agreed upon (Alderman, 2003; Baddeley, 2002; Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Burgess & Robertson, 2002), there is little doubt that the early post-accident Phineas described by Harlow in 1868 would qualify for one of the several labels proposed in the literature.

The “animal passions” are difficult to interpret. Were they uncontrollable sexual drives? Perhaps of some abnormal kind? Given his phrenological orientation, Harlow was almost certainly drawing on a conceptualisation like that outlined by Fowler and Fowler (1837, pp. 45–47), the great American pioneer popularisers of phrenology to whom Animal Passions consisted of the *Domestic* and *Selfish Propensities*. The Domestic constituted man’s social and gregarious nature and the Selfish provided for various animal wants having direct reference to the necessities and desires of the individual. The totality of the Animal Passions was controlled by the totality of the intellectual *Human Moral* and *Religious Sentiments*. Consequently, were Phineas’ intellectual faculties diminished, a variety of behaviours should have been “released” from among the Domestic and Selfish propensities. Since Harlow does not specify which particular behaviours had been released, it is impossible to estimate their effect, if any, on Phineas’ social recovery.

The behaviours considered above would undoubtedly have proved obstacles to adaptation had they persisted. How important are the other behaviours Harlow and others described?

1. *Pertinacious obstinacy*. Is it even an effect of the injury? Harlow wrote that the pre-accident Phineas possessed “an iron will” which was “as indomitable *as ever*” during recovery, while Jackson said the post-accident Gage was “still very obstinate *as he had always been*” (Harlow, 1868, p. 330; Jackson, 1870, p. 147. Emphases added). Is this the maladaptive “perseveration” often reported after traumatic brain injury? Or is it simply a steadfastness of purpose that could assist recovery?
2. *Fabulous recitals*. According to his mother, Phineas entertained “his little nephews and nieces with the most fabulous recitals of his wonderful feats and hair-breadth escapes” with no factual basis (Harlow, 1868,



p. 340). Clearly this would be an obstacle were it equivalent to psychopathic or sociopathic lying and dishonesty, as Damasio has it (Blake-slee, 1994; Damasio, 1994). But need it be more than a doting uncle's tall tales?

3. *Pets and souvenirs*. Phineas' mother also told Harlow of Phineas' great fondness for pets and souvenirs, especially for children, horses, and dogs. Whether or not a consequence of the damage, how would this impede adaptation?
4. *Odd feeling in head*. Harlow (1868, p. 339) noted that in 1848 Phineas had "no pain in head, but says it has a queer feeling which he is not able to describe". Luria may have been describing a similar symptom when he said some patients complained of not being able to make their thoughts flow (Luria, 1979, pp. 150–151). He implicated the patient's inability to generate concepts and make the connections needed to reason about them, and treated it by using such external aids as cuing the patients' conversation, or asking questions that supplied the patient with these connections. Zeigarnik (1965, pp. 152–165) found that in a structured environment it was relatively easy to overcome the more general consequences of these kinds of problems, and help a patient maintain a course of action. Phineas' odd feeling may not have been such a big hurdle.
5. *Memory impairment*. Jackson gave no detail of the impairment in Phineas' memory (Macmillan, 2000, p. 93). Was it behaviour like that of Wilder Penfield's sister after her frontal operation? She was unable to complete sequences of actions, seemingly because she forgot what she had to do (Penfield, 1977; Penfield & Evans, 1935)? Although we cannot know, we could perhaps attribute the peculiarity of Phineas' "memory" to an impairment in sequencing of the kind proposed by Luria, one from which Phineas recovered because his employment was so structured (Luria 1973, p. 301).

Thus "obstinacy" is consistent with a post-accident Phineas intent on recovering as much of his pre-accident self as possible and with a daily life structured by his work, none of the other foregoing behaviours need have been major obstacles. We do not know, of course, if he had learned to control the maladaptive behaviours, or that they had otherwise ceased to have any impact on his functioning, or had disappeared altogether.

Reviewing Phineas' post-accident history we note:

1. He resumes work on the family farm within four months of the accident, and seeks his old job as foreman within another four.



2. He adapts within two or three years to the vocation of “exhibiting”, possibly managing his appearances, advertising, and travel independently, and probably re-learning lost social skills.
3. He works for Currier during 1851–1852, where he possibly learns stagecoach driving and builds on his social re-learning.
4. He is settled and reliable enough in his behaviour for an employer to take him to Chile as a coach driver.
5. He works in Chile for 7 years in a highly structured occupation (possibly for just one employer) where he adapts to the language and customs, and uses the complex psychological and cognitive-motor skills required by his job.
6. Eventually his mental faculties are such that a doctor who had known him well sees “no impairment whatever” in them.
7. He is “anxious to work” after recovering from illness in San Francisco, and finds farm employment.
8. He continues to work even after his first seizure. Only now does he become unsettled and dissatisfied with a succession of employers.

We see in all of this how consistently Phineas sought to readapt.

On this summary, Phineas Gage made a surprisingly good psycho-social adaptation: he worked and supported himself throughout his post-accident life; his work as a stage-coach driver was in a highly structured environment in which clear sequences of tasks were required of him; within that environment contingencies requiring foresight and planning arose daily; and medical evidence points to his being mentally unimpaired not later than the last years of his life. Although that Phineas may not have been the Gage he once had been, he seems to have come much closer to being so than is commonly believed.

## REFERENCES

- Alderman, N. (2003). Rehabilitation of behaviour disorders. In B.A. Wilson (Ed.), *Neuropsychological rehabilitation: Theory and practice* (pp. 171–196). Lisse, The Netherlands: Swets and Zeitlinger.
- Aron, A. R. (2007). The neural basis of inhibition in cognitive control. *Neuroscientist*, 13, 214–228.
- Baddeley, A. D. (1986). *Working memory*. Oxford: Oxford University Press.
- Baddeley, A. D. (2002). Fractionating the central executive. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 246–260). Oxford, UK: Oxford University Press.
- Bigelow, H. J. (1850). Dr. Harlow’s case of recovery from the passage of an iron bar through the head. *American Journal of the Medical Sciences*, 20, 13–22, [Facsimile in Macmillan, 2000, Appendix A].

- Blakeslee, S. (1994). Old accident points to brain's moral center. *New York Times*, May 24, Science Section, pp. B5, B8.
- Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society*, 4, 547–558.
- Burgess, P. W., & Robertson, I. H. (2002). Principles of the rehabilitation of frontal lobe function. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 557–572). Oxford, UK: Oxford University Press.
- Damasio, A. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York, NY: Avon Books.
- Damasio, H., Grabowski, T., Frank, R., Galaburda, A. M., & Damasio, A. R. (1994). The return of Phineas Gage: Clues about the brain from the skull of a famous patient. *Science*, 264, 1102–1105, [Erratum, *Science*, 1994, 265, 1159].
- Eilam, G. (2003). The philosophical foundations of Aleksandr R. Luria's neuropsychology. *Science in Context*, 16, 551–577.
- Evans, J. J. (2003). Rehabilitation of executive defects. In B. A. Wilson (Ed.), *Neuropsychological rehabilitation: Theory and practice* (pp. 53–70). Lisse, The Netherlands: Swets and Zeitlinger.
- Evans, J. J. (2008). Executive and attentional problems. In A. Tyerman & N. S. King (Eds.), *Psychological approaches to rehabilitation after traumatic brain injury* (pp. 193–223). London, UK: BPS Blackwell.
- Fowler, O. S., & Fowler, L. N. (1837). *Phrenology proved, illustrated, and applied, accompanied by a chart*. New York, NY: The Authors.
- Ferrier, D. (1873). Experimental researches in cerebral physiology and pathology. *West Riding Lunatic Asylum Medical Reports*, 3, 30–96.
- Ferrier, D. (1876). *The functions of the brain*. London, UK: Smith, Elder.
- Ferrier, D. (1878). *The localisation of cerebral disease: Being the Gulstonian Lectures of the Royal College of Physicians for 1878*. London, UK: Smith, Elder.
- Ferrier, D. (1886). *The functions of the brain* (2nd ed.). London, UK: Smith, Elder.
- H[amilton, J.W.] (1860). Editorial and Miscellaneous. *Ohio Medical and Surgical Journal*, 13, 174.
- Harlow, J. M. (1848). Passage of an iron rod through the head. *Boston Medical and Surgical Journal*, 39, 389–393, [Facsimile in Macmillan, 2000, Appendix A].
- Harlow, J. M. (1849). Letter in 'Medical miscellany'. *Boston Medical and Surgical Journal*, 39, 506–507, [Facsimile in Macmillan, 2000, Appendix A].
- Harlow, J. M. (1868). Recovery from the passage of an iron bar through the head. *Publications of the Massachusetts Medical Society*, 2, 327–347, [Facsimile in Macmillan, 2000, Appendix A].
- High, W.M., Sander, A.M., Struchen, M.A., & Hart, K.A. (Eds.). (2005). *Rehabilitation for traumatic brain injury*. New York, NY: Oxford University Press.
- Hitch, G. J., & Baddeley, A. D. (1976). Verbal reasoning and working memory. *Quarterly Journal of Experimental Psychology*, 28, 603–621.
- Jackson, J.B.S. (1870). *A descriptive catalogue of the Warren Anatomical Museum*. Boston, MA: Williams.
- Kotowicz, Z. (2007). The strange case of Phineas Gage. *History of the Human Sciences*, 20, 115–131.
- Linsley, D. C. (1857). *Morgan horses: A premium essay on the origin, history, and characteristics of this remarkable breed of American horses*. New York, USA: Saxton.
- Luria, A. R. (1963). *Restoration of function after brain injury* (Trans B. Haigh). Oxford, UK: Pergamon. (Original work published 1948).

- Luria, A. R. (1966). *Higher cortical functions in man* (Trans B. Haigh). New York, NY: Basic Books. (Original work published 1962).
- Luria, A. R. (1973). *The working brain*. Harmondsworth, UK: Allen Lane Penguin.
- Luria, A. R. (1979). *The making of mind: A personal account of Soviet psychology*. Cambridge, MA: Harvard University Press.
- Luria, A. R. (1980). *Higher cortical functions in man* (2nd ed. Trans B. Haigh). New York, NY: Basic Books. (Original work published 1969).
- Macmillan, M. (2000). *An odd kind of fame: Stories of Phineas Gage*. Cambridge, MA: MIT Press.
- Manly, T., Hawkins, K., Evans, J., Woldt, K., & Robertson, I. H. (2002). Rehabilitation of executive function: Facilitation of effective goal management on complex tasks using periodic auditory alerts. *Neuropsychologia*, 40, 271–281.
- Mataró, M., Jurado, M. Â., García-Sánchez, C., Barraquer, L., Costa-Jussà, F. R., & Junqué, C. (2001). Long-term effects of bilateral frontal brain lesion. *Archives of Neurology*, 58, 1139–1142.
- Moody, R. (1967). *Stagecoach west*. New York, NY: Promontory Press.
- Norman, D. A., & Shallice, T. (2000). Attention to action: Willed and automatic control of behaviour. In M. S. Gazzaniga (Ed.), *Cognitive neuroscience: A reader* (pp. 376–390). Oxford, UK: Blackwell. (Original publication 1980).
- Penfield, W. (1977). *No man alone: A surgeon's life*. Boston, MA: Little, Brown.
- Penfield, W., & Evans, J. (1935). The frontal lobe in man: A clinical study of maximum removals. *Brain*, 58, 115–133.
- Ratiu, P., & Talos, I. F. (2004). The tale of Phineas Gage, digitally remastered. *New England Journal of Medicine*, 351, e21–e21.
- Ratiu, P., Talos, I. F., Haker, S., Lieberman, D., & Everett, P. (2004). The tale of Phineas Gage, digitally remastered. *Journal of Neurotrauma*, 21, 637–643.
- Rees, R. J. (2005). *Interrupted lives: Rehabilitation and learning following brain injury*. Melbourne, VIC: IP Communications.
- Rutland Railroad Company. (1897). *Heart of the Green Mountains*. Boston, MA: Rockwell and Churchill.
- Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 298, 199–209.
- Shallice, T. (1988). *From neuropsychology to mental structure*. Cambridge, UK: Cambridge University Press.
- Shallice, T. (2002). Fractionation of the Supervisory System. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 261–277). Oxford, UK: Oxford University Press.
- Shallice, T. (2004). The fractionation of the supervisory control. In M. Gazzaniga (Ed.), *The cognitive neurosciences III* (3rd ed., pp. 943–956). Oxford, UK: Oxford University Press.
- Thomsen, I. V., Waldemar, G., & Thomsen, A. M. (1990). Late psychosocial improvement in a case of severe head injury with bilateral fronto-orbital lesions. *Neuropsychology*, 4, 1–11.
- Tyerman, A., & King, N. S. (2008). *Psychological approaches to rehabilitation after traumatic brain injury*. London, UK: BPS Blackwell.
- Villalobos, S. (1967). *Imagen de Chile Histórico, El álbum de Gay*. Santiago: Editorial Tradición.
- Wilgus, J., & Wilgus, B. (2009). Face to face with Phineas Gage. *Journal of the History of the Neurosciences*, 18, 340–345.
- Wilson, B. A. (2003). Rehabilitation of memory defects. In B. A. Wilson (Ed.), *Neuropsychological rehabilitation: Theory and practice* (pp. 71–88). Lisse, The Netherlands: Swets and Zeitlinger.

- Wilson, B. A., Evans, J. J., & Williams, W. H. (2008). Memory problems. In A. Tyerman & N. S. King (Eds.), *Psychological approaches to rehabilitation after traumatic brain injury* (pp. 136–165). London, UK: BPS Blackwell.
- Wilson, B. A., Gracey, F., Evans, J. J., & Bateman, A. (2009). *Neuropsychological rehabilitation: Theory, models, therapy and outcome*. Cambridge, UK: Cambridge University Press.
- Zeigarnik, B. V. (1965). *The pathology of thinking* (Trans B. Haigh). New York, NY: Consultants Bureau. (Original work published 1961).

Manuscript received December 2009  
 Revised manuscript received February 2010  
 First published online May 2010