

# Coverage of the Phineas Gage Story in Introductory Psychology Textbooks: Was Gage No Longer Gage?

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## Abstract

Most introductory textbooks discuss the story of Phineas Gage and his terrible accident in which he survived a three-and-a-half-foot-long tamping iron that weighed 13¼ pounds exploding through his head. Twenty-three current introductory textbooks were analyzed for the accuracy of their coverage of Gage's subsequent (post-accident) history and psychosocial recovery and for inclusion of recently discovered photos of Gage and the most recent digital reconstruction of the path of the tamping iron through his head. Although coverage was generally accurate when included, only half a dozen textbooks discussed Gage's subsequent history or recovery. Inclusion of the photos and recent modeling work was also lacking. Explanations for these coverage deficiencies and suggestions for improved coverage for teachers and textbook authors are offered.

## Keywords

Phineas Gage, introductory psychology, history of psychology

According to Jarrett (2008), the foundation of introductory psychology textbooks is comprised of classic studies, such as Zimbardo's Stanford prison experiment, Milgram's obedience experiments, and Watson and Rayner's Little Albert fear conditioning experiment, and classic stories, such as the brutal murder of Kitty Genovese and the tragic accident of Phineas Gage. Furthermore, these classic studies and stories have taken on an almost mythical status in psychology textbooks, and as with myths, the way these studies are described and the stories are told may become distorted over time and unhinged from the facts that are available about them. Indeed, recent research has found that current introductory psychology textbook coverage of some of these classic experiments is distorted. For example, Griggs (2014c) showed this was the case for coverage of Watson and Rayner's Little Albert experiment in current introductory psychology textbooks and Griggs (2014a) found similar results for coverage of Zimbardo's Stanford prison experiment. Benderly (2012) refers to the classic stories as "psychology's tall tales" because they have been distorted with time and thus are not completely true. Indeed, Griggs (2015; see also Griggs & Whitehead, 2014) found that the Kitty Genovese story was not covered accurately in many introductory psychology and social psychology textbooks. The focus in this study is on the accuracy of the coverage in current introductory psychology textbooks of another classic story—the saga of Phineas Gage and his terrible accident in which he survived a three-and-a-half-foot-long tamping iron that weighed 13¼ pounds exploding through his head.

A recent article by Kean (2014a, see also 2014b, Chapter 12) argued that "recent historical work . . . suggests that much of the canonical Gage story is hogwash, a mélange of scientific prejudice, artistic license and outright fabrication," which in Benderly's terms would certainly qualify it as a very "tall tale." Kean also pointed out that some scientists now believe that Gage underwent partial recovery after his accident and returned to something at least approximating a regular life (Macmillan & Lena, 2010; see also Kotowicz, 2007). Kean leans heavily upon the work of Malcom Macmillan who has been amassing information about Gage and trying to separate fact from fiction about him for the past 40 years or so. Macmillan provides the best source of information about Phineas Gage—his definitive book about Gage, *An Odd Kind of Fame* (2000a). A good guide to information published about Gage since 2000 and other Gageanalia is Macmillan's website on Gage at <https://www.uakron.edu/gage>.

The only large-scale (and possibly the only) study of the coverage of the Phineas Gage story in introductory textbooks was conducted by Macmillan. In his book about Gage (Macmillan, 2000a), he detailed his analysis of the accuracy of the coverage of the Gage story in 60 introductory textbooks

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published in the 15 years from 1983 to 1998. Macmillan found that the overall level of accuracy was low, but its extent varied across the type of inaccuracy and across textbooks (see Chapter 14 for a detailed description of his findings).<sup>1</sup> The most inaccurate part of the Gage story concerned what happened to him after his accident, what Macmillan termed Gage's "subsequent history" (pp. 322–324).<sup>2</sup> According to Macmillan, events that are not documented anywhere are included along with some that almost certainly did not happen, while important events in Gage's life that did happen are not mentioned or, if mentioned, they are exaggerated. Some sample textbook errors about Gage's subsequent history provided by Macmillan are that Gage never worked again and became a vagrant, that Gage was reduced to exhibiting himself as a circus attraction because he could not hold a steady job, that he toured the country charging admission to see the holes in his head, and that he died penniless in an institution 12 years after the accident. The most egregious error seems to be that Gage survived for 20 years with the tamping iron embedded in his head! Macmillan argued that the main basis of these textbook inaccuracies was the authors' disregard for the four primary sources of information about Gage that exist (Bigelow, 1850; Harlow, 1848, 1868; Jackson, 1870), especially Harlow (1868). According to Macmillan, where accuracy was achieved in textbook coverage, it was typically done by quoting or paraphrasing these primary sources. Macmillan (2000b, see Appendix) provides reproductions of the important parts of what Harlow wrote along with some other primary source material categorized into the following four stages of the Phineas Gage story: pre-accident Gage, immediate post-accident Gage, psychological and behavioral changes in Gage, and subsequent history of Gage.

It is important to point out that the primary sources of information about Gage were not easily accessible to textbook authors during the time period covered in Macmillan's text analyses (Macmillan, 2000b), but they are now. Facsimiles of these documents were made available in Macmillan (2000a, see Appendix A), and the Internet also now provides greater accessibility to these sources. This state of easier access to these primary sources greatly facilitates the task of current textbook authors with respect to helping to ensure the accuracy of their coverage of the Phineas Gage story. In addition, current introductory textbook authors not only have Macmillan's definitive work on Gage (2000a) to use in developing their coverage of the Gage story but also some recent articles on various aspects of the Gage story (e.g., Macmillan & Lena, 2010, on Gage's probable psychosocial recovery). Thus, with these new resources available and the primary sources on Gage more accessible, current coverage of the Gage story in introductory textbooks should be much improved versus that observed by Macmillan (2000a) for textbooks from the 1980s to 1990s.

The obvious downside of inaccuracies in the coverage of the Phineas Gage story is that students will be misled into accepting the story as fact, and sadly, it seems that students seldom question the textbook stories that they are told (Burton, 2001). Introductory psychology is the most popular course in

psychology with an estimated annual enrollment in the United States of 1.2–1.6 million students (Steuer & Ham, 2008) and may be the only psychology course taken by most of these students. Hence, introductory psychology textbooks should be as accurate as possible. According to Morawski (1992), textbooks are the key transmitters of psychological knowledge both to potential new members of the discipline and to those outside the discipline (giving psychology away), and therefore, it is essential that textbook information be accurate. Thus, it is important to the psychological teaching community to identify inaccuracies in our textbooks so that they can be corrected, and we as textbook authors and teachers do not continue to "give away" false information about our discipline. Hopefully, this study will help in achieving this, at least with respect to the Phineas Gage story.

In addition to examining the accuracy of coverage in current introductory psychology textbooks of Gage's subsequent history, this study checked current textbooks for coverage of three important recent developments in the Gage story. These developments were (1) Gage's probable psychosocial recovery (e.g., Macmillan & Lena, 2010), (2) the recent computer-imaging modeling work that, in contrast to the earlier work by Damasio, Grabowski, Frank, Galaburda, and Damasio (1994), determined that the most likely path of the tamping iron *only* went through the left hemisphere of Gage's brain (Ratiu & Talos, 2004; Ratiu, Talos, Haker, Lieberman, & Everett, 2004; also see Van Horn et al., 2012), and (3) the discovery of two post-accident photographs of Gage—the daguerreotype discovered by Wilgus and Wilgus (2009) and a photographic reproduction of another similar daguerreotype that was brought forward by a descendent of a branch of the Gage family.<sup>3</sup> These photographs provide support for the recovery hypothesis because, as Kean (2014a) points out, the images they present of Gage contradict the conception of Gage as "a dirty, disheveled misfit" but rather show that the post-accident Gage was a "proud, well-dressed, and disarmingly handsome" man.

The recent digital modeling work on the path that the tamping iron took through Gage's brain and Gage's probable psychosocial recovery require some explanation. The initial digital reconstructed path of the iron bar as it passed through Gage's brain was developed by Damasio et al. (1994) using a Gage-like skull based on measurements of Gage's skull and indicated that the iron damaged the prefrontal cortex in both hemispheres, but a later path reconstruction using high-resolution computerized tomography (CT) scans of Gage's actual skull (Ratiu et al., 2004) questioned Damasio et al.'s results.<sup>4</sup> Ratiu et al. concluded that the tamping iron could not have crossed over the midline and damaged the right hemisphere. This agreed with Harlow's (1868) assessment of the location of damage based on his examination of Gage's skull. Subsequently, Van Horn et al. (2012) produced Gage's connectome (a detailed wiring diagram of the brain) and in the process concluded that the iron could not have crossed over to the right hemisphere and that it damaged some of the major white matter tracts in the left frontal lobe, supporting Ratiu et al.'s findings. There is an animated video of Ratiu et al.'s reconstructed path

of the tamping iron available at <http://www.nejm.org/doi/full/10.1056/NEJMicm031024>.

Macmillan and Lena (2010) provide a detailed argument that a reexamination of the older evidence provided by the primary sources of information on Gage together with a consideration of new information about Gage, such as the two recently discovered photographs, indicates that Gage seems to have made a surprisingly good psychosocial adaptation to his injury and that Gage's severe mental changes were not as permanent as was once thought and that over time, he became a higher functioning, more socially-adapted person. According to Macmillan and Lena, major factors in this rehabilitation were Gage's highly structured employment and life over a period of nearly 8 years as a stagecoach driver in Chile and the social skills, responsibilities, and challenges entailed in this work. For example, driving a six-horse stagecoach team in which each horse was controlled separately by differing movements of the reins over steep and rough terrain clearly required complex sensory-motor/cognitive skills, and dealing with the non-English-speaking passengers in a foreign country clearly required social skills. With respect to Gage's recovery, Kotowicz (2007) pointed out that a Harvard surgeon, Henry Bigelow, is the only person known to have observed Gage a good time (well over a year) after his accident and to have published his observations (Bigelow, 1850), and he reported Gage as fully recovered. Bigelow arranged to have Gage under his care and at his expense for purposes of observation for 8–9 weeks. Bigelow described Gage as having "quite recovered in his faculties of body and mind" and does not mention anything strange or unusual about his behavior (Macmillan, 2000a, p. 392). In addition, Macmillan and Lena found a statement from Dr. Henry Trevitt, a doctor who lived in Chile at the time Gage was there and knew Gage well. The doctor reported that Gage "was in the enjoyment of good health with no impairment whatever of his mental faculties" (p. 648)," which strongly supports the argument that Gage made a good recovery. Macmillan and Lena concluded that although they did not think that Gage recovered completely and became Gage again, he probably resumed something like a normal life.

It is also important to realize, as Kotowicz (2007) pointed out, that Gage's short-term, post-accident behavior has to be considered in the context of his adjustment to his facial disfigurement. Kotowicz (p. 121) provided some hypothetical examples that allow us to imagine how things likely changed for the disfigured Gage:

First he meets his workmates. Their attitude towards him has changed; now they turn their eyes away, they are not the same easy-going fellows; and the girls do not laugh and flirt with him as they did . . . all this must be really difficult to take. Someone will look at him, and we can imagine him snapping back, 'What are you staring at, you bastard?' And there are also those who are only too ready to give advice, but giving advice to someone in Gage's predicament is a risky business. Again, we can imagine him telling them to go to hell. Very ungrateful; definitely, to 'his friends and acquaintances' he is 'no longer Gage.'

Obviously, adjusting to physical disfigurement takes time, so some of the psychological and behavioral changes described by Harlow (see Macmillan, 2000b, Appendix, for a summary) are understandable in the context of Gage's adjustment to his disfigurement. Given the recently discovered photos of the post-accident Gage, it definitely appears that he did adjust and came to terms with his disfigurement or he would not have had these photos taken. As Wilgus and Wilgus (2009) pointed out, their post-accident photo of Gage shows a handsome, well-dressed, and confident man.

With respect to predictions in this study, given that the primary sources of evidence about Phineas Gage are now widely available on the Internet and in Macmillan (2000a) and that Macmillan has already taken introductory textbook authors to task for inaccurate coverage, especially of Gage's subsequent history, current introductory textbook authors should be more accurate than earlier authors in their coverage of the Phineas Gage story. This prediction does, however, assume that authors are aware of and have attended to these sources and the recent publications about Gage. Similarly, given the recent articles on Gage, such as Macmillan and Lena (2010) and Ratiu, Talos, Haker, Lieberman, and Everett (2004) and authors' awareness of them, the majority of textbooks will likely include some discussion of Gage's probable recovery and the newly proposed path of the iron bar through only his left hemisphere. It also seems likely that most textbook authors would include a photo of Gage because none have been available in the past. If these predictions are supported, then the Phineas Gage story as told in current introductory textbooks should no longer be the tall tale that it has been in past introductory textbooks.

## Method

The textbook sample included the current editions of 23 introductory psychology textbooks. The most recent copyright date of 21 of these texts was 2012–2014, the current 3-year revision cycle for introductory textbooks at the time of this study. I included two texts with a 2015 copyright date because they were already published and available in the summer of 2014, when this study was conducted. Complete reference information for all 23 texts is given in the References section. The textbook sample was a good mix of contemporary (initially published after 2000) and older (initially published before 2000) introductory psychology textbooks. The mean edition number for the sampled texts was 4.7. The sample included the most recent introductory text (Grison, Heatherton, & Gazzaniga, 2015) and the oldest, *Psychology and Life* (Gerrig, 2013), first published in 1937 and now in its 20th edition.

To determine if a text included coverage of the Phineas Gage story, the name index and the subject index were checked for "Phineas Gage." If no entries on Phineas Gage were included in either of the indexes, a page-by-page check of the textbook for coverage of Phineas Gage was conducted in case there had been an indexing error. If Phineas Gage was discussed in more than one chapter in a text, all discussions were analyzed and the chapter topics were noted. For two textbooks

whose current edition was not in my possession, this search process was not used. Instead, the authors of these texts sent me the relevant pages from their texts in PDF files. Next, if coverage was included in a text, it was checked for the following four types of information: (1) its accuracy in terms of Gage's subsequent history, (2) discussion of Gage's psychosocial recovery, (3) inclusion of the projected path of the tamping iron—the one proposed by Damasio et al. (1994) or the one proposed by Ratiu et al. (2004), and (4) inclusion of photos—their number and nature. The appendix in Macmillan (2000b), which summarizes Gage's subsequent history according to the primary sources, was used as a guide for checking the accuracy of textbook coverage of this history. Because Gage's subsequent history and recovery are intrinsically related, the following decision rule for coverage of Gage's recovery was used. If a text discussed Gage's subsequent history and recovery separately, it was given credit for covering both, but if it only briefly mentioned some of Gage's subsequent history within its discussion of Gage's recovery, then it was just given credit for covering Gage's recovery.

## Results and Discussion

Twenty-one (91%) of the 23 textbooks included a discussion of Phineas Gage. This is greater than the 60% observed by Macmillan (2000a), but this difference is likely at least partially due to the fact that Macmillan's introductory textbook sample was not just comprised of introductory psychology textbooks but also included other types of introductory textbooks (e.g., introductory abnormal psychology textbooks; see Footnote 1).

Only 5 of the 21 textbooks included a discussion of Phineas Gage in another chapter in addition to the biological psychology chapter. Two textbooks also discussed Gage in their methods chapter—one as an example of the case study method and the other as an example of studying brain function with brain-damaged patients before brain scanning methods had been developed. Two textbooks also discussed Gage in the motivation and emotion chapter relating his brain damage in the prefrontal cortex to his personality changes. One of these two texts also briefly discussed Gage in the memory chapter as an example of learning about the brain from brain-damaged patients. The fifth text included a discussion of Gage in the language and thought chapter as an example of the role of the prefrontal cortex's control over the mental processes with Gage's prefrontal damage, thus leading to his alleged inability to carry out plans. In addition, one textbook did not discuss Phineas Gage in the biological chapter but rather only in a chapter on memory and attention. This discussion centered on the relationship of the prefrontal cortex with personality, emotional regulation, and the ability to plan and make decisions.

### Gage's Subsequent History

The results rendered the prediction that coverage of Gage's subsequent history would be more accurate than in Macmillan's (2000a) textbook analysis moot. Only 4 (19%) of the 21

textbooks included any discussion of Gage's subsequent history, and three of these four discussions were rather brief but generally accurate. One of these three textbooks only stated that Gage could not be foreman again and had trouble holding jobs but had no difficulty speaking or performing complex movements, like driving a stagecoach. Another text stated that Gage exhibited himself in New England and worked at the stables at the Hanover Inn at Dartmouth College but then skipped ahead about 10 years in Gage's subsequent history to describe Gage having epileptic seizures and dying. The third text only stated that Gage traveled to the larger towns of New England exhibiting himself and the tamping iron. The one text that did provide a fairly detailed, accurate account of Gage's subsequent history used Fleischman (2002) as the source for the history. In sum, only four of the textbooks included any discussion of Gage's subsequent history, and most of these only provided a very limited account of the history.

The scarcity of coverage of Gage's subsequent history was an unexpected finding. Possibly Macmillan's reports of introductory textbook errors in the coverage of the Phineas Gage story, especially in their descriptions of his subsequent history, have led textbook authors to avoid possible inaccuracies in their accounts of this history by not including coverage of it. This scarcity though is more likely due to space constraints in current introductory psychology textbooks. Similarly, space constraints also likely played at least a partial role in the decisions not to include any coverage of the Gage story in the two texts that did so. Introductory psychology textbooks are continually criticized for being far too long, bordering on encyclopedic (e.g., Johnson & Carton, 2006; Landrum, 2000). Thus, there is pressure on introductory text authors to make each new edition the same length or shorter than the last one, but there is also pressure to be up-to-date and include coverage of important new studies and topics and new developments for existing topics (Blumenthal, 1990–1991). In order to accommodate these conflicting demands, expansions of coverage for all of the existing topics required by new developments for those topics obviously cannot make it into the new edition. Hence, coverage of older classic studies is often shortened and sometimes even deleted from texts (Griggs & Jackson, 2007). Thus, the general lack of coverage of Gage's subsequent history in the present sample of current textbooks is probably due to space constraints and this updating process. Given this lack of coverage of Gage's subsequent life history, coverage of Gage's psychosocial recovery was also probably scarce.

### Gage's Psychosocial Recovery

The results for coverage of Gage's psychosocial recovery were consistent with the finding of scarce coverage of Gage's subsequent history. Thus, the prediction that textbooks authors would include coverage of Gage's recovery was not supported. Only 3 (14%) of the 21 textbooks did so, and only one of these texts discussed Gage's subsequent history separately. In addition, the coverage was rather minimal in two texts. One text stated that although Gage lost his job, he did, over time, *adapt*



to his injury to find work as a stagecoach driver, and another stated that his work as a stagecoach driver and the fact that he supported himself throughout his postaccident life seem to indicate that he at least partially *adapted* to his injury. The third text provided more detail and stated that with respect to the changes in Gage's behavior and personality after the accident, the extent and permanence of these changes are in dispute and also that later, more reliable evidence shows a remarkably *recovered* Gage who spent many years driving stagecoaches, a job that required demanding motor, cognitive, and interpersonal skills. This text also tied Gage's recovery to our current knowledge of neuroplasticity. All three texts cited Macmillan and Lena (2010). Two of these three texts included a portrait photo of the postaccident Gage, but neither text explicitly connected Gage's appearance in the photo to Gage's recovery. Because each of these three texts only used one to three sentences to describe Gage's recovery, space constraints are not as limiting in this case. Gage's recovery can be discussed adequately in a few sentences, even if an explicit connection is made to a Gage photo, if one is included.

In addition to the three textbooks that explicitly mentioned Gage's possible recovery, it is important to note that two textbooks did qualify Gage's alleged psychological and behavioral changes following the accident. One text stated that Macmillan (2000a) pointed out that we do not know what Gage was like before the accident and thus some scholars contend that his personality may not have changed as much as is often claimed. Citing Kotowicz (2007), another text pointed out that reports at the time about the changes in Gage's behavior after the accident provided little detail and that if you have previously read about Phineas Gage, you likely read an exaggeration of these details.

### Locus of Gage's Brain Damage

With respect to including a computer-generated image or a drawing of such an image that shows the projected path of the tamping iron through Gage's head indicating the damage to Gage's brain, 14 (67%) of the 21 texts did so. Four of the seven texts that did not include such an image or drawing at least mentioned the locus of the damage to Gage's brain in their coverage. Two of the textbooks stated that the "frontal lobe of his brain" was damaged, one that the "front part of his brain" was damaged, and the other that "much of the brain's left frontal lobe" was damaged. The remaining three textbooks included a photo of a 19th century representation of the path through Gage's skull. One of these texts included a photo of a representation prepared for Bigelow (1850), and the other two texts used a representation from Harlow (1868). The textbook authors did not provide these references for the photos, but the representations that they used are identified in Macmillan (2000b, Figure 1, p. 50).<sup>5</sup>

Contrary to the prediction that the majority of textbooks would include coverage of Ratiu et al.'s (2004) projected path of the tamping iron through only Gage's left frontal lobe, 10 (71%) of the 14 textbooks that provided a computer-generated image or a drawing of an image of the path used the

Damasio et al. (1994) proposed path of the iron through the brain that damaged the frontal lobe in both hemispheres. Two of these texts did not cite Damasio et al.'s article as the source, but the drawing is clearly that of the path proposed by Damasio et al. Only four (20%) textbooks included the path recently proposed by Ratiu et al. that shows damage only to the left frontal lobe. Two of these 14 textbooks incorrectly merged the image or drawing used and the citation for it. One of these two texts included the Ratiu et al. path image, but the citation for it is given incorrectly as Damasio et al. (1994). The other text showed the image of the Damasio et al. path through both hemispheres but did not provide a reference for it in the caption and then strangely cited Ratiu and Talos (2004) in the text proper as showing that the path only went through the left frontal lobe. These two errors are likely the result of incorrect updating during the text revision process. In one case, the image was updated, but the citation was not; and in the other case, the reverse was true. However, why more textbook authors included the older Damasio et al. path that was modeled on a Gage-like skull based on measurements of Gage's skull and not the more recent Ratiu et al. path that used CT scans of Gage's actual skull and is consistent with Harlow's opinion that only the left frontal lobe had been damaged is a mystery. The most plausible explanation would seem to be that the many authors are not aware of Ratiu et al.'s work, possibly because the relevant publications were in journals typically not read by psychologists, the *Journal of Neurotrauma* and the *New England Journal of Medicine*. If this is the case, then this article should help to remedy this problem.

The photos of the very old representations of the path of the tamping iron through Gage's skull discussed earlier may have been used to avoid copyright permission problems, such as a costly usage fee. Permission problems may also help to explain why more texts included Damasio et al.'s (1994) path and three of the four texts including Ratiu et al.'s (2004) path used artists' drawings of the path and not the published image. It is interesting to note that the only textbook that included the published Ratiu et al. image has switched to a drawing of it in its upcoming new edition (D. G. Myers, personal communication, August 21, 2014), indicating possible permission problems. Because these drawings are artists' renderings of the image and not the image itself, there are problems. A good example is that in the Ratiu et al. image, the mouth of the skull is open because they discovered that Gage's mouth must have been open at the time the tamping iron exploded through Gage's head. However, only one of the three drawings in this study depicted the mouth as open. Another important problem with these drawings is that sometimes the exit path of the tamping iron is ambiguous with respect to whether only the left frontal lobe or both frontal lobes are damaged. In sum, the use of such drawings in lieu of the actual image because of permission problems is a solution, but not an optimal one.

### Gage Photos

Surprisingly, fewer texts than predicted included one of the two recently discovered portrait photos of Gage. Only 9 (43%) of

the 21 textbooks included one of these photos—8 were the Wilgus and Wilgus (2009) photo and 1 was the photo provided by a Gage family descendent in 2010. One of these nine texts also provided a photo of a representation of Gage's damaged skull. Three other texts included at least one non-portrait Gage photo. One text included a photo of Gage's skull beside the tamping iron, one included a photo of a representation of Gage's skull without the iron going through it, and one included two photos, a representation of Gage's skull without the tamping iron and a life mask created from the living Phineas (according to Macmillan, 2000b, this mask was prepared for Bigelow circa 1850).<sup>6</sup>

Possibly, the authors of the 11 textbooks that did not include one of the portrait photos of Gage may not have been aware of their existence. The Wilgus and Wilgus photo was published in a non-mainline psychology journal, the *Journal of the History of the Neurosciences*. The second photo does not even appear in a published article but can be viewed at [http://www.brightbytes.com/phineasgage/new\\_image](http://www.brightbytes.com/phineasgage/new_image), and both images are available at the "Meet Phineas Gage" website, <http://www.brightbytes.com/phineasgage/index.html>.

### Suggestions to Teachers and Textbook Authors

Because the coverage of the Phineas Gage story in most of the current introductory psychology textbooks was found to be lacking in several respects, the following are suggestions for introductory psychology teachers to use in revising their lectures on the Phineas Gage story and for introductory psychology textbook authors to consider in revising their texts for future editions to rectify possible coverage problems. These suggestions should also help introductory teachers determine the accuracy of the Gage story in the textbooks they are using in their classes. If the textbook coverage is inaccurate or incomplete, teachers should be aware of it so that they can rectify any problems in their lectures.

First, although not directly addressed in this study, I suggest that teachers and authors review their coverage of the first three stages of the Phineas Gage story (pre-accident Gage, immediate post-accident Gage, and the psychological and behavioral changes in Gage) for accuracy. Macmillan (2000b, Appendix) has greatly facilitated this task by providing summary descriptions of all four stages using material taken directly from the primary sources. In addition, Macmillan (2000a, Appendix A) provides facsimiles of all of the primary sources. If your descriptions are not congruent with the primary sources, I recommend that they be revised in accordance with them. Inaccuracies sometimes arise in descriptions of the psychological and behavioral changes in Gage as described by Harlow (1848, 1868) because teachers and authors attempt to abbreviate and rewrite Harlow's description. Macmillan (2000a, Chapter 14) provides a detailed discussion of such errors. For accuracy then, the actual wording or paraphrasing of the wording in the primary sources should be used.

Second, given the observed lack of coverage of Gage's subsequent history and recovery, I suggest that descriptions of these two topics be added. Macmillan (2000a, Appendix A) provides a description of the subsequent history per the primary sources, and again I recommend using the wording of the primary sources or paraphrasing it for the sake of accuracy. Macmillan and Lena (2010) provide an excellent, detailed argument for Gage's partial psychosocial recovery, and the proposed recovery can be nicely related to our current knowledge of neuroplasticity and rehabilitation from brain injury. Although satisfactory coverage of both of these topics would seem to entail one or two paragraphs, textbook authors with serious space issues could at least provide minimal coverage in a few sentences. Regardless, I think that adding such a discussion is important so that students do not leave the course erroneously thinking that brain damage inevitably leads to entirely irreversible effects and, more specifically, do not leave the course believing that Gage's alleged psychological and behavioral changes following the accident were permanent. This is inaccurate given not only our current state of knowledge about Gage but also our current state of knowledge about neuroplasticity and the brain's ability to heal itself. Some of Gage's post-accident psychological and behavioral changes seem to have diminished or possibly even disappeared. The addition of a brief discussion of this recovery will provide a more positive ending to an otherwise tragic story.

Third, I suggest that coverage of the Ratiu et al.'s (2004) projected path of the tamping iron only through Gage's left frontal lobe be added. Teachers, for example, can include the animated video of this path (available online at <http://www.nejm.org/doi/full/10.1056/NEJMicm031024>) in their lectures. This, however, may be problematic for textbook authors because of possible permission usage problems for this image. Thus, authors may need to go to an artist's drawing of the projected path, and these drawings should be carefully proofed for accuracy. Alternatively, a brief verbal description of Ratiu et al.'s projected path could be included in the text in order to bring the discussion of the locus of the brain damage up to date.

Fourth, I suggest that teachers incorporate one of the recently discovered photographs of Phineas Gage into their lectures. Teachers can import one of these portrait photos from the Internet, and textbook authors can include one in their coverage of the Gage story. Including a Gage portrait photo in lectures and textbooks humanizes his story and allows students to see the face of neuroscience's most famous brain injury survivor. Although drawing inferences from posed photographs is problematic, these portrait photos are generally supportive of Macmillan and Lena's (2010) psychosocial recovery argument in that they show a Gage who is well dressed, appears confident, and is even handsome, despite his facial disfigurement.

I think that these suggestions will not only lead to a more accurate Gage story but also one that leads to Macmillan and Lena's (2010, p. 655) conclusion that although 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" (p. 655).

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## Notes

1. The 60 introductory textbooks that Macmillan (2000a) reported examining were not all introductory psychology textbooks. His sample also included other types of introductory textbooks, such as introductory texts in biological psychology and abnormal psychology. In addition, Macmillan (2000b) reported that he further examined the accuracy of the coverage of the Phineas Gage story in a set of 30 pre-1984 books that included “textbooks, specialized (sic) monographs, and general works drawn from psychiatry, medicine, physiology, linguistics, and the neurosciences as well as psychology” (p. 48).
2. It is important to point out that Macmillan (2000a) distinguished between what he termed the “after picture” of Gage and Gage’s subsequent history. The “after picture” stage in Gage’s life refers to the psychological and behavioral changes that Harlow (1848/1868) ascribed to Gage after his physical recovery. For example, according to Harlow, Gage became fitful, irreverent, grossly profane, and his friends and acquaintances said that he was “no longer Gage.” Macmillan elsewhere (e.g., 2000b) refers to this stage as the “psychological and behavioral changes” in Gage instead of the “after picture” of Gage. In his analyses of introductory textbook coverage of the Gage story, Macmillan classified errors for each stage in Gage’s life separately. In this study, I only examined the sample of introductory psychology textbooks for inaccuracies in the subsequent history stage, which according to Macmillan was the part of the Gage story told with the greatest inaccuracy.
3. The first daguerreotype was discovered in 2009 by Jack and Beverly Wilgus. Being a daguerreotype, it shows Gage laterally (left–right) reversed so a second, compensating reversal has to be applied in order to see Gage correctly as he appeared in real life. Wilgus and Wilgus (2009) provide an explanation of the photographic process involved in creating a daguerreotype. The other Gage image brought forth in 2010 by a descendent of one of Gage’s relatives is a photographic reproduction of a yet undiscovered daguerreotype or similar laterally reversed photograph. These two portraits are the only known images of Gage. Both images are available at the “Meet Phineas Gage” website, <http://www.brightbytes.com/phineasgage/index.html>. In addition, there is a reconstruction of what Phineas Gage might have looked like before his accident at <https://www.uakron.edu/gage/adaptation.dot>. At Macmillan’s request, Beverly Wilgus replaced the damaged left eye with a digitally altered mirror image of the undamaged right eye and removed the highlights and the scar on Gage’s forehead. Because of the asymmetry of facial structure, using the right side and the mirror image of the right side will not portray a face accurately, but the result is as close as we will ever get to seeing what the pre-accident Gage looked like.
4. Macmillan (2000a) points out that even if we were certain about the path of the tamping iron through the brain, it would not “necessarily give us certainty about the parts of the brain that might have been damaged” (p. 82). This is because such estimations do not take into account the additional damage due to the profuse hemorrhaging that Gage suffered, the pieces of bone from the opening in the base of the skull that flew through his brain, and the infection and concussion that Gage suffered. In addition, the position of the brain within the skull and the location of various structures within the brain vary considerably from person to person. In sum, although the path of the tamping iron through Gage’s brain may be accurately estimated, there will always be some uncertainty about the extent and nature of the brain damage due to these other factors.
5. According to Macmillan (2000b; see pp. 48–50), one of these representations of Gage’s damaged skull was prepared in late 1849 or early 1850 by Bigelow to show that the passage of the tamping iron through the skull was possible, and the other representation was prepared for Harlow in 1868 either from Gage’s skull or a photo of his skull.
6. Harlow had the photo of the tamping iron together with Gage’s skull made in 1868 to document his case (Fleischman, 2002). Featured side-by-side in the photo, it is difficult to believe that this iron bar shot through Gage’s head without killing him.

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