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Exploring accuracy in journalism stories reporting on neuroscience research findings: A comparative case study

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Graduate Program in Health Information Science

A thesis submitted in partial fulfillment of the requirements for the degree in Master of Health Information Science

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EXPLORING ACCURACY IN JOURNALISM STORIES REPORTING ON NEUROSCIENCE RESEARCH FINDINGS: A COMPARATIVE CASE STUDY

(Thesis Format: Monograph)

by

Andrea Campbell-Davison

Graduate Program in Health Information Science

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Health Information Science

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Abstract

Neuroscience has seen explosive growth in research and public interest, but research findings are often reported inaccurately, impacting public understanding. Exploratory descriptive case study methods were used to analyze two peer reviewed research articles, one on brain imaging for patients in a Persistent Vegetative State (PVS), and another on Brain Training (BT), and all journalism stories regarding these two studies. Statistical and content analyses were used to analyze the accuracy of the translation of the research into journalism stories. PVS research received more media attention and this reporting was less accurate than for BT research; the information was also discussed and presented in different ways, including broad implications and generalizations in the PVS, but not the BT, stories. The difference in level of media saturation and accuracy between PVS and BT research is likely because the PVS stories often linked the social/ethical issues of life and death to the research.

Keywords: Case Study, Knowledge Translation, Journalism, Neuroscience, Health and Medical Research, General/Lay Public, Science Communication.
“The whole notion of journalism being an institution whose fundamental purpose is to educate and inform and even, one might say, elevate, has altered under commercial pressure, perhaps, into a different kind of purpose, which is to divert and distract and entertain.” (Tom Stoppard, 2011)
This thesis is dedicated to my amazing son Shayne and my amazing daughter Emily, for without their love and support none of this would have been possible. They are the reason I went to university in the first place. They have been my sole source of strength since their birth.
I am very happy to have the opportunity to thank the many people who helped make this thesis possible.

First of all, I would like to thank my thesis advisors, Dr. Nadine Wathen, Meredith Levine, and Dr. Anita Kothari. Their time and efforts have been tremendous. They have added invaluable contributions and helped me through this endeavour; more than that their knowledge and passion have been an inspiration.

I would also like to thank Nazi Torabi for helping in the development of the search strategy.

Last but not least, I would like to thank Ian Arra for his never-failing love and encouragement and support. You are the strongest and most determined person I know. You are my role model, and my heart.
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<tr>
<td>AHRQ</td>
<td>Agency for Healthcare Research and Quality</td>
</tr>
<tr>
<td>CHIR</td>
<td>Canadian Institutes of Health Research</td>
</tr>
<tr>
<td>KT</td>
<td>Knowledge Translation</td>
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<td>IKT</td>
<td>Integrated Knowledge Translation</td>
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<td>CAJ</td>
<td>Canadian Association of Journalists</td>
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<td>CBC</td>
<td>Canadian Broadcasting Corporation</td>
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<td>CIHI</td>
<td>Canadian Institute for Health Information</td>
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<tr>
<td>MS</td>
<td>Multiple Sclerosis</td>
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<tr>
<td>fMRI &amp; MRI</td>
<td>(functional) Magnetic Resonance Imaging</td>
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<tr>
<td>PVS</td>
<td>Persistent Vegetative State</td>
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<tr>
<td>BT</td>
<td>Brain Training</td>
</tr>
<tr>
<td>ISQ</td>
<td>Index of Scientific Quality</td>
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<tr>
<td>RQ</td>
<td>Research Question</td>
</tr>
<tr>
<td>Hyp</td>
<td>Hypothesis</td>
</tr>
<tr>
<td>VS</td>
<td>Vegetative State</td>
</tr>
<tr>
<td>MCS</td>
<td>Minimally Conscious State</td>
</tr>
<tr>
<td>BBC</td>
<td>British Broadcasting Corporation</td>
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<tr>
<td>EEG</td>
<td>Electroencephalography</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>TBI</td>
<td>Traumatic Brain Injury</td>
</tr>
<tr>
<td>ROI</td>
<td>Research of Interest</td>
</tr>
<tr>
<td>PR</td>
<td>Public Relations</td>
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Accountability for, and transferability of, research findings have become of increasing importance to researchers and health care providers and systems (Agency for Healthcare Research and Quality [AHRQ], 2001; Leatherman & Sutherland, 2010; Tetroe, 2007). In Canada, researchers, funding agencies, and health care decision-makers are under increasing pressure to ensure that research results are subsequently relevant and applicable to the current health care context and are communicated to various intended audiences, and that decisions are made based on the best available evidence (most often defined as that derived from rigorous research) (Leatherman et al., 2010; Tetroe, 2007). As a result, the Canadian Institutes of Health Research (CIHR), a government research funding agency, often requires that knowledge translation (KT), “the synthesis, dissemination, exchange and ethically sound application of knowledge,” strategies be a part of any research activities they fund (CIHR, 2012a; Holmes, Scarrow & Schellenberg, 2012; Kothari & Wathen, 2013). The CIHR describes two main forms of KT strategies. The first, Integrated Knowledge Translation (IKT), “involves engaging and integrating those who will need to act on the findings, the knowledge users [(policy makers, clinicians, the public, etc.)], into the research process … with the overarching goal being the co-production of knowledge, its exchange and its translation into action” (Parry, Salsberg & Macaulay, 2012, p.9). The second, End of Grant KT, is where “the researcher develops and implements a plan for making knowledge users aware of the knowledge” following completion of the research (talks, publications, etc.) (CIHR, 2012a). The
following study will focus on End of Grant KT, with a specific focus on how completed research comes to be communicated to the public through mass media.

It is important that researchers find ways to translate their research to the appropriate audiences for two reasons. First, research usually takes a considerable amount of time to be put into practice. For example, Balas and Boren estimate that research from randomized controlled trials takes around 9.3 years to reach a 50% rate of use in practice from its introduction into reviews, papers, and textbooks (Balas & Boren, 2000, p.66). According to the AHRQ in the United States, it takes 10-20 years to get original research findings into routine clinical practice (2001). In the case where treatment is necessary for a particular disease and a treatment with many side effects is the only option, the introduction of a new treatment with fewer side effects could mean a significant improvement in these patients’ quality of life. Secondly, in Canada and the United States some treatments and practices known to be effective are not implemented and some outdated, harmful treatments and practices continue regardless of research indicating otherwise (AHRQ, 2001; Leatherman et al., 2010; Pittet et al., 2006; Schuster, Wathen, Macgredor, Sibbald & MacMillan, 2013).

Currently, efforts are underway to involve the general public and/or its advocates in health care decision-making processes (Abelson, Montesanti, Li, Gauvin & Martin, 2010; CIHR, 2012b; Dallas, 2006; Seale, 2003; Secko, Preto, Niemeyer & Burgess, 2009; Shea, et al., 2005). For example, major government research funders, CIHR and the Canadian Foundation for Healthcare Improvement (formerly the Canadian Health Services Research Foundation), and various Canadian health care organizations have set public engagement as one of the top priorities in health services and policy issues
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(Abelson, et al., 2010; CIHR, 2012b; Law, Flood & Gagnon, 2008). Likewise, the Ontario government has vested significant funding and planning power in their Local Health Integration Networks, which are designed to bring together the public and institutions to develop community specific health initiatives (Abelson, et al., 2010; Ontario Local Health Integration Networks, 2013). The idea is that health care providers, policy makers, and researchers should be accountable to the public for their decisions and the public should be engaged and ‘empowered’ to contribute in all aspects of health care: personal, policy, and research (Harris, Wathen & Wyatt, 2010; Martin, 2008).

Public involvement in health care decision making requires an informed public (Abelson, et al., 2010; Abelson, Forest, Eyles, Smith, Martin & Gauvin, 2003; CHIR, 2012b; Thompson, et al., 2012). For example, Thompson et al. (2012) found that although participants believed their experience with illness provided them with expertise regarding their unique patient experiences, they were reluctant to challenge ‘expert’ (scientists, clinicians, etc.) opinion and often “reinforced the certified professional/non-professional demarcation” (pp. 610) and “associated certified academic qualifications with an enhanced sense of credibility within a research group” (pp. 611). Moreover, participants without prior research training felt the need to engage in training courses (research methods, statistics, etc.) that were offered to them in order to increase their credibility within the group (Thompson, et al., 2012) – a potentially significant burden on them.

Journalism is a potential means to inform the general public on health and medical research. Journalism can be defined as the act of creating, and the product of, fact-based stories for the general public. Although a clear definition in this field is highly
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contested, the Canadian Association of Journalists (CAJ) Ethics Advisory Committee defines journalism as a “disinterested” or non-partisan “act of creation” using “a particular set of methods” to confirm or refute, and gather diverse perspectives on an issue, to ensure fairness and accuracy in the story (CAJ Ethics Advisory Committee, 2011). Currently, in Canada and most western countries, journalism is not a licensed profession (Strasser, 2010). Specialized training is provided by educational institutions (Universities, Colleges), some are recognized by the Canadian Association of Journalists, and the Canadian Journalism foundation, but specialized training is not required. Standards for practice and a general code of ethics exist in many news organizations (CBC, Toronto Star, etc.) whereby certain methods and ethics of practice should be upheld or employees may be fired for non-compliance. However, with many journalists now working as freelancers, and the internet allowing for any individual to publish a story and call it journalism (Kovach & Rosenstiel, 2001), these standards and codes may not underpin much of current journalistic output.

Health and medical journalism is the branch of journalism that reports on health and medical issues. Most journalists are not specialists in health and medicine and many have not had specialized training (Amend & Secko, 2012; Weigold, 2001). Common topics in health and medical journalism are issues associated with biotechnology (new drugs, treatments, and diagnostic tests), lifestyle, risk, and social policy issues (Amend & Secko, 2012; Freedman, 2013; Gunter, Kinderlerer & Beyleveld, 1999; McComas & Simone, 2003; Seale, 2003; Weigold, 2001). Health and medical journalists also commonly rely on a number of meta-narratives to create interest in their stories, these include the dangers of modern life, villains and freaks, victimhood, professional heroes,
or lay heroes (Seale, 2003). As a general guideline stories should be newsworthy, applicable, engaging (able to draw in, and sustain audiences) and have a human element (a particular individual experiencing a disease or undergoing a treatment) (Amend & Secko, 2012).

In order for a health and medical journalism story to be published it needs to be considered newsworthy, in other words, worthy of publication. Researchers have found that certain factors influence whether or not a health and medical story is newsworthy. Factors that lead to newsworthiness of health and medical research include: publication in a major newspaper, publication in a prestigious scientific journal (New England Journal of Medicine, The Lancet, Nature, etc.), whether or not the research was presented in a press release or was concerning one of “the big killers” (e.g., cancer), was from an eminent author, was a topical (of current interest) subject, a rare quirky disease, a new or improved treatment, had a sexual connection or contained controversial subject matter or results (De Semir, 1996; Entwistle, 1995).

Neuroscience research has received a considerable amount of media coverage recently (Racine, Bar-llan & Illes, 2005; Racine, et al., 2006; Ramani, 2009; Tallis, 2009). Neuroscience research is a specific area of health and medical research that is expanding, and where research funding is increasing (David, 2012; Society for Neuro-Oncology, 2011). Neurological medical conditions are common; it is estimated that 1 in 3 Canadians will suffer from a brain condition in his or her lifetime (David, 2012). The economic burden of eleven neurological conditions (Alzheimer’s, cerebral palsy, multiple sclerosis, etc.) mentioned in the Canadian Institute for Health Information’s (CIHI) 2007 report ‘The Burden of Neurological Diseases, Disorders and Injuries in Canada,’ was
estimated at $8.8 billion in 2000-2001 in hospital-based care costs alone. Furthermore, according to the World Health Organization, neurological impairments account for over 6% of the global burden of disease (years lost to disability), and Dua, et al. (2006) predict this number will continue to increase in the future. Finally, incidence of neurological conditions increases as an individual ages and “[a]s the Canadian population ages, the impact of brain conditions will be staggering” (Neurological Health Charities Canada, 2010). As of 2011, 3,558,388 Canadians suffer from neurological conditions ranging from mildly disabling (e.g., migraine headaches) to profoundly disabling (i.e., Alzheimer’s disease, amyotrophic lateral sclerosis) (Statistics Canada, 2011).

Although neuroscience research is important, it is often over-generalized in the media and presented in a simplistic and misleading way (O’Connor, Rees & Joffe, 2012; Poole, 2012; Racine, et al., 2005; Racine, et al., 2006; Ramani, 2009; Tallis, 2009). Therefore, the purpose of this thesis is to explore and identify factors influencing the uptake and accuracy of neuroscience research findings in order to generate hypotheses for future research in reporting on health and medical neuroscience research findings. This research will lead to further avenues for investigation to better understand journalism as a form of conveying neuroscience research findings to the public.
2.1 Journalism

Many individuals actively seek out and often rely on journalism stories to obtain health and medical information and some consider these stories as important as information obtained from health care professionals and as more accessible (Brodie, Kjellson, Hoff & Parker, 1999; Burkell, Wolfe, Potter & Jutai, 2006; Freimuth, Greenberg, DeWitt & Romano, 1984; Gupta & Sinha, 2010; Nagler, et al., 2010; Schwitzer, et al., 2005). For example, Brodie et al. (1999) found that individuals choose the media as a health and medical information source over health care professionals regardless of their views of the media as an unreliable and untrustworthy source. Likewise, Burkell et al. (2006) found that although patients see interpersonal sources of health information (i.e., specialists, general practitioners, and other individuals with the disorder) as more accurate sources, patients found interpersonal sources to be less accessible than media and internet sources.

Furthermore, the public often receives health and medical information from the media whether they actively seek it, or not (e.g., passively watching news) (Pribble, et al., 2006; Schwitzer, et al., 2005; Wang & Gantz, 2010). For example, newspapers, television news, and news websites now have a section or segment devoted entirely to health and medicine or, more broadly, “life” or “lifestyle”, (often overlaps with health content), whereas in the past specific sections for health did not exist and were a part of a larger section on ‘society’ which included news on science, law, curiosities, crime, etc. (De Semir, 1996).
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Although other factors are involved, health and medical journalism can play a role in research priority-setting (Chan, Dipper, Kelsey & Harrison, 2010; Kruvand, 2012). First of all, journalism is said to contribute to what is considered important in a given culture by increasing an issue’s salience (the issue easily comes to mind and/or is a topic of conversation in the public sphere) (Chan, et al., 2010; Cohen, 1963; Driedger & Eyles, 2003; Huck, Quiring & Brosius, 2009). For example, Huck, et al. (2009) argue that what journalists choose to feature in their reporting is perceived as representing the information and values that are important and relevant to the mainstream culture.

Secondly, journalism coverage of health and medical research can increase supply and demand of a particular treatment (Benelli, 2003), as evidenced by positive media presentations of Dr. Zamboni’s ‘liberation procedure’ leading to pressure from Multiple Sclerosis (MS) patients and patient groups to provide the controversial treatment to MS patients in Canada (The Canadian Broadcasting Corporation (CBC), 2012; Rasminsky & TerBrugge, 2013). Finally, as demonstrated by Driedger and Eyles (2003) health journalism can have an impact on further avenues of research; for example, journalists framing the issue of the water purification process as cancer-causing likely led to continued research on this topic (CBC, 2012; Driedger & Eyles, 2003; Rasminsky & terBrugge, 2013). Thus journalism stories can impact what citizens and policy makers understand regarding what is important and culturally relevant at any point in time, thereby influencing publicly-funded research priorities.

Research has also shown that health and medical journalism influences the public’s attitudes, knowledge, and behaviours (CBC, 2012; Cooper, Mallon, Leadbetter, Pollack & Peipins, 2005; Einarson, Schachtschneider, Halil, Bollano & Koren, 2005;
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Kruvand, 2012; Passalacqua, et al., 2004; Rasminsky & terBrugge, 2013; Tanner, Evans & Condrasky, 2008). For example, Kruvand’s (2012) research on the New York Times newspaper coverage of the birth control pill demonstrated that the way the stories were framed coincided with attitudes toward the pill and its subsequent use. Research done by Einarson et al. (2005) found that subsequent media coverage of a health advisory regarding antidepressant use during pregnancy led to anxiety and abrupt discontinuation of use (which could have serious negative consequences for mother and child). Research on media coverage’s effects on attitudes, knowledge, and behaviours has been carried out on coverage of cancer research. For example research by Passalacqua, et al. (2004) found that journalism stories regarding cancer treatments influenced cancer patient’s opinions, feelings of hope, and confusion regarding cancer treatment. Likewise, studies found that news coverage of cancer prevention was related to knowledge of cancer prevention (Slater, Hayes, Reineke, Long & Bettinghaus, 2009; Stryker, Moriarty & Jensen, 2008). Finally, in their analysis of internet search activity, Cooper et al. (2005) found that news coverage of certain types of cancer were associated with internet search activity on these cancer topics.

Health and medical journalism stories are often viewed as of poor quality and containing sensationalized information (exaggeration, appeals to emotion, etc.), errors, and misrepresentations of health and medical research (Cassels, et al., 2003; Cassels & Lexchin, 2008; Chan, et al., 2010; Driedger & Eyles, 2003; Evensen & Clarke, 2012; Gunter, et al., 1999; Roche & Muskavitch, 2003; Seale, 2003; Weigold, 2001; Wilson, Bonevski, Jones & Henry, 2009; Wilson, Robertson, Ewald & Henry, 2012). For example, numerous studies have indicated that journalism stories often exclude important
information such as harms and costs associated with treatments (Cassels, *et al.*, 2003; Cassels & Lexchin, 2008; Evensen & Clarke, 2012; Roche & Muskavitch, 2003; Schwartz, *et al.*, 2012; Wilson, *et al.*, 2012). These exclusions may lead to inaccuracies and inadequate information for informing the public on important health issues such as the risk of contracting a disease or virus or exaggerated treatment effects (Entwistle & Sheldon, 1999; Gunter, *et al.*, 1999; Tsfati, Cohen & Gunther, 2011; Weigold, 2001; Wilson, *et al.*, 2012).

Other research has found that it is not so much outright errors in reporting but often an overly optimistic or one-sided presentation of research findings that is a problem when journalists report on health and medical research findings (Bubela & Caulfield, 2004; Racine, *et al.*, 2005; Racine, *et al.*, 2006). For example, research done by Bubela and Caulfield (2004) comparing scientific journals to newspaper articles on genetic research found that a large proportion of stories, 97%, emphasized the benefits of the research. Likewise, using content analysis, Racine et al. (2006) found that print media coverage of fMRI research presented an overly optimistic picture of the technology with most print media emphasizing the technology’s benefits and maintaining an uncritical tone. The researchers also found that health related articles of fMRI research were less critical than non health related articles (Racine, *et al.*, 2006). Therefore, it is important that further study in the accuracy of research reporting in the media consider all potential aspects of accuracy, not simply errors in reporting findings.

Inaccuracy and sensationalism are also associated with inappropriate resource allocation, decreased willingness to seek treatment, false expectations, loss of hope, anxiety, and rash health decisions (Brewer, 2012; Einarson et al., 2005; CBC, 2012;
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Freedman, 2013; Larsson, Oxman, Carling & Herrin, 2003; McDaid, 2005; Rasminsly & terBrugge, 2013). For example, in 2010, the Canadian health care system wasted time and money on research regarding a novel vein opening procedure for the treatment of Multiple Sclerosis (MS), only to later discover what was arguably already known: that the treatment and its underlying pathology were faulty (CBC, 2012; Rasminsly & terBrugge, 2013). The “liberation procedure,” discovered by an Italian physician, was based on an untested scientific idea that vascular obstruction was causing MS and its related symptoms (Rasminsly & terBrugge, 2013). Patient’s and advocacy groups, fueled by the news media’s reiteration of the “liberation procedure’s” “apparent efficacy,” put pressure on the government to bring the treatment to Canada, leading to inappropriate resource allocation (Rasminsly & terBrugge, 2013). The widespread media attention also led to false expectations and rash health decisions, with patients traveling all over the world, at great personal cost, to receive the experimental treatment (Rasminsly & terBrugge, 2013).

2.2 Neuroscience in the Media

Journalism stories regarding health and medical research tend to focus on biotechnology (new drugs, treatments, screening, etc.), “the big killers” (e.g., cancer), topical issues, rare and quirky diseases, controversial issues, and health risks (Amend & Secko, 2012; Bubela & Caulfield, 2004; De Semir, 1996; Entwistle, 1995; Racine, et al., 2005; Racine, et al., 2006; Seale, 2003; Weigold, 2001). Consequently, scholarly research exploring the quality and impact of health and medical journalism has primarily focused on stories about new drugs, treatments, screening, and health risks (Bubela & Caulfield, 2004; Cassels, et al., 2003; Cassels & Lexchin, 2008; Chan, et al., 2010;
Driedger & Eyles, 2003; Evensen & Clarke, 2012; Gunter, et al., 1999; Roche & Muskavitch, 2003; Seale, 2003; Weigold, 2001; Wilson, et al., 2009; Wilson, et al., 2012), with a small proportion of studies focusing on nutrition research (Hackman & Moe, 1999; Basu & Hogard, 2008) and even fewer on neuroscience research (Latronico, Manenti, Baini & Rasulo, 2011; Racine, et al., 2005; Racine, et al., 2006; Racine, Amaram, Seidler, Karczewsk & Illes, 2008; Racine, Waldman, Rosenberg & Illes, 2010), the health area of focus in this thesis.

Mass media outlets that report on health and medical issues have shown an increased interest in neuroscience research, but at the same time this reporting has raised concerns about overgeneralization and oversimplification of neuroscience findings (O’Connor, et al., 2012; Poole, 2012; Racine, et al., 2005; Racine, et al., 2006; Ramani, 2009). Self-help books, magazines, and journalism stories are using neuroscience research findings to address everyday issues; a tactic commonly referred to as ‘brain porn’ (O’Connor, et al., 2012; Poole, 2012). For example, research done by O’Connor et al. (2012) found common emerging themes in neuroscience journalism: the brain as capital (as a resource), as an index of difference (e.g., differences in categories of people), and as biological proof (e.g., as evidence of their validity), which were applied to a variety of social issues. This application of neuroscience might have substantial effects on how society views themselves, the world, and most importantly for this thesis, the health and medical research findings, as often when neuroscience is used to support a health and medical finding it is seen as more valid (McCabe & Castel, 2007; Racine, et al., 2006; Trout, 2008; Weisberg, Keil, Goodstein, Rawson & Gray, 2008). For example, the mere presence of irrelevant neuroscience information can influence an individuals’
satisfaction with both good and bad explanations of scientific phenomena even when these individuals have some knowledge of neuroscience (Weisberg, et al., 2008).

Likewise, research evidence of a connection between pathologies and neurological imaging patterns can foster a negative interpretation that categorizes people as having “good” or “bad” brains – i.e., “us versus them” - or can label otherwise normal behaviours as pathological (e.g., ‘addiction’ to food, shopping, etc.) (O’Connor, et al., 2012).

Because of the increasing interest and generalization of neuroscience research findings in the mass media, and because individuals often rely on journalism to obtain health and medical information, the accuracy of journalism stories reporting on neuroscience research is important as a topic of exploration (Illes, Kirschen & Gabrieli, 2003; O’Connor, et al., 2012; Racine, et al., 2005; Racine, et al., 2006; Racine, et al., 2010; Ramani, 2007). Key issues are arising in neuroscience making it even more necessary for the public to have a realistic understanding of neuroscience research findings in order to make informed decisions. These key issues include the rise in the aging population and resulting increases in the prevalence dementia, increasingly complex life-sustaining medical technologies (i.e., that allow individuals with traumatic brain injuries to survive beyond what was previously thought possible), neurological discoveries related to hidden consciousness, and the ‘right-to-die with dignity’ or right to continue life-sustaining treatment.

Researchers have started to investigate how neuroscience research is being represented in journalism stories (Latronico, et al., 2011; Racine, et al., 2005; Racine, et al., 2010). For example, in a content analysis of functional Magnetic Resonance Imaging
(fMRI) in print media from 1991-2004, Racine et al. (2005) found that most journalism stories discussed research on higher order cognitive phenomena, attributed broad personal and societal meaning to neuro-images, and emphasized health related benefits and health applications of the technology. They also found that the overall tone of the majority of articles was uncritical, ranging from optimistic to neutral and only one third of the articles presented an explanation of what the technology actually does (2005). However, this research did not compare the original research findings with the media presentations, nor did it look at other neuroscience media coverage outside of the fMRI technology.

A number of studies have looked at media coverage of genetics research, because much like neuroscience, there are many ethical and social issues surrounding genetic research (Bubela & Caulfield, 2004; Brechman, Lee & Cappella, 2011; Nisker & Daar, 2006). For example, Bubela & Caulfield (2004) looked at newspaper articles discussing genetic research and compared them to the original research articles from scientific journals. The researchers found that most claims were not exaggerated, only a small proportion discussed cost and risks, behavioural genetics was the most frequently discussed, and like other research they found a large percentage emphasized benefits of the research (Bubela & Caulfield, 2004). Although this research compared both the original research to the journalism stories, the topic was genetic research. The comparison of journalism stories to the original research articles has yet to be done looking at neuroscience research in the media – this is the focus of this thesis study.

2.3 Background
Dr. Adrian Owen is a neuroscience researcher at the University of Western Ontario in London, Ontario, Canada. In 2010 Dr. Owen and other members of the research team used fMRI to identify patients who may have been misdiagnosed as being in a Persistent Vegetative State (PVS) (patients who have experienced some type of trauma to the brain, who may or may not be receiving life-sustaining treatment, and who are able to move, appear awake, but are unable to demonstrate any consistent repeatable behaviour in response to stimuli) but are in fact minimally conscious (similar to PVS patients but able to show, at least occasionally, consistent repeatable behaviour in response to stimuli) (Coleman, et al., 2009; Cruse, Monti & Owen, 2011a; Monti, Coleman & Owen, 2010a; Monti, Laureys & Owen, 2010b; Monti, et al., 2010c). This research has sparked significant interest and raises considerable ethical questions regarding the diagnosis and treatment of PVS patients (Byrne & Hardiman, 2010; Monti et al., 2010b; Monti, 2012), and indeed, the concepts of life and life quality. Dr. Owen has received a great deal of publicity for this work (Cookson, 2010; Borland, 2010; Groopman, 2007; Walsh, 2010; Wilkinson, 2010), including reference in a recent Supreme Court of Canada decision regarding termination of life support; this makes Dr. Owen’s PVS research a unique case for examining how journalism stories represent health and medical - specifically neuroscience - research and how the larger ethical issues influence how this research is reported on.

A second area of research by Dr. Owen et al. (2010) examined the use of computerized tests to increase cognitive functioning, otherwise known as Brain Training (BT). This study used tools, developed by Drs. Owen and Hampshire at the Medical Research Council Cognition and Brain Sciences Unit in Cambridge, United Kingdom
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(UK), for the assessment of cognitive functioning, in order to determine whether BT enhances cognitive function (Medical Research Council, n.d.). These tests are currently available on the Cambridge Brain Sciences website, www.cambridgebrainsciences.com. The study found these tests to be ineffective at enhancing cognitive functioning. These findings are contrary to the many commercially available brain training programs that promote the idea that these programs enhance cognitive functioning. Thus, while this research is potentially controversial with respect to commercial interests, it does not raise the same life or death ethical issues inherent in the PVS research.

Owen and colleagues published their key studies in these two areas in the same year (2010), and both fall in the same research domain (neuroscience), but with potentially quite different implications in terms of not only ethical issues, but also practical applicability (there are very few PVS patients, but very many people at risk for cognitive decline). These publications, therefore, provide two good cases with which to compare and explore how news media report on health and medical issues when the topic area (neuroscience) and research team (credibility, notoriety, etc.) are, essentially, controlled for. As such this study will provide an in-depth comparison of how both of Owen et al.’s research publications were taken-up in the media, including a description of the uptake process from original research findings to press releases to journalism stories, the accuracy of the resulting messages, and identification of factors that may be associated with the accuracy of these journalism stories. This analysis will contribute to our understanding of how neuroscience research is reported in the media, how different factors influence its uptake and accuracy, and will help generate hypotheses for further study. In addition, using research by the same author regarding topics that are both
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controversial in their own ways but with differing degrees of potential social impact (with and without the ethical life or death issue), will provide a good comparison to explore differences in journalism uptake and accuracy with respect what is being reported on.

In summary, there is a need to further understand and explore, 1) whether a certain type of research is taken up preferentially over another, when they differ on key aspects of implications and applicability, but not on the authority or credibility of the research team, nor the general area of research; 2) how a specific type of research – in this study, neuroscience research conducted by one prominent researcher/lab - is taken up by the media, including both final published stories, as well as intermediary summaries, such as journal- or university-produced press releases; 3) what elements of health and medical research articles specific to two areas of study from this researcher/lab are being reported in journalism stories; 4) how accurately the press releases and journalism stories represent the original research studies, and how they discursively frame the research; and 5) what factors are associated with any differences between the original studies, and the subsequent intermediary summaries and journalism stories.

2.4 Research Questions

1) To what extent is there a difference between the number of press releases and journalism stories, and percentage of coverage in journalism stories, time of journalism stories publication, and length of journalism story regarding Dr. Owen’s Persistent Vegetative State (PVS) research and Brain Training (BT) research?

2) What characteristics of the press release or journalism story are associated with differences in accuracy?
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a. Are there differences in accuracy between press releases and journalism stories, or between the PVS research and the BT research?

b. Are there differences in accuracy when journalism stories contain quotes?

c. Are there differences in accuracy related to the length of time between access to the research and publication of the journalism story?

d. Are there differences in accuracy based on the length of the journalism story?

3) How accurate are press releases and journalism stories based on Dr. Owen’s PVS and BT research?

a. What is omitted from press releases and journalism stories, but is found in the original scientific articles?

b. What is added to press releases and journalism stories, but is not found in the original scientific articles?

c. What wording is used in press releases and journalism stories (emotionally charged language, scientific jargon, etc.)?

   i. How does the typical flow of information from research to press release to journalism story differ?

   ii. How does a, b, & c change across the typical flow of information?

2.5 Hypotheses

Question 1.

Null hypothesis. There will be a similar mean Total Number of Press Releases, or Total Number of Journalism Stories, or Total Percent Coverage, or Word Length for both Cases.
Alternate hypothesis. There will be a different mean Total Number of Press Releases, or Total Number of Journalism Stories, or Total Percent Coverage, or Time, or Word Length for both Cases.

Question 2.

Null hypothesis. There is no association between the accuracy of press releases and journalism stories and the following variables: Case, Type of Communication, Source of Journalism Story, Source of Press Release, Type of Reference, Time, and Word Length.

Alternate hypothesis. An association exists between Case, Type of Communication, Source of Journalism Story, Source of Press Release, Type of Reference, Time, and Word Length.
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CHAPTER 3

Methods

3.1 Methodology

An exploratory comparative case study design, based on Yin (2009), was used. A case study is a research approach that allows a holistic evaluation or description of a particular individual, event, or phenomenon, and the purpose of an exploratory approach is to look at particular aspects of the topic in-depth (Yin, 2009). According to Yin (2009), case studies are effective means of answering “how” and “why” questions and permit description of phenomenon within a given context. Case studies also allow for the use of multiple methods of analysis, which provides the researcher with multiple perspectives on a particular issue that, if convergent, strengthens conclusions drawn from the research (Yin, 2009). Therefore this design allowed for an in-depth exploration of accuracy of health and medical journalism as a conveyor of neuroscience research findings to the general public. The first case was defined as Dr. Owen et al.’s scientific article “Willful modulation of brain activity in disorders of consciousness” (Monti, et al., 2010c) and all press releases and print and electronic journalism stories pertaining to this scientific article from the date of the scientific article’s publication (February 2, 2010) to May 15, 2013. The second case, was defined as Dr. Owen et al.’s scientific article “Putting brain training to the test” (Owen, et al., 2010) and all press releases and print and electronic journalism stories pertaining to this scientific article from the date of the scientific article’s publication (April 19, 2010) to May 15, 2013.

Language is used as a social practice to communicate meaning (Atkinson & Coffey, 2006). Textual analysis in the form of content analysis offers a window to
explore how objects, persons, events, and situations are given meaning in a particular context (Krippendorff, 1989). The use of journalism as a conveyer of research findings to the public is consistent with the idea that journalism contributes to knowledge and meaning in a particular culture (Kellner, 2011). Thus language in the form of text is used by journalists to construct objects, persons, events, and situations in a particular way, directing attention to what issues are deemed important at the expense of alternative issues (Krippendorff, 1989). The analysis of historical texts is also a less obtrusive way to research a phenomenon. Therefore, analysis of journalism text can be used to understand how press releases (the intermediary text between the scientific article and the journalism story) and journalism stories are conveying health and medical neuroscience research and what subject-matter journalists and editors deem important to present based on how frequently certain aspects of the research and its implications are mentioned (Krippendorff, 1989).

A common journalistic practice is to develop a story based on the 6 questions of Who, What, Why, Where, When, and How. These questions are considered the basics in information gathering; the formula for acquiring the complete story on a subject (Scruggs, 2012). The original 5Ws and 1H are; Who is it about? What happened? Why did it happen? Where did it take place? When did it take place? and How did it happen? Although the original research was not necessarily the subject of focus in all the journalism stories (sometimes it was mentioned as a side issue related to the main focus of the story), it will be considered the subject for all the stories for the purposes of this thesis. These categories were used to extract the information on the original research,
because they are in line with the journalistic practice of information gathering and sharing on a subject.

3.2 Sample and Context

Case sampling. Samples of two of Owen et al.’s research articles, concerning two distinct topics in neuroscience, were included as the original research documents and compared, with each case comprising any subsequent press release or journalism story published in the search timeframe. The cases are grounded in the publication of the research articles, after which press releases and news stories were produced. Thus, case selection focused on the particular research articles of interest.

Articles. Two scientific articles on health and medical neuroscience research topics, from the same prominent researcher (Dr. Adrian Owen), were chosen as the cases for this comparative study. The first, and primary, article concerns the PVS research. This article, “Willful modulation of brain activity in disorders of consciousness,” was published in the prominent New England Journal of Medicine on February 18, 2010 (Monti, et al., 2010c). This article was purposively chosen because of its prominence in the media and other public discourse (e.g. Supreme Court case) as described above and its relation to the larger social/ethical issue, ‘right to live/die’. The second article concerns the BT research. This article, “Putting brain training to the test,” was also published in a prominent journal, Nature, on June 10, 2010 (Owen, et al., 2010). With an eye to maximum variation sampling (Yin, 2009), this article was chosen as a comparator for the PVS article as it was published around the same time and involves the same researcher and the same overarching topic (neuroscience), but does not involve the same potential levels of controversy or impact regarding “life and death” issues, and contains
negative findings, thereby providing diversity in the sample (i.e., cases). In addition, the BT research is more broadly applicable to the general public than the PVS research, in that it applies to a greater proportion of the general public (average healthy adults aged 18-60 years old, who play brain games or are considering playing the games).

Press releases. Press releases of both the PVS and BT research from the University of Cambridge, either from the publishers (the *New England Journal of Medicine* and *Nature*), or another source, two weeks prior and up to publication of the scientific articles were identified as key intermediate forms of communication, often serving as the bridge between the original research report, and journalists. As such, these communications permitted the exploration of accuracy of the message at the level of the intermediary.

Journalism stories. Journalism stories are the “translated” form of the research findings directed to the public. These stories were compared to the original scientific articles to explore the communication of key messages at the level of the final published journalism story for public.

Inclusion/exclusion for journalism stories.

i. Both print and web based journalism stories, including blogs from recognized journalists, were included.

ii. Only journalism stories published in English were included.

iii. Only journalism stories specifically referencing the research study were included (may be one sentence, paragraph, or whole article). If the text did not specifically state that it was in reference to the research study, prompts were
used to identify that the text was referencing the research (e.g., ‘A researcher in Canada using fMRI…’).

iv. Headlines were not included as these are often written by someone other than the journalist.

v. Only journalism stories targeted toward a general audience were included. Journalism stories directed at an audience other than a general audience (scientists, health care providers, etc.) were not included.

vi. Journalism stories that were direct replications of an original journalism story (included in the sample) were not included in the content analysis but were included in the statistical analysis, because stories are often syndicated or reprinted in different publications multiple times, and while this is important to determine amount of uptake in media, it would not add to the content analysis.

vii. Only journalism stories from the date of publication of the scientific article to May 15, 2013 were included.

3.3 Data Collection

Scientific Articles. Both the PVS and BT articles were retrieved from the online database (ProQuest) from the University of Western Ontario’s library website and saved in PDF format in a folder labeled ‘data’.

Press Releases. Press releases were requested from the administrative staff at The University of Western Ontario, The University of Cambridge, Dr. Owen’s personal assistant, The New England Journal of Medicine, and Nature. However, of the three who responded to the request, only one provided a press release (Nature, BT press release),
the others directed me to the research team’s media page (no press releases only journalism stories) and to Western University. Therefore, press releases were excluded from the analysis.

*Journalism stories.* Journalism stories from date of publication in the scientific journal (i.e., *The New England Journal of Medicine*, Feb 18, 2010 PVS or *Nature*, June 10, 2010 BT) to May 15, 2013, were obtained via a search strategy suggested by a professional journalist/professor of journalism and further developed by a librarian. Each journalism story with heading and identifiers was placed in individual word documents and hyperlinked to its own reference in an Excel spreadsheet. Index of Scientific Quality (ISQ) scores and contextual information regarding each article were also placed into the Excel spreadsheet (See appendix A for categories).

*Search Strategy.* The search strategy for journalism stories and blogs included using the databases Lexus Nexus, Factiva, and ProQuest Major Dailies using the search terms *Author name* (Owen), *main research terms* (vegetative, coma, conscious, unconscious, brain dead, brain death, and patient) for PVS and (brain train, brain training, brain test, brain testing, brain tests, brain game, brain games, intelligence, cognition, computer games) for BT.

Descriptive statistics were also recorded and placed in the Excel file along with the proportion of journalism articles that referenced the PVS/BT research, and what percentage of the journalism story was devoted to the research – (number of words devoted to the research/total number of words in the journalism story) x 100 – (See appendix A for categories).

3.4 **Outcome Measures** *(See appendix A)*
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In addition to documenting the total Number of Journalism Stories for each Case (RQ 1) (Hyp 1), and the total Word Length of each story (including headline) (RQ 1, RQ 2) (Hyp 1, Hyp 2), the following aspects of each story were assessed to address specific aspects of the research questions.

Coverage. To assess how much of the journalism story was about the case (PVS or BT research), the formula – (number of words discussing the research/total number of words in the article) x 100 – Was applied to each story. Number of words discussing the research was determined on a sentence by sentence basis such that any sentence with reference to the research was included. (RQ 1) (Hyp 1)

Time. To determine whether there was a difference in time between cases and if time was related to accuracy, the formula (time of journalism story publication - time of publication of the case in days) was applied to each story. (RQ 1, RQ 2) (Hyp 1, Hyp 2)

Accuracy. Accuracy of journalism story was based on the ISQ for health-related news (Oxman, Guyatt, Cook, Jaeschke, Heddle & Keller, 1993), and this measure was used to determine whether there were differences in accuracy between the two cases and/or other variables. This measure was originally developed to create a reliable and credible measure of scientific quality for health related news reports (1993). The measure has demonstrated both reliability and sensibility (based on Fienstein’s framework for evaluating sensibility and includes the features of purpose, comprehensibility, replicability (clarity of instructions), responsiveness/sensitivity, face validity, content validity, and ease of practical application (Fava, Tomba & Sonino, 2012)) (Oxman, et al., 1993). This index provided an overall Global Quality Score for the journalism stories. This measure is based on a 5 point scale, ranging from 1 (low – critical or extensive
shortcomings) to 5 (minimal shortcomings), which is based on 7 quality items (each rated on a similar 5 point scale) (See appendix B for ISQ measure). While the measure is described as a measure of quality it is more in line with measures of accuracy/fidelity, and this is how it was used for this thesis. (RQ 2) (Hyp 2)

_Type of Communication._ To determine whether there were differences in accuracy based on the type of communication of the journalism story, one of three categories: magazine, newspaper/website, news wire, was applied to each story (RQ 2) (Hyp 2)

_Source of Journalism Story._ To determine whether there were differences in accuracy based on the source of the journalism story, a source was designated, for example, the organization the journalism story came from, eg. _London Free Press, Toronto Star, New Scientist,_ etc. (RQ 2) (Hyp 2)

_Quote._ To determine if the presence of a quote was related to accuracy, any text in the journalism article greater than 2 words and encapsulated in quotation marks was counted. The story was categorized as either having a quote or not (1=yes, 2=no). (RQ 2) (Hyp 2)

3.5 _Analysis 1_

_Data Analysis._ First, following collection of the journalism stories for each case (PVS/BT) and removal of duplicates from the use of multiple databases, the stories were placed into individual word documents and connected to an Excel reference in the Excel Spreadsheet. The number of resulting journalism stories were calculated in Excel. Secondly, _Coverage_ (the percentage of text devoted to the research study (defined above)), and _Time_ (time from publication of the case article to publication of the journalism story (defined above)) were calculated in Excel, following which, a sum of
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total journalism story coverage was calculated for both the PVS and BT cases. Descriptive variables (Title, Case, Type of Communication, Source of Journalism Story, Author(s), Time of Story Publication, Hour, Page Number, Word Count, and Section), were entered into the same Excel Spreadsheet. Each journalism story was initially read once and then a second time at which ratings were given for each section of the ISQ followed by an overall Global Quality (accuracy) Score (see appendix B) for each journalism story. Scores for each section of the scale and the final Global Quality Score were entered into the Excel spreadsheet. Stories were read again and given a Theme representative of the overall story (primary topic discussed in over three-quarters of the story) and examined for the presence of a Quote (defined above).

Central Themes:

- **Legal Case** – a legal case (i.e., Hassan Rasouli or Terry Schiavo)
- **BT ROI** – the BT research of interest to this thesis
- **PVS ROI** – the PVS research of interest to this thesis
- **EEG research** – a study done after the PVS research, by the same lab, using EEG instead of fMRI (Cruse, *et al.*, 2011b)
- **IQ research** – a study done after the BT research, by the same lab using, fMRI to investigate factors related to IQ, including use of brain games (Hampshire, Highfield, Parkin & Owen, 2012)
- **Technology/Ethics** – potential new technologies and/or ethics in fMRI use
- **Scott/BBC Documentary** – Finding that Scott Routley could answer no to the question “are you in pain?”, using the fMRI technique from the PVS ROI (in
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*Nature, June, 2012*, and/or the airing of the British Broadcasting Corporation’s (BBC) documentary “The Mind Reader” (November, 2012)

- *Move to Canada* – The research team’s move to Canada from the United Kingdom

Independent sample t-tests were performed to examine whether there was a relationship between Time or Word Length for each Case.

Independent samples t-tests were performed to examine whether there was a relationship between the Accuracy of journalism stories (ISQ Global Quality Score) and Case (PVS or BG) and Quote (yes/no) (for each Case). One-way analysis of variance was used to determine if there was a relationship between Accuracy and Source of Journalism Story (eg. London Free Press or Toronto Sun), and Type of Communication (magazine, newspaper/web, newswire) for each Case.

Pearson correlation tests were performed to examine whether there was a relationship between the Accuracy of journalism stories (ISQ Global Quality Score) and Time (number of days from release of the scientific article to release of the journalism story) for each Case. All statistical tests were conducted using SPSS.

3.6 Analysis 2

*Content Analysis*. Data for content analysis were text extracted from the abstract, methods, results, and discussion sections of the two scientific articles, and the entire text of the journalism stories (for both BT and PVS), excluding headlines. Content analysis was used to systematically analyze the text to identify patterns and themes, and make comparisons between the two types of texts (those related to PVS and those related to BT) to determine similarities and differences in content (Berg, 2009). The text was
reviewed looking particularly at the content (meaning and form). Analysis was concurrent with data collection and was an iterative, and inductive process (Berg, 2009). NVivo© software was used to to organize the data and aid in the coding process. Categories based on the elements of journalism, the 5 W’s and H were as follows:

‘Who’ - the sample used in the research,

‘What’ - the findings of the research,

‘Why’ - the rationale for the research,

‘Where’ - where the research took place, the scientific journal the research was published in,

‘When’ - when the research took place, and

‘How’ - the methods used

Other initial categories included sections of the ISQ scale, language usage, context, and implications of the research. Two of the supervisors (NW, ML) reviewed a randomly selected sample (stratified by word length) of journalism stories (10 stories, 5BT, 5PVS) to develop initial codes which were then discussed with the primary researcher, and the coding scheme was refined until a final coding scheme was agreed upon. The final coding scheme was applied to each journalism story, quantified and analyzed. (See appendix C for the detailed code book and categories). Chi-Square analyses on occurrence rates of each category were performed for the categories Who, What, Why, Where, When, How, Implications, Additional content, Reactions, and Quote. This content was also compared across cases (BT and PVS) to explore similarities and differences between the two.
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The primary researcher read and re-read, coded and re-coded, questioned and re-questioned, considered interpretations and brought them back to the data, continually reflecting on interpretations and their plausibility, and kept extensive notes on the processes. The primary researcher also held meetings with the thesis advisory committee to review the data analysis and process. They provided insight, alternative interpretations, and further questions for consideration.

The Excel spreadsheets, SPSS outputs and reports were sent to the advisory team and considered by the researcher in relation to the original research questions, the background literature, and the context of the case. Then the primary researcher met with the advisory team and brought her considerations forward to them for discussion, inquiry on their interpretations, and reflected back on the process as a whole.

3.7 Ethics/Consent

Only publicly available text was used and therefore ethical approval was not required.

3.8 Strategies to Ensure Quality and Trustworthiness

Audit Trail. All text was kept as documents in a database along with the primary researcher’s field note journal. The database was organized by title, source, and date obtained/created in order to maintain a complete record of all data and ensure trustworthiness and transparency. The database contained portable document format versions of the original scientific documents; the Excel spreadsheet; NVivo project file; and Word documents of journalism stories; the primary researcher also documented ideas, personal opinions, interpretations, and a detailed chronology of the research process and activities in a reflexive journal (hard copy book).
Quality Considerations. For an exploratory case study using content analysis relevant quality considerations, and the ones that were used for this study, are credibility, transferability, dependability, and confirmability (Morrow, 2005), described below.

Credibility. Credibility refers to internal consistency/validity of the research and deals with the rigor of the study (Morrow, 2005). Credibility was achieved by prolonged engagement with the text, reflexivity (keeping a journal about the primary researcher’s thoughts and how items were coded and analyzed), co-analysis (data analysis checks with advisors), and thick description (inclusion of excerpts from text in discussion to allow for reader validation) (2005).

Transferability. Transferability refers to the extent to which the reader is able to generalize the findings to his or her own context or situation (Morrow, 2005). This can be achieved by the author providing sufficient information regarding the context, processes, and texts to allow for the reader to determine whether or not it fits with their own particular situation. In this study the methods and text were described in detail as were the contexts of the journalism stories.

Dependability. Dependability is much like the concept of reliability and refers to the extent to which the research is consistent across time, researchers, and analysis techniques (Morrow, 2005). As mentioned above, two of the supervisors reviewed a randomly selected sample of journalism stories and aided in the development of initial codes which were then discussed with the primary researcher, and the coding scheme was refined until a final coding scheme was agreed upon. In order to ensure dependability the research process should be explicit and repeatable, consequently an audit trail was kept (described above) for this thesis to ensure proper documentation of the research process.
Furthermore, source data was used from the original research study articles, and journalism stories rather than relying on interviews to gather this data.

Confirmability. Lastly, confirmability is much like the concept of objectivity (Morrow, 2005). It is an attempt to maintain objectivity during analysis. The use of an audit trail and reflexive notes provided transparency and ensured management of subjectivity to minimize bias.
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CHAPTER 4

Results

This chapter will discuss the findings for each of the research questions, starting with the results regarding media saturation and accuracy associations, followed by findings from the content analysis of media stories and key aspects of word usage in relation to the original research studies. Despite concerted efforts, the researcher was unable to locate the press releases regarding the research findings, thus these questions have been left out of the analysis.

4.1 Included Journalism Stories

Figure 1 presents a flow chart of the search results. The Lexis Nexis search located 1070 Persistent Vegetative State (PVS) stories from Feb 18, 2010 to May 15, 2013 and 699 Brain Training (BT) stories from June 10, 2010 to May 15, 2013, while Factiva located 400 PVS and 112 BT stories. Further searching of ProQuest Canada Newsstand Major Dailies and Google revealed no additional stories on top of the Lexis Nexis and Factiva search. Removal of duplicate (exact duplicates removed only, duplicates from different sources by the same media conglomeration were included) and irrelevant stories from the 1470 PVS and 811 BT stories resulted in 142 PVS and 82 BT stories for analysis.

4.2 Question 1: To what extent is there a difference between the Number of Journalism Stories, Coverage, Time, and Word Length for each Case (PVS/BT)?

Figure 2 presents the total Number of Journalism Stories for each Case. There were almost twice as many stories on the PVS research (N = 142) than on the BT research (N = 82).
Figure 1. Process of including and excluding stories.

Figure 3 presents the difference between the Cases (PVS/BT) for Coverage (percentage of words discussing the research findings). Because the values for Coverage were not normally distributed, an independent samples Mann-Whitney U test was used to analyze whether or not there was a difference between the median Coverage for PVS versus BT. The analysis indicated that there was a difference between Coverage of the BT research (Mdn = 100) and the PVS research (Mdn = 32.5) and that the difference was significant, $U = 3025$, $p < .001$, $r = .40$ (where $r$ is a measure of effect size, $r = Z / \sqrt{n}$). The BT stories had significantly more Coverage than did the PVS stories.
Figure 2. Bar graph showing the difference between the Cases in Number of Journalism Stories reporting on the research.

Figure 4 shows no difference between the Cases (PVS/BT) and the mean Word Length (number of words in the story) (BT stories: $M = 611.38, SE = 59.96$; PVS stories: $M = 719.35, SE = 34.6$), $t(222) = 1.68$, ns.

Figure 5 presents the mean Time (length of time between the publication of research findings and the publication of journalism stories) differed significantly in the two Cases, with more BT stories (Mdn = 1) published within less time from publication of the original research findings than the PVS stories (Mdn = 249.50), $U(2718.5) = -6.76, p < .001, \ r = .45$.

4.3 Question 2: What characteristics of the journalism story are associated with differences in Accuracy?
An Independent samples t-test was used to analyze whether ISQ Global Quality (Accuracy) Score for journalism stories was different depending on the Case (PVS/BT). The analysis indicated that there was a significant difference in ISQ rating with respect to the type of Case reported on $t(222) = 3.20, p = .002$, PVS stories had significantly lower mean ISQ scores ($M = 2.71, SE = .08$) than BT stories ($M = 3.09, SE = .08$) (see figure 6).

A one way analysis of variance was used to analyze whether the ISQ rating was related to whether or not the journalism story was a newspaper/webpage, newswire, or magazine. For both the BG and PVS cases, the analysis indicated that there was no significant main effect for ISQ score (Accuracy) with respect to the Type of Communication (BG: $F(2,79) = 2.06, p = ns$; PVS: $F(2,139) = .91, p = ns$) (see figure 7). The results indicated that there was no difference in Accuracy with respect to whether or not the story was from a newspaper/webpage (BG: $M = 3.00, SE = .09$; PVS: $M = 2.72, SE = .08$),
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![Bar graph showing no difference between the two Cases for Word Length.](image)

*Figure 4.* Bar graph showing no difference between the two Cases for Word Length.

There were insufficient sample sizes to compare ISQ score (Accuracy) with the Source of Journalism Story.

An independent samples t-test was used to analyze whether ISQ Global Quality (Accuracy) Score for journalism stories in each Case (PVS/BT) was different depending on whether or not the stories had a Quote. For BT journalism stories the presence of a Quote was not related to Accuracy $t(80) = 1.22, ns$ (see figure 8). For PVS journalism stories the presence of a Quote was significantly related to Accuracy $t(140) = 3.10, p = .002$ (see figure 9). Journalism stories discussing the PVS research that had a Quote had significantly greater mean ISQ scores ($M = 2.85, SE = .09$) than journalism stories without a Quote ($M = 2.35, SE = .14$).

ewswire (BG: $M = 3.30, SE = .16$; PVS: $M = 2.79, SE = .19$), or magazine (BG: $M = 4.00, SE = \text{only } N = 1$; PVS: $M = 2.20, SE = .49$).
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Figure 5. Bar graph showing a significantly longer mean Time (from publication of the research findings to publication of the story) for the PVS stories compared to the BT stories.

In order to determine whether the association between the presence of a Quote and a higher ISQ score for the PVS journalism stories was based on whether or not the Quote was from one of the researchers and directly discussing the research of interest (ROI) to this thesis (2010 PVS research study) a second independent samples t-test was done. This t-test revealed that the ISQ rating (Accuracy) was significantly related to whether or not the story included a Quote by one of the researchers and directly related to the ROI $t(140) = 4.14$, $p < .001$ (see figure 10). Journalism stories discussing the PVS research that had a Quote from one of the researchers discussing the ROI had significantly greater mean ISQ scores ($M = 2.97$, $SE = .09$) than PVS journalism stories without a Quote ($M = 2.38$, $SE = .11$).
Figure 6. Bar graph showing a significantly lower mean Accuracy (ISQ score) for the PVS stories compared to the BT stories.

Because Time was not normally distributed a Spearman’s rank order (Spearman’s rho) test was used to analyze the data. Analysis of the data using Spearman’s rho revealed a weak but statistically significant relationship between Time and ISQ score (Accuracy) for the PVS case, $rs = -.18$, $N = 142$, $p = .03$, (see Figure 11) but not for the BG case, $rs = -.15$, $N = 82$, $p = .18$. Accuracy of the PVS journalism stories was negatively related to the time the PVS journalism stories were released following publication of the PVS research study. As time between journalism story release and publication of the research findings increased, Accuracy of the PVS stories decreased.

4.4 Additional Analysis

An additional analysis was performed in order to explore whether or not the bimodal distribution in Time (see figure 12) was related to the lower ISQ score (Accuracy) found for the PVS stories (see Figure 13). The bimodal distribution was that a large proportion of stories tended to be released close to (within the first 2 days) the
research study’s publication, then dropped in frequency and later showed a rise in the number of journalism stories released 365-1,095 days after the research study was published. The questions were whether or not there was a difference in Accuracy for Time Period (within 7 days from publication of research findings v. over 1 week from publication of research findings), and if the difference in Accuracy for case (PVS/BT) depended on the time period (whether or not the story was published within a week or not). A 2x2 (case x time period) factorial analysis of variance tested the effects of stories for each case (PVS v. BT) published either within 1 week, or greater than 1 week

\[ F(1,220) = 4.95, p = .027. \]

Journalism stories discussing the Brain Training research \((M = 3.07, SD = .75)\) had significantly greater ISQ scores (Accuracy) compared to journalism stories discussing the PVS research \((M = 2.68, SD = .88)\). There was also a significant main effect for Time Period, \(F(1,220) = 4.36, p = .038.\) Journalism stories released within a week from publication of the original research studies \((M = 3.03, SE = .71)\) had

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**Figure 7.** Line graph showing no difference between Accuracy (ISQ score) and Type of Communication for both Cases.
significantly greater ISQ scores (Accuracy) than journalism stories released after a week following publication of the original research studies ($M = 2.6$, $SE = .94$). There was however, no interaction effect $F(1,220) = .7$, $p = .4$ (see Figure 7). The difference in Accuracy for each Case was not dependent on Time Period and vice versa. Levine’s test for homogeneity of variance was violated however, therefore homogeneity of variance cannot be assumed, increasing the likelihood of type I error (that an effect was found when there was none). However, independent t-tests were done on these variables and the same main effects were found.

4.5 Content Analysis Question 3: How accurate are journalism stories based on the PVS and BT research? What is omitted, what is added, and how are they worded?

For the content analysis word-for-word duplicates included in the previous analysis (for example, from the same media conglomeration but in different sources (i.e., Toronto Sun and London Free Press)) were excluded from the set of articles which}

Figure 8. Bar graph showing no difference between Accuracy (ISQ score) and Quote for BT journalism stories.
resulted in sample sizes of 34 BT and 90 PVS stories (see Figure 1). Appendix D presents the characteristics of the 34 BT and 90 PVS stories included in the content analysis along with binary coded matrix items (Journalists’ Source Verification, Errors, Quality Assessment, Human Element, Quote, Use of Words Evidence/Proof, Consistency/Broad Context). The overall results are summarized in Table 1 with more detail about the specific types of content described below. The following sections describe the PVS and BT story sample in terms of the main journalistic questions (Who, What, Why, Where, When and How).

4.5.1 Five Ws and H

Who (i.e., study sample).

BT

The relevant sample specific information for the BT study that was sought in the media stories was all or some of the following:
Figure 10. Bar graph showing significantly greater Accuracy (ISQ score) with the presence of a Quote from the researcher regarding the ROI for PVS journalism stories.

- 11,430 healthy participants aged 18-60 completed both benchmarking assessments and at least 2 full training sessions during the 6 week period;
- viewers of the British Broadcasting Corporation (BBC)’s popular science program Bang Goes The Theory;
- a portion of 52,617 participants who initially registered for the trial.

Experimental group 1 had 4,678 participants, experimental group 2 had 4,014, and the control group had 2,739. There were no significant differences in the groups for age and gender.

Of the 34 BT stories, 91% described the sample. Ninety-four percent reported the sample size as “more than 11,000” or “11,000,” with relatively few stories indicating the exact number of participants who initially registered for the trial (“52,617”), and the
sample size of the experimental group (“8,600”). Eighty-five percent reported attributes of the sample: 53% reported actual age range (“ages 18 to 60”), 41% reported viewers of the show (“viewers of the BBC science program”), 6% simply saying “adults,” and “members of the public.”

**PVS**

The relevant sample specific information for the PVS study that was sought in the media stories was all or some of the following:

- 54 patients with clinical diagnosis of disorder of consciousness (23 vegetative state (VS – no awareness), 31 minimally conscious state (MCS – some awareness));
Figure 12. Line graph showing the amount of stories published throughout the sampled time period (from publication of the original research to May 15, 2013).

- detailed information was provided on the patient who underwent the communication task (also there was a supplementary paper with detailed information regarding this man’s medical case history), such as how long he had been diagnosed as PVS and that the cause of his injuries were the result of a traffic accident. At time of admission for the fMRI the patient was assumed to be in a VS but extensive testing after fMRI revealed a MCS;
- 16 healthy control subjects (no history of neurological disorder; 9 men, 7 women).
Figure 13. Line graph indicating that the difference in ISQ score for each case (PVS/BT) was not dependent on what time period the stories fell into.

Of the 90 PVS stories 91.1% described the sample. Thirty-nine percent reported sample size: the majority (80%) reported only the sample of PVS participants as “22 more” or “23”; a minority reported the entire sample of MC & PVS patients (e.g., “54,” “54, including 23 who had a vegetative state diagnosed and 31 whose diagnosis was minimal consciousness”). Ninety percent reported attributes of the sample: 67% reported that the study participants were diagnosed or believed to be in a PVS (e.g., “patients diagnosed as vegetative”), some articles discussed additional bedside testing resulted in MC state diagnosis but this was vague and unclear (e.g., “Three showed signs of awareness during intensive standard bedside tests”), and 49% discussed attributes of particular patients in the study (e.g., “29-year-old crash victim”, “young woman”).

What (i.e., study results).

BT
Table 1.

*Percent of stories, reporting key content by research type*

<table>
<thead>
<tr>
<th>Content reported</th>
<th>BT</th>
<th>PVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who (sample)</td>
<td>91%</td>
<td>91.1%</td>
</tr>
<tr>
<td>What (results)</td>
<td>100%</td>
<td>94.4%</td>
</tr>
<tr>
<td>Where (conducted/published)</td>
<td>58.8%</td>
<td>41.1%</td>
</tr>
<tr>
<td>When (conducted/published)</td>
<td>58.8%</td>
<td>60%</td>
</tr>
<tr>
<td>Why (rationale)</td>
<td>73.5%</td>
<td>35.6%</td>
</tr>
<tr>
<td>How (methods)</td>
<td>85.3%</td>
<td>93.3%</td>
</tr>
<tr>
<td>So what (implications)</td>
<td>85.3%</td>
<td>93.3%</td>
</tr>
<tr>
<td>Additional content (not in original research study)</td>
<td>67.6%</td>
<td>62.2%</td>
</tr>
<tr>
<td>Reactions</td>
<td>44%</td>
<td>41%</td>
</tr>
<tr>
<td>Quote included</td>
<td>94.1%</td>
<td>87.7%</td>
</tr>
<tr>
<td>Researcher</td>
<td>91%</td>
<td>79%</td>
</tr>
<tr>
<td>Other</td>
<td>56%</td>
<td>47%</td>
</tr>
</tbody>
</table>

The relevant sample specific information for the BT study that was sought in the media stories was all or some of the following:

- improvements in the cognitive tasks the participants were trained in [differences in BT test scores and ability to answer obscure knowledge questions (effect sizes and confidence intervals)];
- no evidence for transfer effects to untrained tasks even when cognitively closely related, [differences in benchmark tests (effect sizes and confidence intervals)];
- improvements in two of the benchmark tests were numerically greater for the control group;
- potential practice effect of improvement in benchmarking tests;
- no relationship between number of training sessions done and benchmark performance;
- reported a significant effect of gender for two benchmark tests but indicated the effect size was small;
- discussed that even when brain training tested similar cognitive functions measured in the benchmark tests, training related improvements still did not generalize;
- the researchers ran a post hoc correlational analysis to determine whether the amount of BT use was related to the participants’ memory scores and found that it was not, they report that it would take 4 years of training to remember 1 extra digit.

Of the 34 BT stories 100% reported the results of the research, however this varied in the type of result(s) reported. Seventy-four percent reported improvement from the BT (e.g., “participants did get better at the games they practiced. The more they trained, the better they got”), and 68% reported that there was no transfer to other tasks/benchmark tests (e.g., “skills learned did not transfer to unrehearsed mental tasks”). Seventy-one percent compared the experimental groups to the control group (e.g., “no significant statistical differences between the improvements seen in participants who played brain-training games, and those who just surfed the internet for the same length of time”) to discuss the main finding of the study, and only 21% gave an indication of
magnitude of the results (e.g., “it would take almost four years of playing brain training
games regularly each week to remember just one extra digit”). Only 12% gave an all
group comparison (e.g., “improvements were similar across the two cognitive-training
groups and the control group”).

Twenty-one percent discussed the results in terms of the actual outcome measure
(benchmarking test results) (e.g., “researchers found that performance in the
benchmarking tests was slightly improved after six weeks of training activities”), only 1
story (3%) gave an average amount of brain game use (i.e., “on average, they completed
24.47 training sessions each”), and no stories reported statistics. A few journalism stories
discussed significance while the research article reported effect sizes (effect sizes were
reported in the research study because the large sample would lead to significant findings
regardless of whether there was any clinical or real world significance of brain training or
not) (e.g., “no significant differences in tests before and after the six-week trial,” or, more
accurately, “for all groups, the effect of training was small”).

**PVS**

The relevant sample specific information for the PVS study that was sought in the
media stories was all or some of the following:

- The main finding of the PVS study was that five patients out of the 54
  were able to show brain activity in the fMRI scanner following
  visualization prompts;
- brain activity during visualizations (localizer scans) were compared to
  resting brain activity and limited to the supplementary motor area and
  parahippocampal gyrus (two separate imagery tasks - visualizing playing
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tennis v. visualizing walking around your house or a familiar street. The former is a motor-based imagery task and the latter is a spatial-based imagery task);

- four of the patients were diagnosed as being in a VS and one was diagnosed as being in a MCS prior to the fMRI procedure, however following fMRI, two of the VS patients showed behavioural indicators of awareness at the bedside (an indication of a minimally conscious state);

- one man (PVS preceding fMRI and MC following fMRI) was able to answer 5 of 6 autobiographical questions with 100% accuracy (able to show activity in the fMRI in the brain regions of interest, activity was sustained for 30 seconds, was associated with delivery of the verbal cues, and results closely matched the pattern observed in healthy controls);

- researchers suggested that the patient may have fallen asleep for the 6th unanswered question;

- brain activity for the yes/no questions for the patient and healthy controls were compared to localizer scans (results of all his localizer scans were averaged for his visualizations for comparison v. the average of two localizer scans for healthy controls);

- discovery that the patient, in the yes/no question experiment, was able to respond to basic commands at the bedside following the fMRI procedure means that it is not possible to know for sure if he was minimally conscious all along;
• statistics were not reported in this paper (they were reported in a supplementary paper), and all patients that were able to show visualizations (5 out of 54) had traumatic brain injuries.

Of the 90 PVS stories 94.4% reported the results of the research. Forty-eight percent reported on the proportion of patients able to perform the visualization task in response to prompts (e.g., “found that three of the patients displayed evidence of conscious awareness similar to that of the first”); 66% reported the patient’s ability to answer yes or no questions (e.g., “He was able to correctly answer the questions that were asked by simply changing his thoughts”) (one story reported incorrectly that “a few of them [patients in the study] have been able to answer Yes-and-No questions”), 36% reported simply that the researchers found awareness (e.g., “the scans detected signs of awareness”); 16% reported that the researchers were able to communicate with a patient (e.g., “communicated with a man who had been in a coma for five years”), and 12% that the patient was unable to answer one of the questions (e.g., “no answer was obtained to the sixth”). Most stories discussed the fMRI activity demonstrated during the visualization task for the areas of interest (e.g., “able to detect activity in the appropriate brain regions,” or “correct brain areas lit up”); 3% mentioned the areas of the brain active during the particular visualizations (e.g., “noticed significant activity in the supplementary motor area of her brain ... the parahippocampal gyrus, the posterior parietal cortex and the premotor cortex”) but none discussed what measures were compared (i.e., activity during visualization with activity at rest). The finding that the patients who were able to perform the visualization task all had traumatic brain injuries was only included in 2% of the stories (e.g., “patients with serious traumatic brain
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injuries are not always capable...”), with one story offering a potential theoretical explanation for these findings, i.e., “Experts say traumatic brain injury can heal better than...”

A Chi-Square test was used to analyze whether the proportion of journalism stories discussing “What” was different with respect to case (PVS/BT). The analysis indicated that there was no difference in the proportion of stories discussing “What” between the two cases $\chi^2 (1, N = 124) = 1.97, ns$.

Where the research took place.

BT

Of the 34 BT stories 58.8% reported on where the research took place. Forty-six percent reported the location of the study (25% indicated that it was in the United Kingdom, e.g., “U.K. study”), and 44% reported which journal the research was published in (e.g., “published by the journal Nature”).

Of the 90 PVS stories 41.1% reported on where the research took place. Nine percent reported the location of the study (e.g., “Addenbrookes Hospital in Cambridge,” or “conducted in Cambridge and Liege”), and 36% reported in which journal the research was published (e.g., “published last year in the New England Journal of Medicine”).

A Chi-Square test was used to analyze whether the number of articles discussing “Where” was different with respect to whether or not the story was reporting on the PVS or BT research, and these were not significantly related: $\chi^2 (1, N = 124) = 3.53, ns$.

When the research was published or took place.

BT
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Of the 34 BT stories 58.8% reported on when the research was published or took place. Fifty-six percent reported when the study was published (e.g., “earlier this year” or “June 2010”), and 6% reported that it was a “six-week study.”

PVS

Of the 90 PVS stories 60% reported on when the research was published or took place. Forty-two percent reported when the study was published (e.g., “Two years ago” or “4 February”); 7% reported that it was a “three-year study,” 11% gave the date of the study (e.g., “builds on a study published in 2006,” or “2005-2009”), and 7% gave some vague date of when the research was published or took place (e.g., “previously shown” or “in recent years”).

A Chi-Square test was used to analyze whether the proportion of articles discussing “When” was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the proportion of articles discussing “When” between the two cases $\chi^2 (1, n = 124) = .01, ns.$

Why the study was done.

BT

In the research article the researchers indicated that the impetus for the research was that brain games were a multi-million dollar industry with little research evidence to back-up the contention that they can improve cognitive function, specifically in healthy adults.

Of the 34 BT stories 73.5% reported on why the research was done. Of these, 38% reported that brain games were a big money making industry (e.g., “multi-million-dollar industry”), 38% reported that the evidence was lacking (e.g., “up until now there’s
been a real lack of robust evidence”), 29% reported high public buy-in (e.g., “lots of people who buy it,” or “played by millions of people worldwide”), and 6% reported that the BBC initiated the research (e.g., “instigated at the urging of the BBC’s science program”).

PVS

In the PVS article the researchers indicated that the rationale for doing the research was that the standard method for diagnosing disorders of consciousness (i.e., assessing patient’s behavioural responses at the bedside) often leads to misdiagnosis (40% of patients are incorrectly diagnosed as being in a PVS). Building on the case of a patient they placed in the fMRI in 2006 the researchers wanted to determine whether they could get patients to show awareness via brain activity. The rationale for the yes/no question experiment was to determine whether the visualization technique could be used to answer yes or no to autobiographical questions.

Of the 90 PVS stories 35.6% reported on why the research was done. Of these, 18% mentioned the inadequacy of current diagnostic tests (e.g., “standard tests may overlook patients,” or “40% of patients in the vegetative state are misdiagnosed”), 14% indicated the motive was just to see if it could be done (e.g., “to see if brain scans could detect signs of awareness in patients who were thought to be closed off from the world”), 6% claimed it was “on a whim,” and 2% “given these results” (as a result of finding awareness in 5 of 54 patients the researchers went on to try and communicate with one of them).

A Chi-Square test was used to analyze whether the proportion of articles discussing “Why” was different with respect to whether or not the story was reporting on
the PVS or BT research, and these were significantly related: $\chi^2 (1, n = 124) = 14.33, p < .000$. The results indicated a significantly greater proportion of “Why” for BT stories (2.4, higher than expected) than PVS stories. In other words, more BT journalism stories than PVS journalism stories reported “Why” the research was done.

How (i.e., study methods).

BT

Of the 34 BT stories 85.3% reported on the methods used in the research. Of these, 68% described the different groups in the experiment (e.g., “split into three groups, with two practising training games every day and the third only browsing the internet”), 29% reported the time frame and/or ‘dosage’ (e.g., “participants trained for at least 10 minutes a day, three times a week, for up to six weeks”), 56% described the cognitive skills that being targeted for training via the brain games (e.g., “designed to improve reasoning, memory, planning, visuospatial skills and attention”), and 53% reported the outcome measure used in the study (e.g., “all participants took benchmarking tests at the beginning and end of the six-week period”).

PVS

Of the 90 PVS stories 93.3% reported the methods used in the research. Of these, 80% mentioned the device used (e.g., “functional Magnetic Resonance Imaging (fMRI) which measures...”), 78% described in general what was done “scanned the brain,” “asked him to perform the motor imagery task if the answer was yes...,” 77% described the visualization task “she was instructed to imagine playing tennis (motor imagery task) and second, she was asked to imagine walking around her house (spatial imagery task),” and 9% reported the time frame of the study “between 2005 and 2009.”
A Chi-Square test was used to analyze whether the proportion of articles discussing “How” was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the proportion of articles discussing “How” between the two cases $\chi^2(1, n = 124) = 1.97, ns.$

4.5.2 Other Categories

*So What (Implications).*

*BT*

The information regarding the implications of the BT study sought in the media stories was all or some of the following:

- The study does not support the belief that brain games are effective in improving cognitive function in a large, general population sample;
- brain games may be helpful for certain populations (elderly or people with cognitive disorders);
- face to face training and/or more intensive training could lead to transfer to other cognitive tasks but that this was unlikely based on the results of their study.

Of the 34 the BT stories 85.3% discuss implications of the research. Of these, 44% reported that BT were a potential waste of time and money (e.g., “brain-training games that are designed to make users more intelligent are likely to be a waste of time and money,” or “may be other things people could do with their time that “might be cheaper and more fun”), 32% indicated that BT may be beneficial for other populations (e.g., “I still think brain games offer tremendous potential for helping people with conditions such as Attention Deficit Hyperactivity Disorder and learning disabilities”).
Included in the story but not found in the research article were: 47% reported that alternatives might be better than BT (e.g., “people would be better off getting some exercise,” or “people should consider learning a new language or sport if they really want to improve their brain power”); 44% reported that it won’t make you smarter (e.g., “it doesn’t make you any smarter overall,” or “do nothing to improve I.Q.”); and 18% that the findings will surprise many people (e.g., “our findings will no doubt surprise millions of people,” or “will be a blow to the dozens of companies selling brain-training”). Twelve percent reported that for BT to be beneficial they have to be more difficult and less fun (e.g., “Improving cognitive function requires more than just some fun and games,” or “If people are enjoying the brain games, Adey said, they probably aren’t being challenged and might as well be playing a regular video game”); finally 3% indicated that more research was necessary (e.g., “need for more study”).

PVS

In the research article the researchers discussed the possibility that PVS patients may have been misdiagnosed and may have some awareness, and that the fMRI technique could be added to current diagnostic methods in order to identify misdiagnosed PVS patients who qualify for MC treatments (there are more treatment options for MC patients than for PVS patients). The researchers also mentioned that in the future the fMRI technique could be used to address important clinical questions, such as asking patients whether they are in pain, providing a means for the patients to communicate, express their thoughts and control their environment (in a basic way).

Of the 90 PVS stories 93.3% discuss implications of the research. Fifty-eight percent of these reported the potential for the technique to be used as a means for patients
to communicate, express their thoughts, and control their environment (e.g., “might ultimately allow patients “to express their thoughts, control their environment and increase their quality of life,” or “in future we could ask what we could do to improve their quality of life”), 28% reported that PVS patients may be aware (e.g., “the research suggests that standard tests may overlook patients with some consciousness,” or “some patients diagnosed as being in a PVS are consciously aware”), 27% reported that it may/will change the way patients are diagnosed and treated (e.g., “suggested that functional MRI be added to traditional methods of diagnosing patients with consciousness disorders,” or “has enormous implications for the treatment of vegetative patients”); finally 11% reported that more research was needed (e.g., “much more work is needed to confirm the findings and refine the technology,” or “much more research is needed to confirm findings and refine the technology”).

Included in the stories but not in the research article were: 53% reporting the PVS research finding’s potential to either ‘fire up’ the right to live/die issue (57% discussed the right to live/die issue with 53% discussing it as an implication of the research) or its potential to be used to determine if the patient would like to end their life/continue living (e.g., “the ability to read patients’ minds raises fundamental questions surrounding the end of life,” or “hoped his work would enable more patients to have a say in their care, even the ability to refuse life-prolonging treatment”), 25% reported the time and or expense of the procedure (e.g., “Using an MRI machine requires moving patients from nursing home facilities to academic medical centers for the costly scans,” or “$3 million for an MRI machine”). Finally, 2% reported that the technique cannot be used to rule out
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consciousness (e.g., “while a scan might find the lost, it can never do the reverse and show that there is no consciousness”).

The right to live/die issue was balanced/critical in a significant proportion of the stories in that they presented both sides of the issue, or discussed the inability to use the research findings for the purposes of answering these larger issues. For example in 41% of the 51 stories mentioning the right to live/die issue, journalists discuss the inability for patients with disorders of consciousness to make such decisions due to low cognitive functioning or the inability for yes/no questions to capture complex communication (e.g., “how deep is the understanding of the question? How stable the answer?,” or “while they may be able to answer yes/no questions, their brain damage may mean they lack the capacity to give informed consent”).

The number of stories discussing the right to live/die issue differed depending on the overall theme of the journalism story (see Table 1). The presence of the right to live/die issue was in 100% of the stories where the main theme was a legal case focused on the issue; in 60% of the stories where the main theme was the PVS research; in 60% of the stories where the main theme was technology/ethics; in 60% of the stories where the main theme was the EEG research; in 25% of the stories where the main theme was the Scott Routley (are you in pain?)/documentary; and in 12% of the stories with the move of the research team from the United Kingdom to Canada as the main theme.

A Chi-Square test was used to analyze whether the proportion of articles discussing “So What” was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the
proportion of articles discussing “So What” between the two cases $\chi^2 (1, N = 124) = 2.79, \text{ ns.}$

A Chi-Square test was used to analyze whether the proportion of articles with additional content (content regarding the research but not mentioned in the original article) was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the proportion of articles with additional content between the two cases $\chi^2 (1, N = 124) = .96, \text{ ns.}$

Reactions.

BT

Of the 34 BT stories 44% reported on a reaction from someone outside the research (27% of these reactions were from an individual or group associated with BT manufacturers), 30% discuss implications of the research, and 20% mentioned limitations of the research (all but one were associated with manufacturers of the games, e.g., “the study was limited to the computerized world,” or “the people who participated in the British study were under 60, probably in fine cognitive shape, barring illness. Also the “dosage” was small”). Nine percent had game manufacturers saying they did not claim their games were based on evidence (e.g., “Nintendo does not make any claims that Brain Training or More Brain Training are scientifically proven to improve cognitive function”), and others claimed there was research that shows BT works (e.g., “We’ve done a few systematic reviews or formal analysis of the results from a number of different trials and those results indicate that brain training in that context [with older adults at risk for dementia] can be effective”), 6% said it was the “best study to date,” that the “study puts the burden of proof now on game manufacturers to show they really
offer meaningful benefits,” and a few said there was a lack of evidence in support of the games (e.g., “there is precious little evidence to suggest the skills used in these games transfer to the real world”), and were surprised by the results as they run counter to the “learning-to-learn concept.” Other reactions were that “brain scientists and brain-game experts don’t all agree on the findings,” that “brain games might be useful, but only if they weren’t fun,” the games “do not make users any smarter,” and that “it’s simply poor scientific reasoning to draw the conclusion that since these particular games didn’t work in this experiment, brain training doesn’t work” (each mentioned in one story).

PVS

Of the 90 PVS stories 41% reported on a reaction from someone outside the research. Of these, 18% said the research raised important questions (e.g., “raised a host of ethical and practical questions,” or “will lead to a new class of very thorny questions”; 88% of these questions were in regards to the right to live/die issue), 10% said that it was too early for the fMRI to be considered as evidence of awareness or useful for communication (e.g., “Currently, fMRI techniques are not sufficiently developed to form part of the standards assessment battery,” or “while this scientific development might hold some promising benefits in the future, at present, it is a speculative conclusion at best”), and 6% mentioned limitations of the research (e.g., “he cautioned against assuming too much about the patient’s level of awareness, given the small sample Dr. Owen has studied and the limitations of his methods,” or “activity was detected in a small number of patients in the study, only in some patients whose brain injuries were from trauma, and none who had suffered strokes or oxygen deprivation”).
A Chi-Square test was used to analyze whether the proportion of articles with a reaction discussing limitations of the research was different with respect to whether or not the story was reporting on the PVS or BT research, and these were significantly related: $\chi^2 (1, n = 124) = 6.38, p < .01$. The results indicated a significantly greater occurrence of a reaction discussing limitations of the research for BT stories (2, higher than expected) than PVS stories.

Eight percent of the PVS stories reported that the findings would have “a profound impact across medicine,” and “broad implications,” and suggested the technique be added to traditional methods of diagnosing consciousness disorders (e.g., “suggested that functional MRI be added to traditional methods of diagnosing patients,” or “potentially adds to the clinical exam we currently use,” and said that the finding “changes our understanding” of the condition”), 6% discussed how awful it would be to be in that situation (e.g., “difficult to imagine a worse experience,” or “knowing that someone could persist in a state like this and not show evidence of the fact that they can answer yes/no questions should be extremely disturbing to our clinical practice”), and that more technical development would lead to the ability to identify patients trapped in an unresponsive body and communicate with them (e.g., “Obviously, more technical development is required, but we now have the distinct possibility that, in the future, thanks to Owen and colleagues’ work we will be able to detect cases of other patients who are conscious, and what’s more, we will be able to communicate with them”). Other reactions included that “the research does not indicate that many patients in vegetative states are necessarily aware or have any hope of recovery” (1 story), that “So far, only an fMRI machine can offer any certainty” in identifying these patients and that fMRI was
impractical as a diagnostic tool or communication method “a single machine costs €4
million ($5.5 million) and weighs five tons” (1 story).

A Chi-Square test was used to analyze whether the proportion of articles with
reactions was different with respect to whether or not the story was reporting on the PVS
or BT research. The analysis indicated that there was no difference in the proportion of
articles with reactions between the two cases $\chi^2 (1, n = 124) = .09, ns.$

Quotes.

Earlier analysis revealed that the presence of a quote resulted in higher ISQ scores
for PVS stories, indicating more accuracy in stories containing a quote. Here, quotes were
examined as content. The presence of a quote for each case was considered along with
what those quotes were.

BT

Of the 34 BT stories 94.1% contained a quote. Of these, 56% contained a quote
from someone other than the researchers (these findings are encapsulated in the reaction
category) and 91% contained a quote from one or more of the researchers in the study.
The majority of the quotes by the researchers (50%) were discussing the methods or
findings of the study (e.g., “participants did get better at the games they practiced”), and
12% of the quotes were that “Brain training is a multi-million-pound industry.” The
remainder of quotes by the researchers were regarding implications of the research (e.g.,
“If you’re doing the games with the hope of getting some kind of general cognitive
improvement, the evidence suggests you’re wasting your time,” or “it doesn’t make you
any smarter overall,” or “there may be other things people could do with their time that
“might be cheaper and more fun”). An exception was one quote that mentioned that the
research study was “one of the largest public health experiences ever going on in society, because millions of people are using these games.”

*PVS*

In the PVS stories 87.7% contained a quote. Forty-seven percent contained a quote from someone other than the researcher (these findings are encapsulated in the reaction category), and 79% contained a quote from one of the researchers in the study.

A *Chi*-Square test was used to analyze whether the proportion of articles with a quote from one of the researchers was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the proportion of articles with a quote from one of the researchers between the two cases $\chi^2 (1, n = 124) = 1.97, ns$.

A *Chi*-Square test was used to analyze whether the proportion of articles with a quote from someone other than the researchers was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the proportion of articles with a quote from someone other than the researchers between the two cases $\chi^2 (1, n = 124) = .84, ns$.

Only 10% of the quotes from the researchers found in the PVS stories were in relation to the methods or findings of the study (e.g., “He was able to correctly answer the questions that were asked by simply changing his thoughts, which we then decoded using our fMRI technique”). The most frequently occurring quotes (22%) focused on the one patient able to respond to yes/no questions – “not only did these scans tell us that the patient was not in a vegetative state but, more importantly, for the first time in five years it provided the patient with a way of communicating his thoughts to the outside world,”
and the potential of the technique to allow patients to communicate and control their environment (19%, e.g., “in future we hope to develop this technique to allow some patients to express their feelings and thought, control their environment and increase their quality of life”). Some quotes were regarding the Scott Routley (13%), and EEG study (13%) findings (e.g., “Scott has been able to show he has a conscious thinking mind”); 12% of the quotes were regarding the researcher’s confidence that the findings meant the patients were aware (e.g., “so, when it happens – and we are very extremely careful because it is clinically very important – but when we see it, we are prepared to put our money where our mouths are and say, yes, these patients are conscious and they are communicating”), and that this was possible despite diagnosis (e.g., “it was possible to detect that these patients were actually aware despite being diagnosed as “entirely unconscious” using standard clinical assessments”). Eight percent contained quotes by researchers regarding the right to live/die issue (e.g., “Obviously this fits into the issue of when patients should be allowed to die,” or “An obvious question you might ask is whether you want to be kept alive”) (71% of these quotes also included discussion of whether or not these patient have the cognitive ability to answer such question, e.g., “just because they can answer a yes/no question does not mean they have the capacity to make complex decisions”).

A Chi-Square test was used to analyze whether the proportion of articles with quotes was different with respect to whether or not the story was reporting on the PVS or BT research. The analysis indicated that there was no difference in the proportion of articles with quotes between the two cases $\chi^2 (1, n = 124) = 1.06, ns$.

4.5.3 Word Usage
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This section describes the word usage contained in the stories. Table 2 presents the overall percentages of stories containing jargon, hyperbole, emotional words, and exaggerations, metaphors and vivid descriptions. Following the table is a more detailed description of the content found in these categories.

BT

Eighty-two percent of the 34 BT stories contained jargon (defined as professional specific terms that may or may not be understood by others outside the profession, and that have a specific definition for the term when it is used in the professional context). The majority of jargon found in the BT stories were research study terms (62%), for example stories included terms like “randomized,” and “control group.” Only 28% of the jargon found in the BT stories was defined, and of the terms defined only 2% of these were the research terms.

PVS

One hundred percent of the PVS stories contained jargon. The majority of jargon found in the PVS stories were terms used for disorders of consciousness (41%), for example “persistent vegetative state,” “minimally conscious state.” Fifty-five percent of the jargon found in the PVS stories was defined, and of the terms defined 51% were the terms used for disorders of consciousness. However the quality of the definitions for disorders of consciousness ranged from good to poor. Examples of poor definitions for PVS were “vegetative, meaning no awareness,” and “unable to move a muscle,” and “people who inhabit the twilight zone between consciousness and unconsciousness.” Examples of good definitions were “diagnosis that someone is in a vegetative state is a difficult one, and is based on how patients respond to sounds, touch and other stimuli,”
EXPLORING ACCURACY IN JOURNALISM STORIES

Table 2
Percent of stories, by research type, word usage

<table>
<thead>
<tr>
<th>Content reported</th>
<th>BT</th>
<th>PVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jargon</td>
<td>82%</td>
<td>100%</td>
</tr>
<tr>
<td>Hyperbole, emotional words &amp; exaggerations</td>
<td>79%</td>
<td>93%</td>
</tr>
<tr>
<td>Metaphor &amp; vivid description</td>
<td>94%</td>
<td>82%</td>
</tr>
</tbody>
</table>

“patients go through the cycles of sleeping and ‘waking.’ Often, they can open their eyes, swallow and even grunt or move limbs. But usually they do not respond in any organized way to the presence of other doctors, nor to questions or commands,” and “awake, with eyes open at least part of the time, but not ‘aware’ of their environment or responsive to most stimuli. If they stay that way for weeks, their state is considered ‘persistent,’ more than a year ‘permanent’...” Some of the definitions were incorrect in saying PVS patients cannot move at all “they are mute and immobile...” Some used the different diagnostic terms for disorders of consciousness interchangeably such as using “coma” and “persistent vegetative state” when discussing PVS patients, or used multiple diagnostic terms without differentiating between the terms and/or only defining one or two of them. Some defined what the fMRI machine measures, e.g., “measures the real time activity of the brain by tracking the flow of oxygen rich blood.”

Hyperbole/emotional words.

The PVS stories contained more hyperbole (a figure of speech in which exaggeration is used for emphasis or effect) and emotional words (words expressing emotion e.g., fear, sadness, elation) than the BT stories.

BT
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Seventy-nine percent of the BT stories contained hyperbole (excessively strong statements or exaggerations, i.e., hugely popular, no doubt surprise millions) and/or emotional words (words expressing an emotion, i.e., terrified). The majority of these were statements regarding the popularity of the brain games “hugely popular,” “all the rage” (21%), 18% contained statements regarding the surprising nature of the findings “will no doubt surprise millions of people worldwide,” “astonishing results,” 14% contained negative affect statements “seniors who are terrified of losing their minds,” “the ravages of Alzheimer’s disease.” Nine percent stated that brain games had “failed their first big test,” and only 6% stated that the research was “groundbreaking.”

PVS

Ninety-three percent of the PVS stories contained hyperbole and emotional words. The majority of these were regarding the importance of the findings “fundamental questions,” “huge implications” (52%), 44% were regarding the remarkable nature of the findings, “at the forefront,” “remarkably,” 43% stated the research as “groundbreaking” or “pioneering,” and 42% indicated the surprising nature of the findings, e.g., “startling results,” “astounded doctors.” Thirty-seven percent contained negative affect statements “extremely disturbing,” “ultimate horror”; 34% described the PVS patients as “buried alive,” “lost-souls” or “trapped,” and 15% used the word “victim.” Thirteen percent used statements such as “read the minds” and “read thoughts,” and 9% used statements implying the patients who were able to show brain activity were “entirely conscious” or “perfectly consciously aware.”

Metaphor/vivid description.
There were more BT stories with metaphors (figure of speech where a word or phrase meaning one thing is used to mean another, e.g., brain workout) and vivid descriptions (detailed description which allows the reader to create a detailed image in their mind) than PVS stories.

**BT**

Ninety-four percent of the BT stories contained metaphors or vivid descriptions. The majority of the metaphors were the fitness analogy of the brain as a muscle and it needing exercise (commonly used by the manufacturers of the BT) (53%), e.g., “exercise the brain,” “exercise the mental muscles”; 32% were regarding boosting the brain, e.g., “boost their IQ,” “boost your ability,” and 32% were the common metaphor used to describe activity on the internet, e.g., “surfed the net,” “surfing the internet.” Twenty-one percent of the stories described brain usage, ability, or activity as “power,” 21% used the metaphor “tap into,” and 12% used the term “use it or lose it.”

**PVS**

Eighty-two percent of the PVS stories used metaphors or vivid descriptions. The main metaphor used was likening consciousness and communication to alternate worlds or closed off spaces (49%), e.g., “communicate with the outside world,” “no awareness of himself or the outside world,” “interact with their world,” “opened the door,” or “provided a window,” and 9% likened the ability of the patient to visualize as some kind of a magic trick, e.g., “conjuring up imaginary scenes in his head.”

4.5.4 Additional Observations

The PVS research is discussed as a form of treatment in 11% of the stories (e.g., “he might qualify for new treatments by celebrated brain researcher Adrian Owen”); two
stories point out that this is not a treatment but a research study, and “important that news reports be clear about the distinction between diagnosis, prediction of outcome and therapy, and avoid fueling false hopes”), one is discussing the news stories making this mistake and the other is a court case where the judge points out that this technology is still in research. In 8% of the PVS stories the fact that patient families always knew their loved ones were aware is discussed (e.g., “it confirms what the family has always known,” or “his family have always maintained that there was more going on with Scott”). Two (6%) of the BT stories provide a declaration or disclaimer (e.g., “this material is designed for general educational purposes only”). Finally, more BT stories directly address the audience (e.g., use the word “I” or “We (not in reference to the researchers talking about themselves)” or “your”) 62% compared to 42% of the PVS stories “the very thought that you could be...”

4.6 Readability Tests

Readability tests were performed using the Readability Test Tool (http://www.readable.com/) on 14 (purposefully selected to get a range of stories with varying word lengths) of the journalism stories (7 BT, 7 PVS) to get an idea of the readability level of both types of stories. The results indicated that the BT stories had an average grade level of about 11 while the PVS stories had an average grade level of about 15.
CHAPTER 5

Discussion

The present study was a novel, multi-method analysis of the print and electronic media reporting on two high-impact neuroscience research studies. A number of interesting findings emerged with potential implications for researchers publishing results, and journalists and others reporting on them. This chapter will first discuss the initial statistical analyses and content analysis results followed by a synthesis of these findings and their implications, then end with limitations and potential future research.

5.1 Quantitative Analysis

5.1.1 Comparison of cases (media saturation, time, and word length)

*PVS more newsworthy.* PVS research was discussed in more journalism stories than BT research in this study. However the BT research had a significantly greater proportion of stories with a larger percentage of the story covering the original research than the PVS stories – i.e., more of the individual stories on BT were actually about the research article. Finally, more of the BT stories were published within the first week, but there was no difference between the two types of research and the average amount of words in the story.

At first glance, one might prematurely conclude that the greater amount of media attention on the PVS research was because the PVS research was more applicable to the general population than the BT research. However this explanation seems unlikely because the BT research, which is about improvement in cognitive function for, theoretically, anyone aged 18-60, using relatively accessible tools (brain games), is, on its face, more applicable to a much larger percent of the population. In contrast, the PVS
research only has direct application to a tiny fraction of the general population, and only, according to the findings, a very small proportion of PVS patients themselves. Therefore, it is reasonable to assume that something other than “applicability” led to the greater ‘newsworthiness’ of the PVS research.

Previous studies have shown that newsworthiness of health and medical research is based on factors such as whether the research is in a prestigious scientific journal, a similar story has been published by other major or rival newspapers, or there has been a press release (prestigious scientific journal press releases are more favoured). Other factors include whether the topic covers a common fatal disease, a current subject of local interest, a rare but interesting, ‘quirky’, disease, a disease with a sexual connection, new or improved treatment(s), high technology medicine, or controversial subject matter or results (De Semir, 1996; Entwistle, 1995; Stryker, 2002). Both the PVS and BT research studies in the current analysis fit this model of newsworthiness in that they both were published in prestigious journals that are often consulted by journalists, the PVS research assessed new medical technologies (i.e., a new use for a technology), and the BT research presented controversial (in that it was opposite to what manufacturers were claiming), or at least unexpected, results. Based on previous findings suggesting controversy is over-reported in journalism, the BT research should have received more news attention (McComas & Simone, 2003). This was not the case. Again, this suggests that something else about the PVS research led to it receiving a greater amount of media coverage over a longer period of time.

The BT stories had a significantly larger percentage of the story devoted to discussing the research than did the PVS stories. One potential explanation is that
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publication of additional, *new* research studies related to the PVS research, might have led to a brief reiteration of the original study in journalism stories reporting on the *new* research (i.e., Monti, *et al.*, 2010; Owen *et al.*, 2010). However, both BT and PVS had only one new research study (Cruse, *et al.*, 2011b; Hampshire, *et al.*, 2012) published in relation to the original findings throughout the sampled time-period. Furthermore, the PVS research received more attention (had a greater number of journalism stories mentioning the original research) after the *new* research than did the BT research.

Three other points highlight the media’s greater attention to the PVS research. First, PVS research was mentioned in stories discussing the research team’s move from the UK to Canada, news that pertained to both BT and PVS research, yet only the PVS research was discussed in these news items. Second, the novel case of patient Scott Routley communicating he was not in pain via the same fMRI visualization technique covered in the paper “The Mind Reader” (in *Nature*, June, 2012) and the airing of the British Broadcasting Corporation’s (BBC) documentary “The Mind Reader” (November, 2012), also led to further print media stories discussing the original PVS research. Third, although the BT research was done in collaboration with the BBC, one of the largest and most respected journalism organizations in the world (Crissel, 2002), the PVS research was still mentioned in more journalism stories. Thus, although the BT stories on average had a significantly larger proportion of the story devoted to the original research, the PVS research remained more newsworthy.

There was no difference between the two cases in mean word length of the stories. This finding demonstrates that both stories on BT and PVS research were on average the same length and of typical journalism story word length.
5.1.2 Comparison of accuracy

Accuracy of the stories was compared to determine whether or not the type of research (BT or PVS), time of story publication and/or the presence of a quote was associated with accuracy scores. Whether or not the research was BT or PVS, time of story publication, and the presence of a quote all were associated with accuracy scores.

What the Index of Scientific Quality (ISQ) calls “quality,” is actually a measure of the fidelity of the story to the original research article, since an evaluation of overall “story quality” would include a broader range of factors, including how well the story was written, how accessible it was for readers, and what other facts and points were included, beyond the actual research study. Thus while this section discusses “quality/accuracy” according to ISQ, a discussion of broader quality issues is left to a later section in this chapter, when results of the content analysis are also included.

*Case, time, and use of quote are related to story accuracy.* The PVS stories were more often rated as less accurate than the BT stories. Publication of the story closer in time to the original research article publication, and the presence of a quote, were related to higher ISQ scores but only in the PVS case. This finding is similar to previous research which has shown low accuracy in journalism stories reporting on health and medical research (Cassels, et al., 2003; Cassels & Lexchin, 2008; Evensen & Clarke, 2012; Wilson, et al., 2009). However the difference between the BT and PVS stories suggests that something about the PVS stories led to even lower accuracy scores than the BT stories. The finding that more of the story was discussing the original research in the BT stories may be one driving factor for this result. For example, a sub-analysis of the ISQ scores for those stories with 100% coverage of the research found no significant
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difference on ISQ between the BT and PVS stories. However, the mean ISQ scores for
BT stories were still higher than the ISQ scores for PVS.

The presence of a quote was associated with a better ISQ score, especially when
the quote was discussing the research, but this was only found in the PVS case. It could
be that journalists who include quotes or undertake interviews, above and beyond
reviewing the research article, have had more time or a chance to clear up any confusions
or misunderstandings and therefore are able to simply write more accurate stories
regarding research findings. However, this does not seem to be the case considering that
the BT stories were more accurate and this accuracy was not related to the presence of a
quote. A quote can be from text, interviews, or press releases, thus it may be possible that
the PVS research was more complex than the BT research and therefore required a
review of the original research article, attendance at a press conference, or an interview
with one of the researchers in order to clarify the research and its implications and/or
offer a more balanced representation of the research by providing alternative viewpoints.

As the length of time increased between the publication of the original research
findings and the publication of the journalism stories, the accuracy of the journalism
stories decreased, but again this was only significant with respect to the PVS case. A
potential explanation for this finding is that journalists may rely on previous news stories
and misinterpretation may result from second or third party explanations, new related
research may influence interpretations of the original research, and/or may lead to less
discussion of the original research. However this does not seem to be the case because the
BT case did not show a similar decrease in accuracy. Furthermore, the argument that as
time passes new studies, similar to research reported on previously, could lead to more
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accurate stories by providing further contradictory or confirmatory support for the findings, was not supported by this thesis.

5.1.3 Additional analysis

A bi-modal distribution of story publication occurred; a large number of stories were published within a few days from publication of the original research, and a second increase in publication of stories occurred 2 years later. This discovery prompted an investigation to see whether the difference in ISQ scores for the PVS and BT stories was related to the time the stories were published. The analysis revealed that time of publication was not significantly related to the difference in ISQ scores. However, Figure 7 indicates that the PVS stories do show a steeper drop in ISQ scores from time 1 to time 2 when compared to the BT stories. It may be that as time passes less information regarding the original research is available to the journalist. Consistent with this argument is that the scientific journal’s public relations department is more actively involved in supporting the journalists, to report on the research during the days up to, and shortly following, publication of the research in the journal (De Semir, 1996; Entwistle, 1995).

Based on the above accuracy analyses, PVS stories were more often rated less accurate according to the ISQ, the presence of a quote in PVS stories was associated with higher ISQ scores, and the longer the time between publication of the original research article and release of the journalism story, the poorer the accuracy for PVS stories. Less accuracy in the PVS stories could have been the result of these stories being distributed throughout the time period and a smaller proportion of the story discussing the
research. However a more in-depth look at the content of the stories, as follows, indicates that these ratings may have more to do with what is being reported on in the story.

5.2 Content Analysis

5.2.1 What from the original research was included/excluded and what was added?

Content analysis was conducted on both the original research articles and the journalism stories to determine the extent to which the research article contents were discussed in the stories. The content was sorted into categories based on the six basic questions journalism stories answer for their audiences in order to provide full information on a subject, also known as the 5Ws and H (who, what, why, where, when and how). Other categories explored in depth included implications of the research, quotes, and reactions. These categories demonstrated that although the stories each touched on the main journalistic elements of 5Ws and H, these were reported in different ways based on whether the research was BT or PVS. Likewise, although both BT and PVS discussed implications of the research that were not included in the original article, the PVS stories made broader generalizations to larger ethical and social issues.

5Ws and H, implications, reactions and quotes, similar yet different. Significantly more BT stories included the Why element. Although there was no difference between the two types of research in the number of stories discussing Who, What, When, Where, and How, all of these categories contained different information, except Where. The BT stories were presented in a way that is more congruent with the way researchers present their work in scientific journals, and more congruent with how quality/accuracy is assessed in research, and with how the ISQ is scored, which may also account for some of the discrepancies noted in the previous section.
A larger portion of BT stories reported on Why the research was done, perhaps because Why the BT study was done was an important aspect of the study (brain games are expensive and popular, but there is a lack of sufficient evidence to support their use). However, the misdiagnosis of disorders of consciousness is equally important to the PVS study. Another explanation might be that the BT argument for Why the research was done was more applicable to the general public (the audience of the stories).

The sample (Who) used in the research study was described in both PVS and BT stories, but there were differences in how this information was presented. For example, fewer PVS stories gave the sample size than did BT stories, and PVS stories focused on the attributes of one or two patients compared to BT stories. In fact, the BT stories often described the sample as a whole and further emphasized the large sample size of the BT study. In quantitative research, a large sample is privileged as it is said to increase the power and generalizability of the study’s findings. Interestingly, this may have been mentioned less often in the PVS stories, or left out altogether, in order to minimize the study’s small sample size as a potential flaw of the research. This potential explanation seems likely considering the PVS stories that included sample size often only reported the vegetative state patients, and not the entire sample. Previous studies indicate that journalists do consider the size of the population to be important and are to some extent more wary of small samples (Entwistle, 1995). The PVS stories also emphasized the human element, a common journalistic practice, describing a particular patient case to make the story interesting and personal, while only a few of the BT stories did this (see Table 1) (Amend & Secko, 2012). An important issue to touch on here is that often journalists consider these peer-reviewed scientific journals to contain stories that have
undergone rigorous quality checks from other researchers (i.e., peer review) and the
journal, thus because the PVS study was published in the *New England Journal of
Medicine* further validity tests may not have been deemed necessary. Likewise, while the
Who as a sample may not be as important as the findings, it is necessary if the intent for
the reader is to use such information to make informed health care decisions (e.g., is this
research sufficiently reliable and generalizable, and does it apply to me?).

Both BT and PVS stories included the results of the study (What), yet they were
presented in different ways. The BT stories were more consistent with how research is
reported in scientific journals (e.g., describing comparisons between groups, describing
the results in terms of the outcome measure used), albeit in a more general and less
formal way (e.g., without the statistics). For example, the BT stories presented the main
findings as the participants improving on the tasks they were trained in but that this
improvement did not transfer to other tasks, or as a comparison across groups on the
outcome measure. By comparison, the majority of PVS stories reported simply that a
PVS patient was able to communicate, and how particular areas of his brain “lit up” in
response to questions (e.g., not the specific outcome measure or comparisons across
groups).

Only half of the journalism stories reported the actual proportion of the sample
able to perform the visualization task and a small proportion reported that the researchers
simply ‘found awareness’ in these patients. While the communication finding (the patient
was able to answer yes/no autobiographical questions through visualization) was the most
discussed, this procedure had the smallest sample of both procedures in the study (1 of 54
patients diagnosed with a disorder of consciousness, or 1 out of 5 that showed awareness
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from 54). The frequent mention of the communication finding suggests that there was something about this finding that led to it being mentioned more often.

Due to the complexity of fMRI measures it may seem reasonable and even practical to describe the PVS findings in terms of brain areas that “lit up,” however, presenting the findings in this way could potentially lead to a simplistic understanding of a process that is very complex. As a result, the public may be led to believe that the results are relatively simple and thus more accurate or conclusive than they actually are. This argument has been presented in other research looking at how fMRI findings are presented in news media (Racine, et al., 2005; Racine, et al., 2006). For example, Racine and colleagues (2005) found that only one third of stories reporting on fMRI research present an explanation of what the fMRI actually measures, potentially leading to a simplistic understanding of the process and findings.

Finally, only two PVS stories discussed the finding that all of the patients who were able to show awareness were patients with a Traumatic Brain Injury (TBI) and only one of these stories gave an explanation as to why TBI PVS patients were able to show awareness. The discovery that only patients with TBI were able to demonstrate awareness using this method is important because it decreases the study’s applicability from a very small original population of a subset of PVS patients, to something even smaller (PVS patients with TBI). While it may be possible that the journalists did not pick up on this information in the research article (or press release, if it was mentioned there), the question remains as to why such relevant and important information was left out. It could be that by providing this information the journalist may down-play the research and therefore degrade the importance of the story and the likelihood that the story will be
picked-up by the editor. Again, it appears that the population size was emphasized less in PVS stories.

Both types of stories contained errors in their explanation of the results. For example, in the BT stories the journalists reported significance when the researchers used effect size and in the PVS stories a few said that all the patients underwent the communication experiment. However, consistent with other research investigating the accuracy of health and medical reporting, outright errors were only found in a small percentage of stories (Bubela & Caulfield, 2004; Canales, Breslau, Nelson & Ballard-Barbash, 2008). Therefore, it is less a matter of outright errors as it is potential miscommunication and misrepresentation.

Both BT and PVS stories included information on the methods of the study (How). These ranged from brief/general descriptions, i.e., “patient’s brains were scanned,” to detailed descriptions of the cognitive skills being targeted, or what the visualization task entailed. In the BT stories there was more explanation of what skills were being measured and trained, and what the control group did. Most PVS stories mentioned the device used (fMRI), with only a small percentage describing what it measures. A large number of PVS stories described the visualization task (what the two different types of visualizations were and sometimes what brain areas they were expected to activate). Over half of both PVS and BT stories reported When the research took place. In summary, both PVS and BG stories presented answers to the main journalistic questions of the 5Ws and H, yet they presented them in different ways depending on what research they were reporting on (PVS or BT).
Researchers are required to make inferences about what the research means and future directions that it may take, but these implications must remain logically within the boundaries of what was found in the study being presented. Both types of journalism stories discussed implications of the research raised by the researchers in the original research article, however there were also instances where implications above and beyond the research were found in the journalism stories. Of the implications added in PVS stories, over half included the right to live/die issue (the legal and ethical issue of removal or continuation of life sustaining treatment (respirators, feeding tubes, etc.)). The decision to continue or terminate life sustaining treatment may be made by a family member, someone with power of attorney, or a health care provider. Often various people involved in the patient’s care disagree regarding whether or not life sustaining treatment should be removed or continued and conflict may occur (i.e., case of Terry Schiavo in 1998 and Hassan Rasouli in 2013). Likewise, there are people who are very ill and wish to die who cannot do it themselves and thus seek assisted suicide, which was also a right to live/die issue found in the PVS stories.

Discussing the larger ethical/social issue is not a problem in itself, but discussing the research findings as a solution to this issue without a critical consideration of its applicability and the early stage of the research, is problematic. A frequent message in the PVS stories was, to paraphrase, ‘now that we can communicate with these patients, sometime in the near or far future we will be able to ask them if they want to live or die’. Other messages included: ‘now that we know these patients are aware, it would be wrong to remove life support’, or ‘we cannot be sure that these patients are not aware in some way, so we should continue life sustaining treatment’. Equating the right to live/die issue
to these research findings could lead readers of the stories to erroneously conclude that these patients are cognitively capable of answering such questions or that these findings are conclusive and apply to all PVS patients. Based on the frequency of this message, it is likely that the fundamental issues of what constitutes life/death, and who decides this, made these stories more newsworthy; these issues were discussed in 57% of the stories but were not included in implications discussed in the original research article.

Another interesting finding was that examination of the story’s main theme (legal case, Research of Interest (ROI), EEG research, technology/ethics, move to Canada) in conjunction with the right to live/die issue, revealed the presence of the right to live/die issue in all of the stories regarding legal cases, in 60% of stories specifically discussing the original PVS research, EEG research, and technology/ethics, in 25% of stories discussing Scott Routley and/or the documentary, and least of all (12%) in stories discussing the research team’s move to Canada. It seems understandable that the legal cases were discussing the issue as the stories pertained directly to fights over the removal of life support for PVS patients (however it remains interesting that this research is referred to while it is still in its infancy). However, when the ROI is the main theme, the issue is brought up well over half the time, and to the same degree with the technology/ethics theme. Only 25% of the stories on Scott Routley contained the right to live/die issue. This is interesting given that Scott was asked a clinically important question of whether or not he was in pain and the researchers deciphered his answer as being “no, he was not in pain” through the fMRI visualization technique. It is possible that the finding that he was able to answer the yes/no question of “are you in pain?” made the question of whether he wants to live or die less relevant. It may also be possible that
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the question of whether or not he was in pain and his ability to answer it via brain imaging techniques was sufficiently interesting/newsworthy on its own.

In some of the stories the right to live/die issue was presented in a balanced/critical way (the stories provided a critical look at whether or not this research could apply to the right to live/die issue); for example, a balanced story mentioned that it would be difficult to know if these people have the cognitive facilities to make these decisions, or that yes/no questioning could not provide a deep enough method of communication. It is possible that when journalists discuss the right to live/die issue with the researchers the interpretation of the issue is more balanced, however, presence of a quote did not necessarily lead to more balanced writing on the issue. Previous studies have also found an unbalanced presentation of health and medical research in print journalism (Bubela & Caulfield, 2004; Canales, et al., 2008; Racine, et al., 2005).

The high cost and difficulties in using fMRI to assess awareness in PVS patients did not really gain attention until the later EEG research. The EEG research (Cruse, et al., 2011b) suggested a potentially cheaper, more portable device to identify and communicate with patients misdiagnosed as being in a PVS. It is possible that this relevant information regarding costs was left out in order to make the story more positive, or alternatively that the cost of the machine was unknown until the researchers mentioned it as the rationale for the EEG research. This finding is also consistent with previous research indicating that print journalism tends to present a more optimistic view of research findings by discussing the benefits and leaving out information on the risks, costs, or limitations of the research (Bubela & Caulfield, 2004; Canales, et al., 2008; Racine, et al., 2005).
Contrary to the PVS stories, more reactions from individuals outside the original research were about study limitations in the BT stories. The main reaction for PVS stories was that the research raises important legal and ethical issues (i.e., 88% discussed the right to live/die issue). On the other hand, reporting of the BT research focused on the fact that the findings were in direct conflict with the claims from companies that sell brain games. Since conflict such as this is often newsworthy, and individuals associated with brain games would be motivated to respond to research that challenges their claims, this might help explain the greater inclusion of limitations of the research in BT stories. Likewise, the BT study was set up to test the claims made by the manufacturers of the games and majority of the quoted individuals who discussed the limitations of the BT research in these stories were associated with the brain game industry. Nevertheless, this finding coincides with the idea that the BT stories were more consistent with scientific journal publications in their presentation. Researchers are often required to discuss the limitations of their research when considering their findings.

In only one PVS story there was a reaction that the results do not necessarily mean that many people are aware or have any hope of recovery and two of the stories described the fMRI as the gold standard or the only test that can offer certainty of diagnosis. Change in diagnosis of a patient from a vegetative state to a minimally conscious state does not mean that the patient will recover or is aware and able to make conscious decisions. Likewise, the term ‘gold standard’ has a specific meaning in medicine, “the standard test to which all else is judged” (Claassen, 2005). By describing this technique as the ‘gold standard’ the journalists are saying that it is the best possible test for diagnosis of disorders of consciousness. However, the technique is still
considered in the research phase and has not yet been incorporated into clinical practice, let alone considered the standard to which all other diagnostic tests for disorders of consciousness are compared. These examples demonstrate how the PVS stories were often misleading.

Half of the quotes made by the researchers (50%) in the BT stories were in regards to the methods or findings of the study, compared to only 10% of quotes in the PVS stories. The remaining quotes in the BT stories were mainly about the implications of the findings, such as wasting time and money. For the PVS stories, the majority of the quotes from the researchers were also regarding the implications. What is interesting to note is that some of the quotes by the researchers discussed the right to live/die issue and a large percentage of these quotes also included discussion of whether or not these patients have the cognitive capacity or ability to answer such questions. It is possible that when the researchers are discussing this issue they can present a more balanced/critical interpretation and ensure the findings are kept in context. However, as mentioned earlier, the presence of a quote in the story from one of the researchers did not always mean a balanced/critical discussion and a balanced/critical discussion was also observed when a quote from one of the researchers was absent.

A possible explanation for the poorer ISQ scores for the PVS stories is that the larger life/death issue was detracting from a more comprehensive discussion of the details of research itself, and a potential discussion of limitations, or that the whole research discussion was framed in a different way due to the larger life/death issues. The BT research appears to be framed in a more critical or balanced way compared to the PVS research. The differences found in the reporting of the answers to the 5W and H
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questions, implications, reactions and quotes for the two different types of research adds further support for this explanation. Other categories in the content analysis suggested a similar pattern and style. For example, BT stories often included discussion on issues of the study’s validity and strength, and mentioned the broad context (where this study fit in the larger research area) of the research nearly twice as often as the PVS research.

5.2.2 Jargon, hyperbole, emotional language, metaphor, and vivid description.

Similar word styles, different emphasis. Different types of language and word use were observed in the PVS and BT stories. Of note is the use of research terms in the BT stories versus clinical terms in the PVS stories, the accuracy of definitions for disorders of consciousness, the use of affective words in PVS stories, the emphasis on the groundbreaking nature of the PVS research, the greater use of metaphor in BT stories, and the types of metaphor used in the PVS stories.

BT stories contained more jargon than PVS stories, but the jargon in BT stories was research related, while the jargon in the PVS stories was more clinical. For example, the BT stories used terms like “randomization,” “experimental,” and “control” whereas the PVS stories used clinical terms such as “persistent vegetative state,” “fMRI”, and “parahippocampal gyrus.” The more frequent use of research terms in BT stories is consistent with the idea that BT stories were presented in a way similar to how research findings are presented in scientific journals. The clinical terms used in the PVS stories indicate that the PVS stories had more of a clinical focus. This is likely due to the journal the PVS research was published in, “The New England Journal of Medicine,” which is directed toward health care professionals and due to the research being based on a clinical population.
Only a small percentage of the jargon was defined in BT stories. Although over half of the PVS stories included definitions, the definitions varied in clarity and accuracy. It is understandable that the terms used to diagnose disorders of consciousness are difficult to define, especially when clinicians might have difficulty diagnosing these disorders with certainty (Monti, et al., 2010b), yet it is important that these terms are defined appropriately and accurately so as to not be misleading to the reader. Furthermore, multiple types of disorders of consciousness were often discussed with only one or two of them actually being defined, and some stories did not differentiate between the different types, such as coma and PVS, adding to the ambiguity and potentially misleading the reader.

Both PVS and BT stories contained hyperbole and emotional language. The majority of this type of language use in BT stories was regarding the brain games themselves and the surprising nature of the findings. More PVS stories than BT stories described the research as groundbreaking or pioneering. A large percent of the stories used hyperbole and negative affect words or phrases - like “buried alive,” “lost souls” and “trapped” - to describe the PVS patients and/or their situation. The remainder were comments of being able to “read minds” and over-exaggerations of the cognitive state of the PVS patients who showed awareness (“perfectly consciously aware”). The use of hyperbole and emotional language (i.e., “perfectly consciously aware”) could lead to misunderstandings in matters such as the certainty of the findings or abilities of these patients.

Both BT and PVS stories contained metaphors and vivid description. However, the majority of the metaphors used in the BT stories were in relation to the fitness
analogy commonly used by brain game manufacturers to market their product. The PVS stories, however, contained mostly metaphors of alternate realities or separate worlds, and likened the ability of the patient to use visualization as a type of magic trick. The use of alternate realities or worlds and visualization as a type of magic suggests a mystical or surreal representation of the PVS research. The use of metaphor and vivid description are necessary to create an interesting story that people want to read, and they also the journalist with a way to describe something in a way that is accessible. However, the use of such words can also conflate the research and/or lead to misunderstandings in the applicability and certainty of the findings and what they mean. Conversely, the use of terms representing magic or other mystical forces may make individuals doubt the findings. As such, when used appropriately metaphors and vivid language can aid in understanding so long as they do not distort the message.

5.2.3 Other Observations

One very important finding was that the PVS research is discussed as a form of treatment in 11% of the stories, e.g., “he might qualify for new treatments by celebrated brain researcher Adrian Owen.” Although it was only found in a small percentage of stories, it is a major error in reporting: the idea that fMRI is a treatment can lead to false hopes or misunderstandings.

Likewise, 8% of the PVS stories discuss that the patients’ families always knew their loved ones were aware, as in “it confirms what the family has always known,” “his family have always maintained that there was more going on with Scott.” This statement could also lead to conflicts and misunderstandings. Often the family’s subjective perceptions of the condition of their loved one are not consistent with the medical
evidence. The presentation of the findings in the journalism stories as something that the patient’s family “knew all along” may turn the subjective perception into something supported by ‘evidence’, potentially leading to further conflicts with health care providers and opposing family members.

5.3 Summary

The PVS research was more newsworthy, most likely due to the over-arching, ethical life/death issue; however the related news stories were more often less accurate, as assessed by the ISQ. Both BT and PVS stories presented the 5Ws and H in different ways; the BT stories appeared to present the research in a format similar to scientific articles, i.e., in a more objective/critical way. Therefore, the presentation of the research in this way could have led to the BT having better ISQ scores than did the PVS stories. This seems especially likely considering the content measured in the ISQ (appendix B), which is very consistent with quality/accuracy considerations in research (validity, consistency, etc). Overall the BT stories were more balanced, in that they presented both sides of the argument (for and against the utility of brain games). Whereas the PVS stories appeared to present an overly optimistic picture of the findings, a more personal picture of the participants, and larger social implications of the research.

The discussion of the right to live/die issue in over half of the PVS stories and the discussion of the PVS research in stories regarding legal cases is notable as it is an extraordinary extension or over-generalization from the more direct implications of the research findings. While over-generalizations are not necessarily problematic in journalism especially if they are presented in a balanced way, if the intent of journalism in reporting on research findings is to inform the public about the research, over-
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generalizations can lead to misconceptions and misunderstandings in the general public about the findings and their applicability to these larger issues (Payne & Schulte, 2003).

Although it is not possible to know who (e.g., the researchers, journalists, editors) or what (e.g., discussion of the issue in other news, court cases, social movements) was ‘initiating’ these bigger ethical discussions regarding this research, it was possible to see that the right to live/die issue was discussed by multiple individuals represented in the stories, including the researchers themselves.

5.4 The larger picture – Journalism as a KT tool for translation of health and medical research to the general public

Researchers are increasingly required to share new knowledge with various stakeholders for a variety of reasons, from enhancing “evidence-based decision-making” to ensuring that research is impactful and accountable - i.e. that it adds value-for-money - to its sponsors (Leatherman et al., 2010; Tetroe, 2007). In the case of government funded research projects, these funders are ultimately the taxpayer. Scholarly communication has traditionally focused on publication in scientific journals and conference talks (Holmes, et al., 2012); now, however, researchers are encouraged to engage stakeholders, including the public, in the findings of their research (CIHR, 2012a) – a much broader approach to “knowledge translation”.

To be sure, a well-informed public can facilitate appropriate allocation of health care funds (i.e., better decisions about tests and treatments, and health behaviours to prevent illness), appropriate health care practices, and a democratic health care system (Brewer, 2012; Einarson et al., 2005; CBC, 2012; Freedman, 2013; Larsson, et al., 2003; McDaid, 2005; Rasminsky & terBrugge, 2013). However in order for this to occur, the
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public requires accurate, timely, accessible information that is not misleading (CBC, 2012; Einarson, et al., 2005; Rasminsky & terBrugge, 2013).

A number of studies have indicated that journalism can provide the general public with health information and furthermore, the media is often the first source of information for the general public regarding new health and medical research (Brodie, et al., 1999; Freimuth, et al., 1984; Gupta & Sinha, 2010; Nagler, et al., 2010; Schwitzer, et al., 2005). However, this study and others indicate that the media may not be the best method for translating research findings to the general public. Journalism stories may not be true to the original research and in-turn can be misleading, especially in the case of research findings where there are larger ethical and social issues involved, where it is even more necessary that accurate, non-misleading information is provided (Pollard, 2003). Given the economic pressures on media organizations and time constraints on journalists and editors (Amend & Secko, 2012; McDaid, 2005; Waddell, et al., 2005) it is unrealistic and problematic to put the onus solely on journalists to provide the public with accurate, accessible information on health and medical research findings.

Journalism in North America has become increasingly commercialized and what was once a large body of independent news sources has now been taken over by investors, with advertising as the primary source of revenue (Scott & McChesney, 2002). For example, various governments in Canada fund a portion of media outlets like the Canadian Broadcasting Corporation (CBC) (Benson & Powers, 2011; CBC annual reports, 2012), yet the number of independent Canadian media organizations dropped to 1% in 2005 (Kerr, 2012), and even public broadcasters supplement much of their revenues with advertising (Benson & Powers, 2011; CBC annual reports, 2012).
addition, advertisers are now moving from ‘old’ media (radio, newspaper, television) to ‘new’ media (internet, social media) because they see these as more beneficial to their business model (Kerr, 2012; McChesney, 2012). Less government funding coupled with a decrease in advertising revenues has put greater pressure on media organizations to find ways to attract advertiser dollars in an increasingly crowded media landscape (Kerr, 2012; McChesney, 2012).

These commercial pressures have led to changes in the purpose of journalism from information provider to entertainer, with some individuals accusing media outlets of being more interested in selling content and acquiring advertising dollars than in providing accurate, impartial information to the public (Amend & Secko, 2012; Larsson, et al., 2003; McChesney, 2013; McDaid, 2005; Waddell, et al., 2005).

Although journalists’ ultimate goal may be to inform the public, their immediate goal is to write a story that gets accepted and printed and it is here the commercial interests are increasingly coming in to play (Amend & Secko, 2012; McDaid, 2005). Furthermore, the final text of a health and medical story, including length, is often determined by an editor. The editor’s final cut may include deleting information that would enable readers to gain a better understanding of the issue (Amend & Secko, 2012). This thesis was unable to analyse how editorial processes might have influenced the accuracy or other aspects of the media stories, however this type of analysis could provide useful information about the reporting process.

Another key issue at play is journalist experience/expertise. With advertising revenues decreasing, and a downturn in the economy, employment cuts have had a negative effect on specialist areas like health and medical reporting (Kerr, 2012). These
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specialist reporters are often the first to be laid-off, leaving those with little expertise in the area to take over reporting on health and medical issues in addition to the types of stories they normally cover (Kerr, 2012; Leask, Hooker & King, 2010; Wilson, Robertson, McElduff, Jones & Henry, 2010). On top of this, these reporters are also required to post online (blogs, twitter, etc.) and create multiple versions of their stories for various media platforms (audio, video, text, etc) for little or no extra compensation (Paulussen, 2012).

All of these changes reduce the amount of time journalists actually have available to report on stories and inevitably affect story quality/accuracy (Amend & Secko, 2012; Larsson, et al., 2003; Leask, et al., 2010; Waddell, et al., 2005). For example, in Leask et al.’s (2010) study, journalists reported time pressure as a major issue in the quality of their reporting, indicating having only a short period of time from the identification of a potential story, or receiving notification that they would be covering a particular story, to the time they had to submit it. As a result journalists are often forced to rely more heavily on press releases and public relations (PR) individuals which often leads to biased, subjective and inaccurate stories (Schwartz, et al., 2012; McChesney, 2012). Familiar with the demands on journalists, PR professionals (hired by individuals and companies to present a positive image (Public Relations. 2013)), capitalize on the limited time journalists have to write stories (McChesney, 2012), neatly packaging information in a way that makes writing the story easier and faster for journalists. Currently, PR individuals outnumber journalists 6 to 1, and that number is expected to increase. Although journalists are skeptical about PR messages, they still rely on them and often
simply regurgitate the PR message without further investigation (Amend & Secko, 2012; McChesney, 2012; Weigold, 2001).

Time constraints also result in difficulty accessing high quality sources (Amend & Secko, 2012; Larsson, et al., 2003; Leask, et al., 2010; McDaid, 2005; Waddell, et al., 2005; Weigold, 2001). Sources are a primary means of providing, explaining and verifying information for journalists (Wilson, et al., 2004) and according to Amend, and Secko, (2012) “a main job component of health and science journalists is finding appropriate sources” (p. 260). In health and medical journalism, journalists must find experts in a given area who can speak in an accessible language without jargon, can add credibility to the story, and can help journalists put the research in context (Amend & Secko, 2012; Leask, et al., 2010; Waddell, et al., 2005). As mentioned earlier, increased workload and time constraints force journalists to use sources that are accessible and who can get back to them within the time they have allotted to finish the story (Amend & Secko, 2012; Leask, et al., 2010; Waddell, et al., 2005). Often the most accessible sources are those with conflicts of interests (Amend & Secko, 2012; Larsson, et al., 2003) which may in part explain why there were so many sources connected to the brain-game industry in the BT stories. Many of those with a conflict of interest are often made readily available to journalists through the PR arm of their company, or through outside PR companies working on contract. Although journalists remain skeptical of PR professionals, it is difficult for them to dismiss the accessibility of these sources.

Neither of the cases examined in the current study had direct tie-in to commercial interests (e.g., research connected with Big Pharma). In fact, the BT research could be considered as conflicting with commercial interests in that it demonstrated that there was
no effect of Brain Training and therefore contradicts what game manufacturers are claiming. It is also possible that PR professionals from the brain game industry were made readily available to the journalists which would explain why individuals connected to the brain game industry were quoted frequently. Consequently, the presentation of BT research in journalism stories was more balanced/critical, as limitations of the study were often presented. This is a potential indication of economic pressures influencing what gets presented.

Some studies have suggested that if researchers work with journalists to ensure the findings are clear and accurate, the resulting story will be more accurate (Amend & Seck, 2012; Gunter, et al., 1999; Racine, et al., 2008; Waddell, et al., 2005). While journalist involvement with the researchers does help in clarifying and understanding the study and its findings, conflicting ideals and constraints make it less likely that the resulting story will present the information in a balanced and critical way. Likewise, as mentioned earlier, accessibility of these sources is often an issue. However, in the present cases, Dr. Owen was very accessible to the media (Western University, n.d.), yet the PVS research was still inaccurate and potentially misleading.

Maximum variation sampling was used to insure research with both negative and positive findings were included. Another study using a sample of cases with only positive or negative outcomes may obtain different results. Previous research indicates that positive research findings are more likely to be reported by journalists (Koren & Klein, 1991), however further investigation by Neus (1992) demonstrated that Koren and Klein’s study had limited search results and when the search strategy was broadened; the findings were that both positive and negative research was discussed in print journalism.
Any difference in reporting would be difficult to determine, as ‘reporting bias’ (the tendency to disseminate mainly positive findings) is not only evident in journalism stories but also in the publication of scientific articles (Dickersin & Chalmers, 2010).

5.5 Limitations

One limitation of this research is the accuracy rating scale used, the ISQ. This scale was the only one found for the purpose of determining accuracy in journalism stories reporting on health and medical research. Although this measure demonstrated face and content validity along with sensibility (applicability, appropriateness, clarity and simplicity, adequacy of instructions, etc. as evaluated by science writers and epidemiologists), the inter-rater reliability of this measure was found to be low and subjective, especially when raters were from different professional backgrounds (science writers, epidemiologists) (Oxman, et al. 1993). In their evaluation of the instrument Oxman et al. (1993) found that it was necessary for the rater to be “knowledgeable or [have] background information about the specific topic” (pp.992). Therefore, in the present study, only one rater was used to score the stories. While this decreases the reliability/objectivity of that aspect of the findings, it increases consistency within and between scoring of the stories. Furthermore, the content analysis was consistent with the ISQ finding that the PVS stories were generally less accurate, when accuracy is primarily defined as fidelity between what the research article reports, and what is included in the media story. Included in the appendix is a detailed description of how the categories were defined and scored (further detailed notes are available on request from the researcher regarding the way the categories were scored).
The fact that the content analysis was conducted by one analyst and inter-rater reliability was not assessed is another limitation of this study. However, Krippendorff (2004) has indicated that statistical measures of reliability in content analysis may not be a clear indication of the generalizability of the findings. The use of one rater also leads to greater consistency in coding and deeper meaning in the categories and codes (Krippendorff, 2004). Plus the detailed descriptions of the categories, presented in this thesis, facilitate transparency and rigor in methods and findings (Krippendorff, 2004; Morrow, 2005). Furthermore, the purpose of the study was to explore and describe two particular cases of research uptake in the media in order to generate testable hypotheses. Therefore, the reliability of coding is of less import than a clear description of what was looked at and what was observed (Krippendorff, 2004). Finally, interpretation of the findings were checked and discussed with the research supervisors as part of the thesis supervisory process.

Another potential limitation is the inclusion of duplicates in the initial analysis. The inclusion of duplicates could have led to differences in the findings. However the purpose was to determine media uptake and these duplicates are the result of multiple publications from, for example, newspapers owned by the same media conglomeration. Thus, in order to get a full picture of media uptake it was necessary to include these in the initial analysis.

Another limitation of this research is potential misclassification bias. The jargon count might be somewhat inflated due to the researcher classifying certain terms (i.e., “coma”) that may not be considered jargon by others. The researcher added terms such as “coma” to jargon as they are classifications intended for the medical profession and the
actual clinical definition may be understood in a limited way. Likewise, certain assumptions were made by the researcher as to what constitutes a ‘good’ or ‘accurate’ definition of PVS. For example, the researcher categorized a ‘good’ or ‘accurate’ definition as one that contained no errors and explained how these patients were diagnosed and what they were capable of. The researcher also made assumptions regarding what was understandable to a general audience. The inclusion of detailed definitions of categories and examples of coded content provide transparency into the assumptions made by the researcher. However, while these were subjective categories, this was still a useful analysis in order to generate hypotheses.

Finally, despite significant efforts, original press releases on both stories (from the university or journal) were unavailable, which limited the ability to analyze the stories as they progressed from the article format, through the distilled and perhaps meaning-altering press release format, and on to the journalism story. Knowing which version (original or press release) the journalist relied on in writing the story would lend significant interpretive strength, but this was not possible. However, other studies indicate that press releases are often used as an initial source or ‘appetite wetter’ and that the scientific journals along with interview sources, if possible, are used as the primary information source for the journalism story (Bubela & Caulfield, 2004; Canales, et al., 2008). Likewise, Brechman et al. (2011) have found that press releases, although not completely accurate, are more accurate than the journalism stories reporting on the same research. Therefore, future studies should be structured such that cases are required to include this crucial mediating document.

5.6 Suggestions for Future Research
Based on these results, there are many potential follow-up studies, three of which are suggested here. A first key question is: “where and how does this right to live/die issue come into the discussion in relation to the research findings, and who initiates these discussions?,” For example, are the researchers discussing this issue during press conferences or are reporters inquiring about it?, is it being discussed in other news regarding a social movement and/or court case?, and who is saying what in the stories (i.e., journalist, researcher in the study, researcher outside the study, someone with commercial interest, etc.)? Second, further research could look at whether or not the audience misperceives the research represented in journalism stories. For example, whether the general public perceive the research to be more definitive than it is, if they perceive the application of the PVS research to the larger life/death issue as realistic, and what factors mediate such perceptions. Finally, the hypothesis that the BT research was presented in a format more consistent with scientific research articles (e.g., more critical/balanced/objective, v. one sided/optimistic/favorable) warrants further investigation of the structure and content within the stories. A good method to explore this would be through qualitative analysis. Therefore, a proposed next step in this research process will be a thorough qualitative investigation of these stories.
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CHAPTER 6

Conclusions

The purpose of this study was to explore and identify factors influencing the uptake and accuracy of two particular cases of neuroscience research findings in order to explore accuracy in print media representations of the research and generate hypotheses for future scholarship on neuroscience research in the print media as a form of knowledge translation to the public. The current study found that the PVS research was more actively, but less accurately, taken up than was the BT research. From this analysis, it seems likely that the larger ethical issue of what constitutes life/death, and how these decisions get made, was a leading factor that influenced ‘newsworthiness’ although further research is necessary to determine if this is in fact the case.

Based on the results of this study, it appears that the use of journalism as a KT tool for providing accurate information on new health and medical research findings to the public is problematic. Although it is often the first place the public finds out about new health and medical information, economic pressure forcing journalists to create newsworthy stories in a limited amount of time, that will appeal to as large an audience as possible, means that the accurate and balanced/critical information necessary for the public to understand the research and its findings may not be possible. Therefore, economic pressures and working conditions in journalism need to change, or other ways of informing the public about new health and medical research are necessary.

The results of this study suggest that the PVS research is not being described as a health message to inform the public about the research, but as a means to discuss a ‘hot’ topic, the social and ethical issue of defining life and death. Accurate presentation of the
research is secondary to grabbing the attention of the audience. Likewise, research that may be more relevant, necessary, and/or applicable may not receive sufficient media attention as a result of the privileging of ‘hot’ topics. Future research is necessary to determine the extent to which economic and/or commercial interests drive the reporting of neuroscience research.

Another point of note is that factors that led to the journalism story not accurately representing the scientific research article vary in level of misrepresentation. While some of the journalistic practices, such as using emotional words or presenting information in a simplistic form, may be benign, other misrepresentations of the research may not be (e.g., describing the fMRI technique as the ‘gold standard’ or as a form of treatment). The extent to which these messages are or are not harmful is not possible to determine from this study and requires further investigation.

In closing, a European initiative to bring together members of the general public to discuss ethical and social issues in neuroscience research demonstrated that the public was interested in obtaining accurate non-simplified (that is, important information is not omitted) research information and led to some interesting suggestions for educating the public on neuroscience research. Improving the education of individuals to encourage critical thinking, “the creation of a ‘brainpedia’ database or some sort of centralised database that brings articles on brain science together, to which all citizens have open access” (pp.14), “engage the responsibility of knowledge producers… organiz[e] more communication activities” (pp.16), to name a few were all suggestions from this public gathering (Meeting of Minds Europe, 2006). Theater can also be useful as a KT tool for informing the public about new research, especially when the research contains
EXPLORING ACCURACY IN JOURNALISM STORIES

“scientifically and morally complex, emotionally charged, and controversial” issues (Nisker, Martin, Bluhm, and Daar, 2006, pp. 266) like the right to live/die issue found in the PVS research. This is because theater (with a workshop/panel, and a script validated by key informants) permits ‘multi-directional education’ (audience receives information from the play and other audience and panel members, and can ask questions which provides further discussion and information), and is cognitively and emotionally engaging (Nisker, et al., 2006). Furthermore, it provides an environment where potential misunderstandings can be addressed. Although some of these options may not be possible or may take time and resources to implement, it remains necessary that some method of informing the public, that augments health and medical journalism, is necessary to ensure the public has access to accurate, up to date, non-misleading information, and not simply the ‘flavour of the day’.
EXPLORING ACCURACY IN JOURNALISM STORIES

BIBLIOGRAPHY


EXPLORING ACCURACY IN JOURNALISM STORIES


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EXPLORING ACCURACY IN JOURNALISM STORIES

APPENDICES

Appendix A: Categories/Variables

Identifier: number assigned for identification of story

Title: Title of the story

Case: BT or PVS

Type of Communication: Web/Newspaper, Magazine, News Wire

Source/Publisher of Journalism Story: i.e., London Free Press, Toronto Sun

Author: Individual(s) who wrote the story

Date: Date of story release

Hour: Hour of story release

Study Date: Date research was published

Time: Time between journalism story release and release of research publication (Study Date - Date)

Page Number: Page story was published on (if applicable)

Word Length: Number of Words in the story including the headline

Relevant Words: Words discussing the research of interest to this thesis (PVS and BT in 2010)

Coverage: ((number of words discussing the research/total number of words in the article) x 100)

Section: section story was published on (if applicable)

Overarching Theme: i.e. the research of interest, another study, court case, technology

Qual Score Q1: Score for applicability

Qual Score Q2: Score for opinions v. facts
EXPLORING ACCURACY IN JOURNALISM STORIES

Qual Score Q3: score for validity

Qual Score Q4: Score for magnitude

Qual Score Q5: Score for precision

Qual Score Q6: score for consistency

Qual Score Q7: score for consequences

Accuracy/Global Qual Score: score for overall accuracy considering all other scores

Quote: Two or more words encapsulated in quotation marks

Quote from Researcher Regarding ROI: Quote from Researcher Pertaining to the Research of Interest to this thesis
Appendix B: ISQ Measure

1. Applicability: Is it clear to whom the information in the report applies (i.e. to which population the evidence is applicable)?

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially misleading</td>
<td>Minor lack of clarity</td>
<td>Minimal ambiguity</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

* i.e. a reader might be led to wrongly assume that information applies, when it does not

2. Opinions versus Facts: Are facts clearly distinguished from opinions?

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially misleading</td>
<td>Statements are attributed to sources, but the underlying evidence is ambiguous</td>
<td>The evidence underlying the main points is clearly cited</td>
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<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
<td>5</td>
<td></td>
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</tbody>
</table>

* i.e. there are bold statements suggesting there is evidence when no evidence is cited, and it is uncertain there is any

3. Validity: Is the assessment of the credibility (validity) of the evidence clear and well-founded (not misleading)? (In making this assessment take into account only the explicit message not the implicit assessment.)

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not done or potentially misleading</td>
<td>Study design or type of evidence reported, but not properly assessed</td>
<td>Strength of the research methods adequately assessed</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
<td>5</td>
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</tbody>
</table>

* i.e. no indication is given as to how good the underlying evidence is, or the quality of the evidence is misrepresented; where “quality” refers to the strength of the research methods, not statistical significance or consistency among studies

4. Magnitude: Is the strength or magnitude of the findings (effects, risks, or costs) that are the main focus of the article clearly reported?

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not done or potentially misleading</td>
<td>The magnitude of effects or risks is reported incompletely or ambiguously</td>
<td>Magnitude of main effects or risks clearly reported (including, if relevant, the baseline risk and dose-response relationship)</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
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</tbody>
</table>

* i.e. the magnitude (practical importance) of the effects, risks or costs that are the main focus of the article is not reported or is reported in a way that is likely to be misleading
EXPLORING ACCURACY IN JOURNALISM STORIES

5. Precision: Is there a clear and well-founded (not misleading) assessment of the precision of any estimates that are reported or of the probability that any of the reported findings might be due to chance?

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not done or potentially misleading</td>
<td>Indirectly or not completely; e.g. sample size reported but not properly assessed</td>
<td>Statistical significance or precision adequately assessed</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
<td>5</td>
<td></td>
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</tbody>
</table>

* i.e. a reader might be led to a false assumption regarding the precision of any estimates that are provided, the statistical significance of the findings, or the probability of a type II error if “negative” findings are reported

6. Consistency: Is the consistency of the evidence (between studies) considered and is the assessment well-founded (not misleading)? (In making this assessment take into account only the explicit message, not the implicit assessment.)

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not done or potentially misleading</td>
<td>More than one study discussed, some ambiguity re how many studies there are or their consistency</td>
<td>Number of studies and consistency (with respect to the direction of their findings) clearly reported</td>
</tr>
<tr>
<td>1</td>
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<td>4</td>
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</table>

* i.e. no evidence cited, or only one study referred to without reference to other relevant research (or the lack of other relevant studies), or cited studies are likely a biased sample of the available relevant research

7. Consequences: Are all of the important consequences (benefits, risks, and costs) of concern relative to the central topic of the report identified?

<table>
<thead>
<tr>
<th>NO*</th>
<th>PARTIALLY</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially misleading</td>
<td>Potentially important benefits, risks or costs are not considered</td>
<td>Most important benefits, risks &amp; costs are clearly identified</td>
</tr>
<tr>
<td>1</td>
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<td>3</td>
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</table>

* i.e. seemingly important consequences (benefits, risks or costs) are not considered relative to the associations (effects or risks) about which the article is written

8. Global: Based on your answers to the above questions, how would you rate the overall scientific quality of the report?

<table>
<thead>
<tr>
<th>LOW</th>
<th>MODERATE</th>
<th>HIGH</th>
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<tbody>
<tr>
<td>Critical or extensive shortcomings</td>
<td>Potentially important but not critical shortcomings</td>
<td>Minimal shortcomings</td>
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## Appendix C:

### Code Book

<table>
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<tr>
<th>Code Name</th>
<th>Definition</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Who is the story discussing, who (population) do they say the research pertains to, definitions of who</td>
<td>Characters (patients, research population), definitions of characters/population of the ROI</td>
<td>individuals outside the ROI, Headlines</td>
<td>“more than 11,000 people between the ages of 18 and 60”; “normal healthy adults”; “severely brain injured patients”; vegetative or minimally conscious patients”; “29-year-old patient”; “British viewers”; “one of 23 PVS patients”</td>
</tr>
<tr>
<td>What</td>
<td>What does it say happened in the research, specifically what was outcome, results</td>
<td>Descriptions of the outcome of the research, the results, findings, only the ROI</td>
<td>Descriptions of what happened with a patient (regarding the accident that led to the brain injury), other research, other issue, outside the research of interest to this thesis, not methods; not refuters opinions or comments on limitations; headlines</td>
<td>“Participants did get better at games they practiced...But there was still no translation to any general improvement in cognitive function”; “performed no better than the control group. In two tests, the quiz participants actually improved more than the game players”; “Their scans looked the same as those of healthy volunteers who were asked to...”</td>
</tr>
<tr>
<td>Code Name</td>
<td>Definition</td>
<td>Inclusion Criteria</td>
<td>Exclusion Criteria</td>
<td>Examples</td>
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</tr>
<tr>
<td>When</td>
<td>What time did the research occur/was published</td>
<td>Time of ROI publication; time of ROI</td>
<td>Times unrelated to the research, eg. Time Adrian Owen’s team moved to Canada, Time of Mind Reader broadcast and length, length of time patient in a vegetative state; times regarding other research; time related to how long the study was and when testing took place (eg. methods should be in how)</td>
<td>“out this week”; The study is published today in the journal Nature”; “between 2005 and 2009”; “previously shown”; “almost three years ago”</td>
</tr>
<tr>
<td>Where</td>
<td>What was the location of the research, Where was it published</td>
<td>Location of research</td>
<td>Location of newspaper; location of interview; location of dissenters or assenters; location of people in similar states not investigated by</td>
<td>”In the UK”; “In the New England Journal of Medicine”; “published by the journal Nature”; “British study”</td>
</tr>
<tr>
<td>Code Name</td>
<td>Definition</td>
<td>Inclusion Criteria</td>
<td>Exclusion Criteria</td>
<td>Examples</td>
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</tr>
<tr>
<td>Why</td>
<td>What led to the initial research and why do the authors say such research is necessary, based on the original article, how well does this map on</td>
<td>Explicit and implicit explanations for the importance or rationale of the research</td>
<td>Owen’s team (eg. Terry Schivao); location of the patient; location of publisher</td>
<td>“instigated at the urging of the BBC’s science program Bang Goes The Theory”; “The scientific evidence that these games work is really rather lacking”; “there is an enormously high misdiagnosis rate in this population”; “has never before been tried in a patient who cannot move or speak”</td>
</tr>
<tr>
<td>How</td>
<td>How did the researchers test the hypothesis, what was the study design</td>
<td>Study design, methods, process, questions asked; only ROI</td>
<td>What was found; What the results or outcome of the research was; research outside the ROI</td>
<td>“online experiment”; “six-week computer-based training regime”; “split into three groups”; “asked him to perform the motor imagery task if the answer was yes and the spatial imagery task if the answer was no”; “activity is detected by the fMRI”</td>
</tr>
<tr>
<td>Code Name</td>
<td>Definition</td>
<td>Inclusion Criteria</td>
<td>Exclusion Criteria</td>
<td>Examples</td>
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<tr>
<td></td>
<td>A statement or comment regarding the ROI that is an incorrect presentation of the original research (Binary, yes/no [% of stories that provide any indication of study validity table])</td>
<td>Only the ROI</td>
<td>Not research outside of the original studies, eg. Not the Scott Routley finding, or EEG study; not things left out, not exaggerations or misrepresentations</td>
<td>“about one in five who have scans can answer questions”; “24 vegetative or minimally conscious patients”; “11,000 volunteers”; “Statistically, there are no significant differences between the improvements seen in participants who played our brain training games, and those who just went on the internet for the same length of time.”</td>
</tr>
</tbody>
</table>
| Quote (binary plus explanation) | Statements made by an individual in writing or another form that are encapsulated in the story in quotation marks with the indication of who or what the quote was from | All statements in quotation marks and where they are from | Statements without quotation marks; titles, names and such with quotes that are not a quote written or spoken by another person; not quotes used to describe the questions used in PVS study | “Participants did get better at games they practiced. The more they trained, the better they got. But …said lead author Adrian Owen, assistant director of Medical Research Council.”; “Overall, I
<table>
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<tr>
<th>Code Name</th>
<th>Definition</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>methods of verification used by journalist</td>
<td>Describes process undertaken to gather information; compare sources (interview, article, other interview, or another source) with other sources; references other studies or research; contradictory account; indicate they did an interview or they reviewed the article; stakeholders as sources</td>
<td>Explicitly stated methods used, eg. Said Adrian Owen in a phone interview….</td>
<td>Not statements such as in a study, or so and so said, where it is impossible to know if the journalist took the information from the actual study paper, or individual or another source</td>
<td>“say scientists from England's … They said in a Tuesday press briefing”; “Fernandez says in a telephone interview”; “He told Panorama”; “New Scientist quoted Owen as saying”; “he said during a press briefing on Tuesday”</td>
</tr>
<tr>
<td>validity/strength of study (Binary, yes/no [% of stories that provide any indication of study validity table])</td>
<td>Statements related to assessment of the strength/quality of the research methods specific to the ROI</td>
<td>Explicit statements of evaluation of quality; shortcomings/limitations; can include other scientists comments of quality/validity</td>
<td>Not implicit statements</td>
<td>“Study shortcomings include the fact that it didn't focus on the aging population … experts said.”; “didn't look at specific commercial games (researchers created their own”</td>
</tr>
<tr>
<td>Code Name</td>
<td>Definition</td>
<td>Inclusion Criteria</td>
<td>Exclusion Criteria</td>
<td>Examples</td>
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<td>------------------------------------------------------------------------------------------------------</td>
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<td>--------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
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</tbody>
</table>
| Implications (full   | Statements regarding the practical importance, benefits, risks, harms, and/or costs of the ROI      | Explicit and implicit statements of implications; concerning the ROI                  | research outside the ROI in this thesis; not simply findings/results                  | “Remembering numbers is not going to help you remember what's on your shopping list”;
exploration) | results/findings                                                                                     |                                                                                                    |                                                                                                    |                                                                                                    |                                                                                                    |                                                                                                    |                                                                                                    |                                                                                                    | |                      |                                                                                                    |                                                                                                    |                                                                                                    | “But if you're expecting [these games] to improve your IQ, our data suggests this isn't the case”;
|                      |                                                                                                    |                                                                                                    |                                                                                                    | “Now, thanks to recent groundbreaking neuroscience research, it appears there might just be a way to peer into the minds of people who are incapable of expressing their thoughts”;
<p>|                      |                                                                                                    |                                                                                                    |                                                                                                    | “In future we could ask what we could do to improve their quality of life”; “Ethicists say Owen's discovery raises highly charged questions” |                                                                                                    |                                                                                                    |                                                                                                    |                                                                                                    |                                                                                                    |</p>
<table>
<thead>
<tr>
<th>Code Name</th>
<th>Definition</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency/Broad Context</td>
<td>Statements discussing other research studies related to the original research or statements of the lack of research done in the area of study (BG/PVS)</td>
<td>statements of the context of the ROI with respect to the research as a whole in the area</td>
<td>not the broader context in the story e.g., Study takes aim at the multimillion dollar industry; not statements like more technical development is necessary; not suggestion of future research needed</td>
<td>“best study done to date”; The evidence appears to be contradictory”; “more research is needed”; “this research is in its infancy”; “the actual meaning of either the presence or absence of these signals from brain imaging technology is not yet well understood”</td>
</tr>
<tr>
<td>Language/clarity</td>
<td>Scientific or complex words or phrases (difficult for the general public to understand; scientific terms used for a particular discipline); Words meaning one thing are used to originally jargon, can sort this</td>
<td>Jargon with definitions; diseases and disorders (although may be commonly used and understood still)</td>
<td>not term brain training (could be understood easily)</td>
<td>“standard cognitive assessment”; “significant statistical differences”; “crystallized intelligence”, “By factoring in a mental workout in the same way that we might go to the...”</td>
</tr>
<tr>
<td>Code Name</td>
<td>Definition</td>
<td>Inclusion Criteria</td>
<td>Exclusion Criteria</td>
<td>Examples</td>
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<td>----------------------------------------------------------------------------</td>
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<td>------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Human element</td>
<td>Uses a particular patient or family member to discuss something; uses a person to discuss something from their point of view</td>
<td></td>
<td></td>
<td>“The boy tapping randomly at his computer without even paying attention to the game? He was in the fourth-grade class”; “a Canadian man who was believed to be in a vegetative state for more than a decade has been able to tell scientists that he is not in any pain”</td>
</tr>
<tr>
<td>Reaction (full</td>
<td>People who agree or disagree with the research and/or the results; statements of disagreement, agreement, and/or conflicting ideas</td>
<td>People or research in disagreement or agreement with the research of interest to this thesis; Individuals outside</td>
<td>Not studies that are not being directly used to refute or disagree with the findings (the one story they discuss research with the N-back transfer can work); “While this</td>
<td>“it did not look at benefits of more intense training, said Alvaro Fernandez … it does not deny that”</td>
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<tr>
<td>exploration)</td>
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<tr>
<td>describe another; used</td>
<td>out later); exaggerations; metaphors; poor explanations/definitions</td>
<td></td>
<td>gym to exercise”; “boost their brain power”; “it’s not a death knell for gaming”; “tremendous potential”; “seniors who are terrified of losing their minds”; “effectively buried alive”; “taps into a primal fear”</td>
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<td>two different things</td>
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<td>meaning; are used to</td>
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<td>create a picture;</td>
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<td>describe something in</td>
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<td>detail, or</td>
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<td>convey an emotion;</td>
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<td>Statements that make</td>
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<td>things appear smaller</td>
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<td>or larger than they</td>
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<td>Examples</td>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>the original</td>
<td>research study; professionals; family members; other researchers</td>
<td>and such); not shortcomings unless a refuter is using them to make their argument</td>
<td>against the research (eg. NOT the researchers in the ROI or sponsors/institutions</td>
<td>scientific development might hold some promising benefits in the future, at present, it is a speculative conclusion at best, &quot;Gropper said&quot;;</td>
</tr>
<tr>
<td>Evidence/proof</td>
<td>Binary, Words like proof and evidence used</td>
<td></td>
<td></td>
<td>&quot;Hank Greely of Stanford Law School opines that this development raises many important legal and ethical questions&quot;</td>
</tr>
<tr>
<td>yes/no [ % of</td>
<td>provide any indication</td>
<td></td>
<td></td>
<td>&quot;anecdotal evidence&quot;; &quot;no evidence&quot;; &quot;There is tantalising evidence to suggest&quot;; &quot;puts the burden of proof now on game manufacturers&quot;; &quot;proved to be indistinguishable&quot;; &quot;evidence of intention – incontrovertible evidence&quot;</td>
</tr>
<tr>
<td>stories that</td>
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<td>provide any</td>
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<td>of study validity</td>
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## Appendix D: Content analysis table

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</table>
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