Making the Invisible Visible: The Effects of Neuroscience on Mental Injury Claims

by

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Abstract

As neuroscience knowledge progresses, a biological understanding of learning, memory, behaviour, perception, and consciousness can be ascertained. As a result, neuroscience coupled with advancing neurotechnologies give novel insights into issues of the mind and its impact on various aspects of legal thinking. This thesis will argue that neuroscience will fundamentally change how injuries in tort law are perceived, using examples of concussions-related and brain injury litigation. This is possible because the progress made on neuroimaging of concussions and brain injuries will blur the line between physical injuries, and emotional and invisible injuries, thereby making the latter “visible” in the eyes of the law. Issues of proof of harm and causation can be more readily recognized and this new neuroscientific evidence will change how future concussion cases, and more broadly mental injury cases, are dealt with in the future.
I would like to thank Dr. Trudo Lemmens for being a wonderful mentor, supervisor, and teacher.

To my mom and dad, the deepest gratitude and love for always being there for me with their unfaltering support.
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1 Introduction

Interdisciplinary research in the law has become a hallmark of legal research. It has provided legal scholarship with many new ideas. One such avenue that has only recently begun to be explored is the intersection of cutting research in science and technology with the law. Few areas have been more discussed recently among scientists and in the media than the role of the brain, its functions, and how its inner workings impact the world. Neuroscience is the scientific study of the brain and nervous system. It involves the understanding of the biological basis of learning, memory, behaviour, perception, and consciousness. Stemming from neuroscience has been the development of neurotechnology, which has a large influence on how we understand the brain and its higher functions. As this technology continues to progress and move neuroscience knowledge forward, interdisciplinary research involving neuroscience has come to the forefront and the promise of providing novel and unique views on old issues and questions is intriguing and exciting. The law is one such subject that can benefit greatly from new ideas and thinking that neuroscience offers, where the intersection of law, neuroscience and neurotechnology is one that is beginning to be discussed extensively. As science and technology becomes increasingly advanced, the world must continue to adapt legal conventions and norms to reflect these new findings.

Legal effects and their consequences are tied to neurological and behavioural issues. Therefore, neuroscience can offer a more comprehensive and accurate approach to legal phenomena. Brain science and neuroscience research provide new opportunities to see how the law responds to such scientific advances. The brain remains a critical organ where so much is yet to be understood. It provides the key to emotion, decision-making, cognition, and other higher-order
functions. Previously, it was not well understood how and in what capacity the brain was affected when subject to injury and how this affects one’s decision-making capabilities, cognitive functioning, or capacity. With the rise in neurotechnology, the ability to image and diagnose these brain injuries and diseases is becoming increasingly possible. One such topic that will be influenced by advances in science and technology is in regards to concussions and brain trauma. The prevalence of concussions and mild traumatic brain injury in athletes has always been a known and common problem. However, it has come into the public eye more recently with litigation involving major sports organizations such as the NFL, NCAA, and the NHL. As more is being discovered regarding concussions and concussion-related diseases, such as Chronic Traumatic Encephalopathy (CTE), there are increasing amounts of litigation from athletes towards sports organizations. How do further advances in neuroscience regarding concussions bring new insights into concussion litigation cases and what are the effects of these discoveries on future cases? This thesis will focus largely on neuroscience and its role in the construction of knowledge claims about concussion injuries in sports and health. Much concussion-related injury litigation stems from the basic premise that the professional sports leagues acted negligently and breached their duty of care to their participating athletes by not taking reasonable steps to prevent head injuries despite knowing how severe the repercussions may be for an athlete who suffers a head injury.

Through an analysis of recent concussion-related injury and brain injury litigation, the thrust of this thesis will be to argue that neuroscience will fundamentally change how injuries in tort law are perceived. This is achievable because of the progress made on the neuroimaging of concussions and concussion-related diseases such as CTE, blurring the line between physical injuries, and emotional and invisible injuries. It will be contended that new neuroscientific concepts and technologies that allow for in vivo (in the living organism) imaging and diagnosis
of concussions and CTE will make these invisible injuries and emotional symptoms “visible”. This means proof of harm and causation can be more readily demonstrated and recognized, thus affecting the success of these types of injury claims in the future. Furthermore, it will be argued that this new neuroscientific evidence will change how future concussion cases are dealt with, by shifting the blame to professional organizations. This will affect the assumption of responsibility in the future, placing pressure on professional organizations to adapt strong policies to help those with head injuries.

This thesis will be presented in four sections. Section 1 will provide the background information on neuroscience and concussions and the impact that repeated head trauma to the brain has on the nervous system. This section will include a general overview of neuroscience and its importance, an overview of the science of concussions and how neuroscience helps to explain CTE, and an overview of the technologies that are currently available for diagnosing CTE as well as emerging technologies that will allow for diagnosing and imaging CTE in living patients. It is important to provide a solid foundation and synopsis of how concussions and brain injuries work in order to understand how and why this is a problem and the types of injuries that occur during a concussion. The significance of this section stems from the recognition that concussions and CTE are largely a hybrid of emotional and invisible injuries, rather than a purely physical one, thus leading to the difficulties in successfully claiming for damages and remedies under tort law concussion litigation.

Section 2 will assess the impact of neuroscience on law and the technologies that help impact the law. While much scholarship has focused on how neuroscience impacts criminal law, it will be contended that neuroscience has the potential to equally affect how we think about other areas of the law, such as tort law. It will first be discussed how neuroscience has impacted the law and
how it has already begun to change ideas in criminal law, such as the notion of criminal responsibility. It will then be argued that neuroscience affects how we think about legal concepts within tort law, and raises questions regarding whether a classic negligence approach used for physical, visible harms should be used to replace traditional emotional and invisible harm doctrines. This will be achieved through a description of invisible and emotional injury doctrines and how those types of injuries are generally treated by the law. This will lay the foundation for the argument that by making the vast majority of injuries “visible” through neuroscience techniques and imaging, invisible and emotional injury doctrines in tort will no longer be needed.

Section 3 will provide an overview and an analysis of the various concussion-related injury litigation against professional sports leagues, such as the NFL, NCAA, NHL, and FIFA. It will be assessed what impact the cases have on concussion-related injury claims and the role neuroscience plays in their outcomes. A thorough analysis of these cases will be used as an example to reinforce the idea that concussions-related injury litigation has been difficult to deal with due to the non-physical and emotional pain and symptoms that occur, rather than overtly physical ones.

Section 4 will discuss how advancing neuroscientific technologies that allow for imaging CTE in living patients, as opposed to deceased ones, will affect these concussion-injury claims. It will focus on how present concussion-related injury claims will change with these advances in technology in regards to the assumption of responsibility and concussion-injury claims. It will be argued that concussions provide a strong example of how neuroscience will fundamentally alter how injuries in tort law are perceived and dealt with by removing the distinction between a physical, and an invisible or emotional injury, through the ability to physically see them, thereby
blurring their perceived distinction as “invisible”. Further dialogue will be given to the shift of assumption of responsibility, and place the blame on professional sports leagues, rather than the participants themselves. This is due to the ability of recent technology to diagnose and image concussions and concussion-related diseases such as CTE in vivo, which would thereby prove causation or a form of causation by showing that the injury directly resulted from injuries suffered during play. Finally, this shift in how one views tort related injury claims would lead to more legislation and policies on concussions and concussion safety to prevent these types of claims from becoming too prominent.

2 Neuroscientific Background Information

The brain is the most critical organ in the body but remains the least understood. Most of what we have discovered about the brain was discovered in the past 20 years. In the United States, the 1990s were hailed as the “decade of the brain” by President George W. Bush, who urged an increase in “public awareness of the benefits to be derived from brain research”. Canada followed suit from this proclamation and now contributes heavily to neuroscientific research as can be seen through organizations, such as the Canadian Association for Neuroscience, and through an increase in funding towards brain research, such as The Canada Brain Research Fund, which as of 2017 has allocated over $200 million in funding to support neuroscience research.

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and projects. Neuroscience has become increasingly dominant in our mainstream understanding of the human being, and particularly, the mind. Questions about human consciousness that have been questioned by psychologists, physiologists, and philosophers for decades are beginning to be answered by neuroscience research and imaging technology. Approximately 100 billion neurons in the brain that interact through the trillion synaptic connections have come to be regarded as the key to unlocking humanity and providing the answer to every element of human behavior.

Through neuroscientific technologies and the identification of biomarkers, it is clear that neuroscience knowledge has changed the very ontology of concussions, providing clinicians and scientists with new evidence of concussion. The medicalization of concussion knowledge through imaging technologies makes possible diagnostic claims that in turn produce new regulatory practices. It is therefore important to understand neuroscience and the science behind concussions in order to understand the nature of concussion litigation and how policies and future litigation will be affected by emerging neuroscience knowledge and technologies.

2.1 Overview of the Science of Concussions and How Neuroscience and Neurotechnology Relate with Concussions

2.1.1 Overview of Concussions

Generally, a concussion is regarded as a head injury that results in a temporary loss of normal brain function and can be differentiated from other head injuries by its effects on consciousness.

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3 The Canada Brain Research Fund <https://braincanada.ca/canada-brain-research-fund/>
In the United States, the incidence of sport-related concussions is estimated to affect between five and eight events per 1000 player hours, which is about 1.6 to 3.8 million concussions per year. Similarly, in Canada, in youth sports alone, 64% of visits to the hospital were the result of participation in sports, and physical activity, and of that 64%, 39% were diagnosed with a concussion and a further 24% were possible concussions. Concussions are observed not only in football but in other contact sports, including rugby, soccer, boxing, wrestling, basketball, field hockey, volleyball, and lacrosse in similarly high rates. It is clear that this is an increasingly recognized health-related problem. NFL players aged 30 to 49 years old have developed some degree of cognitive impairment, dementia, emotional lability, and depression reported at 1.9%, which is a 20-times higher prevalence than the age matched population in the general public.

The rate of concussions is increasing and represents a large public health problem. Based on press headlines, media broadcasts, high-profile lawsuits, investments in research and development efforts and government action, sports concussions have become one of the signature public health issues in modern times. Professional sports garner the most attention on concussion issues, but sport participation is an important aspect of youth and child development, education, and health, and the threat of neurologic injury to participants has generated a high level of concern that has motivated the general public to join the debate and seek answers.

Several highly-publicized suicides by former professional football players have focused public

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7 Canada, Government of Canada, Concussions in Sport, online: <https://www.canada.ca/en/canadian-heritage/services/concussions.html>
attention on the long-term repercussions of repetitive head injuries common to athletes in all contact sports and soldiers in combat situations. Players continue to donate their brains after they have passed away and this brain bank continues to grow. This is important because it will allow research to continue on CTE. This will have a strong effect on the legal implications of this disease, as more information about diagnosis and imaging is taken from the brain bank.

2.1.2 Overview of CTE

Sports-related concussions have gained increased prominence and interest, in part due to the media coverage of the NFL’s concussion litigation and the deaths of several well-known professional athletes as a consequence of chronic traumatic encephalopathy (CTE). Research into this area has been sparked significantly by the increased public awareness of the long-term effects of sports-related concussions and subconcussive brain trauma.

Concussions and concussion symptoms were first studied in boxers and was described by Dr. Harrison Martland in 1928 as a condition characterized by “tremors, slow movement, confusion, and speech problems”.\textsuperscript{11} Studies on boxers continued into the 1970s, but the first report of CTE came in 2005 in a study by neuropathologist Bennet Omalu and colleagues on the case of a retired NFL player, Mike Webster. They identified a relation between concussion and the effects of low-grade, long-term repeated concussive brain injuries.\textsuperscript{12} This study helped the diagnosis of concussion, previously only made possible through visual markers and cognitive tests, become more scientifically determinable through post-mortem and neuropathological examinations of an athlete’s brain.

\textsuperscript{11} Harrison S Martland, “Punch Drunk” (1928) 91:15 \textit{JAMA} 1106.
Currently, the ability to diagnose CTE is only possible in the post-mortem with retroactive litigation or remedies coming too late. Studies have shown that players of contact sports may be at increased risk of long-term neurological conditions, in particular, CTE. Mez et al performed a study whose aim was to determine the neuropathological and clinical features of deceased football players with CTE who played American Football at any level of play.\textsuperscript{13} They showed that of the 111 players examined, 110 had CTE. Furthermore, professionals and higher levels of play were associated with more severe CTE. However, it is important to note the confirmation bias limitation in this study, as all brains submitted in the sample were those who were believed to have CTE or exhibited symptoms of CTE. It would be highly likely that in a sample where all the brains exhibited symptoms of CTE would produce a finding where the majority would have CTE. It is impossible at the present to claim an outright causal effect of football and CTE. Despite its limitations, the study importantly shows that this can have major implications on concussion litigation for the NFL and other concussion litigation.

There is a clear basis for engaging in this research as NFL players are undoubtedly suffering from neurodegenerative disease in connection with concussions sustained during play. Another study by Durham et al in 2017 provides further support of the idea that traumatic brain injury is associated with the development of CTE.\textsuperscript{14} It examined 41 individuals with a history of traumatic brain injury (TBI) associated with development of chronic traumatic encephalopathy (CTE). It was seen that many years after injury, TBI patients exhibit abnormal metabolic


responses and altered relationships between circulating amino acids, cytokines, and hormones. This pattern is consistent with TBI, inducing a chronic disease state in patients. Understanding the mechanisms causing the chronic disease state could lead to new treatments for its prevention, and new legal ramifications.

Another study that discusses the potential effects of exposure to tackle football and CTE is one assessing early age exposure to football. A study by Michael Alosco and colleagues examined the effect of age and timing of first exposure to tackle football on CTE pathological severity and neurobehavioural symptom onset in tackle football players with neuropathologically-confirmed CTE.\textsuperscript{15} Through analyses that accounted for decade and duration of play, the study concluded that although younger age of exposure to tackle football was not associated with CTE pathological severity, it still predicted earlier neurobehavioural symptom onset. The authors concluded that exposure to tackle football may reduce resiliency to late life neuropathology and may be a risk factor for future development of CTE.\textsuperscript{16}

2.1.3 Clinical Features of CTE – Histopathology and Pathophysiology

In 2005, Omalu et al. was the first to describe the histopathological findings of CTE in an American football player, with their findings closely resembling a patient suffering from Alzheimer’s disease, including tau deposits and neurofibrillary tangles without the presence of amyloid deposits.\textsuperscript{17} Other studies have demonstrated that even a single TBI could lead to both


\textsuperscript{16} Ibid.

\textsuperscript{17} Omalu, supra 12 at 134.
clinical and histopathological findings consistent with CTE, emphasizing and supporting the idea that CTE is neurodegenerative in nature.\(^\text{18}\)

Currently, it is generally understood that the clinical manifestations of CTE are similar to neurodegenerative diseases and are thought to be progressive.\(^\text{19}\) The symptoms usually manifest in midlife and several years after exposure to repetitive head trauma.\(^\text{20}\) This is confirmed by studies on the medical histories of subjects with a history of repetitive mild traumatic injury. The frequent association of chronic traumatic encephalopathy with other neurodegenerative disorders suggests that repetitive brain trauma and hyperphosphorylated tau protein deposition promote the accumulation of other abnormally aggregated proteins including TAR DNA-binding protein 43, amyloid beta protein and alpha-synuclein.\(^\text{21}\)

Initial symptoms of CTE include impaired cognition, mood, and behavior, as well as short-term memory problems, difficulty with executive function, depression, impulsivity, emotional stability, and suicidal ideations and behavior.\(^\text{22}\) Later manifestations include worsening memory, executive function, speech, and motor skills, as well as aggressive and irritable behavior.\(^\text{23}\) Many such severe impairments result in dementia. The manifestation of symptoms years after the removal from exposure to repetitive traumatic injury (which could have implications on the


\(^{19}\) Ibid.


legal side of things) can potentially be explained by the fact that the clinical presentation of CTE is a distinct entity from concussions and postconcussive syndrome and is due to progressive neuronal dysfunction and death.\textsuperscript{24}

It is clear from the clinical features, histopathology and pathophysiology, and overviews of both concussions and their associated diseases such as CTE, that these types of head injuries and diseases are invisible injuries and without physical knowledge of their presence. One does not wear a cast or a brace as commonly seen with external injuries. While symptoms manifest that allow for their diagnosis, the difficulty in making concussion-based claims in law relates to the invisibility of the injury and its associated diseases. CTE especially has proven difficult to diagnose and much CTE and concussion related litigation has been unsuccessful because the disease cannot be physically seen. Until recently, there has been no possibility of diagnosing and imaging the disease, and the symptoms do not manifest immediately but rather develop gradually over time. This proves problematic when bringing claims involving concussions and concussion-related diseases as it is difficult to prove their existence.

\subsection{2.2 Overview of Neurotechnology}

Imaging technologies are important because they help to visualize an “invisible injury” in concussions and CTE, making it visible. In the cases of concussion, imaging technologies such as MRIs have been used to examine brain anatomy, specifically grey matter, to physically view

areas of the brain for biomarkers of brain damage. For example, Leddy et al have used fMRIs to examine how concussive brains have “abnormal blood flow”.

2.2.1 Research on the Current Ability to Diagnose CTE In Vivo

Despite the limitations of current neuroscientific technologies, there is a great deal of growing research dedicated at in vivo confirmatory diagnostic testing that can help to determine who is at greatest risk of developing CTE and identifying CTE early. Identifying CTE in living individuals and in individuals with a high risk of developing the disease will allow for effective treatment and prevention strategies and will subsequently also have a tremendous impact on how we view the law in this area.

Various magnetic resonance imaging (MRI) sequences have proven to be of value in the diagnosis of CTE. Functional MRIs have proven to help in distinguishing CTE from other types of neurodegenerative states, such as Alzheimer’s disease or Lewy body dementia. Much of the current research has now shown that neuroscience and neuroimaging is closer than ever to imaging and diagnosing CTE in vivo which could have large implications on concussion litigation and the legal field of study. Dickstein et al present a study that examines the possibility of new positron emission tomography (PET) ligand ([18F]T807/AV1451), that can possibly allow the detection of tau aggregates in vivo. This case study is a report on a retired NFL player who suffered 22 concussions and manifested neuropsychiatric symptoms, including decline in


executive function, processing speed, and fine motor skills. Overall, the authors concluded that the new ligand used is a promising tool to detect and diagnose CTE-related tauopathy in living subjects. At the current stage, definitive identification is still only possible postmortem but these advancements show that diagnosis in vivo will likely be possible soon. Another example of the potential to diagnose CTE in living patients is by Hong et al, who show that the $[^{11}\text{C}]$Pittsburgh compound B (PiB) amyloid imaging has revealed increased ligand binding following acute traumatic brain injury (TBI), which appears to be greatest immediately (hours) following the injury and gradually decreases over time. The residual amyloid present in some individuals 1-year post-TBI may (dependent on their age) reflect slowed clearance of acutely deposited amyloid, which can be an accurate representation of development of CTE. This has the effect of providing another example of new strategies for imaging and diagnosing CTE in vivo.\textsuperscript{28}

The most recent study done by Omalu et al in 2017 presents a modality that may be instrumental in diagnosing CTE in living patients. This study was based on a brain autopsy confirmation of [F-18]FDDNP-PET findings that have a high binding potential for in vivo imaging visualization of tau and amyloid fibrils, which are characteristic of CTE neurodegeneration in the brain.\textsuperscript{29} CTE has been confirmed to exhibit a distinctive neuropathological signature with differential and selective topographic vulnerability of brain regions, which are temporally progressive and eventually occur in all regions of the brain in advanced CTE. The use of the [F-18]FDDNP-PET brain signal potentially confirms this neuropathological signature, and can therefore be used as a


means of diagnosing CTE in living patients.\textsuperscript{30} The study by Omalu et al. was a confirmation of another study done by Barrio et al. who also suggested that the tau-sensitive brain imaging agent [F-18]FDDNP may be able to detect CTE disease in living people with varying degrees of symptoms.\textsuperscript{31}

Omalu’s study is one of the most recent examples of the advances in technology being made in the ability to diagnose chronic traumatic encephalopathy in living humans. Early detection would facilitate the most effective management strategies and provide a baseline to measure the effectiveness of treatments. More importantly, for purposes of this thesis, it allows one to assess the effects of this detection capability on the law. The ability to diagnose CTE and concussion related diseases \textit{in vivo} would change not only the outcomes of past litigation on concussions, but may significantly affect future litigation and policy decisions.

\section{Neurolaw}

\subsection{What is Neurolaw?}

The emergence of neuroscience has already revolutionized medical practices by providing an immediate and powerful catalyst to understanding how the nervous system works. Neurolaw is an attempt to explore the effects of these discoveries in neuroscience on legal rules.\textsuperscript{32} There are

\begin{itemize}
\item \textsuperscript{30} \textit{Ibid} 238.
\item \textsuperscript{32} Noel Shafi, \textit{“Neuroscience and Law: The Evidentiary Value of Brain Imaging”} (2009) 11 \textit{Graduate Student Journal of Psychology} 27.
\end{itemize}
hundreds of criminal and civil law cases that demonstrate that law and neuroscience increasingly intersect. Neurolaw hopes to provide new ways of thinking about complex legal issues by assessing how neuroscience knowledge can impact the law. Much of law hinges on how brains work. In criminal law, the criminal’s mental state at the time of the act, or what the person remembers is vital to answering questions in the law.\textsuperscript{33} In civil law, questions regarding the level of pain a person is experiencing or whether one is competent to enter into a contract or administer their own affairs can be answered through neuroscience.\textsuperscript{34} Furthermore, the rapid development of new technologies that enable us to learn about the structure of the brain, as well as how it functions, how it perceives, and how it chooses actions will allow for new insights into the inner workings of the mind. At the present however, one must be cautious in applying neuroscience into the law and avoid getting too exuberant. Our understandings of various brain operations are constantly evolving and brain imaging technologies are still imperfect. It is not so simple to conclude that specific behaviours of interest to the legal system are caused by particular brain features or activities. Due to differences among individuals’ brains, there is no direct mapping of mental functions to specific areas of the brain.\textsuperscript{35}

With that being said, neuroscience has the potential to change how we think about the law. Legal scholars, policy makers, and lawyers would greatly benefit from an understanding of neuroscience which can provide useful insights and potentially new frameworks of thinking about legal issues. The law is sometimes used to judge human behaviour, and through a better


\textsuperscript{34} Ibid.

understanding of how the brain works, how and why people behave the way that they do, and the factors contributing to potential changes in future behaviours, the law may ultimately be more effective. At its core, the law can be seen as an instrument to regulate human behaviour and the relevance of neuroscience in law will depend on the specific legal issues and context. The law exists mainly to channel behaviour to how people would have been behaving in the absence of legal intervention. Therefore, it follows that because law is ultimately about changing behaviour, and behaviour, mechanistically, comes from the brain, a deeper understanding of the relationship between brain and behaviour would aid in the effectiveness, efficiency, and justness of the law.36

Currently, one example where neuroscience has begun to intersect with the law is in tort law and criminal law, where one must assess the blameworthiness in order to assess punishment. The blameworthiness of a defendant, and hence his or her deserved punishment, varies according to varying levels of intent, though the extent to which lay people, and thus, jurors, can meaningfully distinguish between legally distinct mental states has been questioned.37 Blameworthiness is also affected by the presence of mitigating circumstances (such as duress) that bear directly on a defendant’s mental state, and their capacity to form a specific level of intent. In this regard, neuroscience can lend a hand on the issue of self-control, where an individual’s ability to control his or her behaviour is central to many legal decisions, often as a component of assessing the culpability of past acts. The idea of self-control is a cornerstone of criminal liability.38

Neuroimaging and neurotechnology can affect certain criminal cases, especially in the sentencing phase, by providing biological evidence supporting claims of impairment of one’s

volition and allowing for mitigation of culpability due to reduced self-control. This could be, for example, in the form of showing brain imaging or the presence of a mutation in one’s genome that is linked to poor impulse control.\textsuperscript{39}

Some argue that neuroscience can help give novel insights into law and help push forward legal thinking and decision-making similar to the contributions of “law and economics” or “law and sociology”. As neuroscience has become more accepted as a mode of enhancement and diagnosis, concerns are beginning to grow regarding how neuroscience questions and reshapes the “fundamental ontologies of ourselves” by challenging new conceptualizations of society and of the human brain.\textsuperscript{40} Rose claims that this unease stems from the explanatory gap of our ontologies of ourselves that philosophers have struggled to explain for generations that can now be interpreted by humans through technology.\textsuperscript{41} There is increasing evidence that neuroscience knowledge can make significant contributions to issues within sports through studies on enhancing performance, but that it can also be used for diagnostic, rehabilitative, and regulatory purposes, which explains the crossover into the law.

### 3.2 Neuroscientific Technologies That Help Inform the Law

Much of neurolaw depends on state-of-the-art medical technology, whose products and results are being interpreted within the legal field. These technologies include functional magnetic resonance imaging (fMRI), positron emission tomography (PET), magnetic resonance imaging (MRI), electroencephalography (EEG), and single-photon emission computed tomography

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(SPECT). Much of the techniques of importance that are employed by neurolaw involve the
detailed mapping of the human brain, which would allow technicians to visualize brain activity.
For example, fMRI is an imaging technique that allows one to demonstrate regional, time
varying changes in brain metabolism using oxygen-specific mapping. These metabolic
changes can be the consequences of task-induced cognitive state changes or the result of
unregulated processes in the resting brain. The theory behind fMRI technology is that localized
areas of the brain that are active, for example, in response to a painful stimulus, require more
oxygen. Similarly, PET scans use a radioactive tracer injected into the body to create images of
body function and metabolism and can be used to evaluate normal and abnormal biological
function of cells and organs. For example, some psychiatric disorders, such as depression or
schizophrenia, have been shown to exhibit visual abnormalities in the brain that can be
visualized using neurotechnologies. These neuroscientific technologies have the potential to
interact with the law by allowing for a mechanistic and causal view of brain disease or brain
injuries.

However, these technologies are not without their faults. For example, fMRI technology does
not provide for a direct measure of neural activity. As this technology measures changes in
blood flow that are assumed to be “tightly coupled in both space and time”, some scientists
have questioned this assumption based on experimental findings that showed more oxygenated
blood was transferred to an area of the brain than was metabolically required based on that

Blood Flow Metab 458.
46 Ibid at 387.
region’s activity. Recent work has challenged this assumption even further by demonstrating that oxygenated blood may flow to an area of the brain that is almost completely neurologically inactive. Therefore, one must proceed with caution when applying neuroscience techniques and findings to legal issues and any inferences that are made.

3.3 Limitations of Neuroscience When Bringing New Insight Into Law

Before discussing at length how neuroscience carries with it the promise of changing and improving the law, it is important to recognize that it also poses new problems and carries with it severe limitations at the present. Despite the excitement surrounding the potential neuroscience brings to the world, many scholars are quick to argue for a slowdown on the expectations of the field and its potential promises. Some scholars have questioned the normative force of neuroscience knowledge.

Scholars such as Stephen Morse, a professor at the University of Pennsylvania Law School, describe this incursion of neuroscience knowledge as “neuroexuberance”. Neuroscience offers much potential for predictive capabilities, through the use of structural or functional brain nervous system variables to make any type of prediction, such as medical prognoses or behavioural forecasts. At present, these neuroscientific tools are still error prone and must be questioned. Examining neurocorrelates on a brain scan is not value free science but rather highly interpretive. But as the technology develops, bioethicists will likely resort to various resources to address any resulting ethical and legal challenges.

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47 Ibid at 388.
New technologies can pose distinct problems for judges who must distinguish the admissible evidence from the inadmissible. For example, in the United States, several cases highlight the difficulties judges have in deciding whether to admit the results of lie-detection tests that used fMRI technology results as evidence. One of the most prominent cases in the last ten years involving neurotechnology was the *Semrau* case. In this case, a federal court ultimately held an extensive *Daubert* hearing and concluded that the proposed fMRI-based lie detection evidence should be excluded.\(^{49}\) This was due to the fact that the technology had not been fully examined in “real world” settings and suffered from a large “false positivity” problem.\(^{50}\) It is clear that these technologies are not readily understood and suffer from their own internal problems as well.

Buckholtz and Faigman argue that the promise of neuroscience for the law comes with fundamental conceptual issues that limit its usefulness.\(^{51}\) Cognitive neuroscience has developed at a rapid pace and in the past, the discussion of neuroscience’s impact on the law has centered around the speculation of its promises, such as detecting liars, objectively determining criminal responsibility, predicting violence, or for purposes of this thesis, quantifying and diagnosing suffering. Buckholtz and Faigman argue that neuroscience and the law have a fundamental “chasm” between the aims and methods of scientific research and how the law might use that research.\(^{52}\) These problems stem from inferential challenges for neuroscience in the law. The primary issue that comes about is translational issues that can impose significant barriers to the valid integration of scientific data into the law. Most legal rules that reference the mind are

\(^{49}\) *United States v Semrau*, 693 F (3d) 510 (6th Cir 2012) at 523.

\(^{50}\) *Ibid* at 6.

\(^{51}\) Buckholtz & Faigman, *supra* n 38 at 861.

\(^{52}\) *Ibid* at 861.
underspecified to a degree that confounds neuroscientists. For example, legal standards such as ‘volitional capacity’ and ‘irresistible impulse’ are meaningless as they do not map onto specific mental processes or discrete brain circuits.\textsuperscript{53} Conversely, neuroscience constructs such as ‘action cancellation’ or ‘delayed reward discounting’ are concepts that can be measured reliably and precisely, yet are foreign to legal decision-makers.\textsuperscript{54} There is no current framework that links legal standards with neuroscientific concepts and principles, especially when dealing with quantifiable data. Buckholtz and Faigman conclude that due to this chasm that separates the two disciplines, the value of neuroscientific data will be limited. They argue that the difficulties of the interdisciplinary nature of neurolaw stem from a disconnect between what law wants neuroscience to do, what commentators claim neuroscience can do, and what neuroscience actually does.

Another domain that law can be affected by neuroscience is in inferring mental states. Mental state inference is central to legal decision-making and the administration of law.\textsuperscript{55} It has been argued that neuroscience can help bring to light determinations of one’s mental state in the context of law and help improve the accuracy of such inferences. But it is clear that this is still extremely speculative; it remains at the core to be only an inference of these states rather than a definitive view of one’s mental state.

Finally, there could be issues of external and incremental validity.\textsuperscript{56} Legal policy must account for the fact that neuroscience evidence may not generalize across different settings. There is a

\begin{footnotesize}
\textsuperscript{53} Ibid at 864.
\textsuperscript{54} Ibid at 864.
\textsuperscript{55} Henry T Greely, “Reading minds with neuroscience--possibilities for the law” (2011) 47:10 Cortex 1254.
\textsuperscript{56} Ibid at 865.
\end{footnotesize}
large concern regarding potential interpretational biases inherent in brain science and brain imaging. Presently, it is difficult to ascertain how much behaviour measured in the laboratory reflects behaviour in the real world. Punishment for a wrongful act hinges on a determination of moral blameworthiness, in a criminal context, or liability, in the law of torts. These determinations require inferences about beliefs, intentions, and motivations of the individual in question. Neuroscience at the moment may have difficulty still in providing answers to these questions.

Despite some of these flaws, some legal scholars argue that these challenges are overblown and while neuroscience has some ways to go before it can be reliable, it can still remain a positive contribution to the current state of law. Shauer, for example, claims that “because law’s goals and norms differ from those of science, there is no more reason to impose the standards of law on science”.57 It is clear that neuroscience and law still have a tumultuous relationship but with increased neuroscience knowledge and technology, its impact on the law is only beginning to be uncovered.

3.4 How Neuroscience and Neurotechnology Help Inform Tort Law

Since neurolaw is a relatively novel form of scholarship, it is important to provide a brief overview as to how neuroscience impacts tort law. There is clear evidence that neuroscience has a lot to offer in terms of changing how we view criminal law,58 but it is arguable that neuroscience will change how we view tort law injuries as well. Tort law in both the US and

Canada both favor physical injuries more than emotional and invisible injuries.\textsuperscript{59} Emotional and invisible injuries are difficult to prove and because litigants have incentives to get higher damage awards, they can, and do, lie about their injuries and fake their pain.\textsuperscript{60} The courts may deny these recoveries because of fear of phoney claims. However, the “mere fact that a person can offer no physical evidence of pain…does not mean that his reported symptoms are disingenuous”.\textsuperscript{61} Advancements in neuroscience allow tort litigants to potentially introduce neuroimaging evidence as objective proof of pain that has traditionally been unverifiable.

There are two forms of tort law. One requires the plaintiff to show proof of harm. This can be seen, for example, in claims of negligence. The unintentional infliction of mental suffering requires proof of harm and causation, despite the act being unintentional. The second does not require proof as the act is considered harmful in itself, such as in instances of trespass or assault. The former form of tort law will be most severely affected by neuroscience because of the need to show proof of harm. Physical injuries are the most accepted of the three categories of harm. This is because the existence of a physical injury will be less in contention than emotional or invisible harms.\textsuperscript{62} Furthermore, plaintiffs with physical injuries benefit from favorable legal doctrines such as the eggshell skull rule, where the defendant takes the plaintiff as he finds him.\textsuperscript{63} Damages for emotional harms are more difficult to recover. Claims for PTSD or

\textsuperscript{61} Ibid at 442.
\textsuperscript{62} Ibid at 440.
\textsuperscript{63} For a discussion on the eggshell skull rule, see for example, Allen M Linden and Bruce Feldthusen, Canadian Tort Law, 8th ed (Toronto: LexisNexis Butterworths 2006), where, if the negligence of the defendant renders the skull of the plaintiff thin, making the plaintiff more susceptible to additional injury or sickness, the defendant is responsible for further complications. Any unexpected frailty of the injured person is not a valid defense to the
infliction of emotional distress are difficult to recover because of the lack of physical damage seen. In the United States, a plaintiff must prove that a defendant’s “extreme and outrageous conduct intentionally or recklessly caused severe emotional distress”. In Canada, there is generally a refusal to allow for liability for psychiatric or mental injury other than a nervous shock, which is a psychiatric illness resulting from emotional trauma. The courts are cautious to recognize psychiatric injury for fear of a floodgates argument that could lead to indeterminacy concerns in relation to the nature of the illness, high social cost, and a difficulty in determining causation. Invisible injuries are a hybrid of a physical and emotional injury and have characteristics of both types of injury. These injuries do not show up on standard imaging studies and the survivor may appear outwardly normal or only gain symptoms later on in life.

One example of such an injury is a concussion and concussion-related diseases, such as CTE, that are difficult to detect without extensive imaging techniques or the patient being post-mortem. This level of injury, as well as the associated pain and suffering, is difficult to quantify and thus it is difficult to compensate injured parties in an effective manner. A plaintiff’s ability to quantify their injury is important not only to prove certainty and extent of damages, but also prove that the harm or injury in fact exists. Since invisible injuries are more difficult to quantify and verify than physical injuries, they are subject to increased scrutiny and doubt. Neuroscience and neuroscience imaging have the ability to change this by reducing the stigma associated with emotional and invisible injuries and allow for a quantifiable and verifiable method of viewing non-physical injuries such as concussions and CTE. As mentioned previously, techniques such

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64 Restatement (Second) of Torts § 46 (1965).
as fMRI and PET would allow for claimants suffering from these invisible injuries to provide proof of causation and clear signs of injury.

Recent litigation has shown a desire to shift away from a distinction between physical and emotional/invisible injuries, to recognizing that the law of negligence treat mental and physical injury claims the same. Previously, society has tended to view mental illness and mental injuries as different from physical illness and physical disease. There is a tendency to be more wary and skeptical of mental injuries, as they are viewed as inherently subjective problems or personal failings. The law has generally reflected this thought process, providing for different and more stringent tests for establishing a compensable mental injury. These common law tests are rooted in these general social attitudes and especially arise out of concern that mental injuries present additional challenges with respect to proof. Efforts have been made to identify “real” mental injuries from everything else that people tended to complain about after a mishap. This has led to the adoption of distinct concepts, such as “nervous shock,” and distinct tests, such as the need to prove mental injuries with specific medical diagnoses and appropriate expert evidence.

However, the law has been moving in the direction of greater recognition of invisible injuries and mental health injuries as somewhat or fully equivalent to other health problems. This gradual shift can be seen slowly from the 2008 case of Mustapha v Culligan of Canada. In this case, the plaintiff experienced a very extreme psychological and mental reaction to noticing that one of his unopened water bottles contained dead flies. The trial court found the defendant liable. However, the Ontario Court of Appeal overturned that decision, and it was upheld by the

66 Kolber, supra 60 at 434.
Supreme Court and the plaintiff received nothing. This ruling seemed to reflect the general skepticism regarding claims for mental injuries. The Supreme Court analysis, however, did not invoke or apply any unique or specific “mental injury” test and instead applied standard steps or tests of a traditional negligence analysis. While this is not a hybrid injury such as concussion or a concussion related disease, it highlights the beginnings of a blurring of the distinction between mental and physical injury.

This distinction is then further addressed in the case of *Saadati v Moorhead*, which seemed to put an end to any common law distinctions between mental and physical injury in tort law. The claimant was a tractor trailer driver who was involved in five motor vehicle collisions. As a result of these collisions, the claimant sustained injury including chronic pain that was only aggravated following the multiple collisions. The trial judge also confirmed that the second accident caused psychological and concussion-like injuries, including personality changes and cognitive difficulties. This finding was based upon the evidence of family and friends who confirmed their observations that the plaintiff’s personality and cognitive skills worsened after the second collision. The British Columbia Court of Appeal overturned the trial judge’s decision on the grounds that the claimant is required to provide evidence of a medically recognized psychiatric or psychological injury, as the evidence from family and friends was not sufficient. Worthy to note here is that had neurotechnology been employed, a diagnosis of psychiatric injury would have been supported by neuroimaging and one would not have to solely rely on family or friends to provide evidence of worsening personality and cognitive functioning. Had

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69 Ibid.
71 Ibid
72 Ibid
this biological evidence been present at the onset, the legal process would have been expedited, saving time, money, and resources. The Supreme Court of Canada (SCC) disagreed with the BC Court of Appeal and ruled that mental and physical injuries are to be treated identically in tort law. There is no second standard or special evidentiary requirements for mental injuries as compared to physical ones. Justice Russell Brown and the court emphasized that all forms of injury claims, including claims for negligently caused mental injury, should be subject to the same ordinary duty of care analysis. They describe that recovery for mental injury in negligence law depends on the claimant satisfying the same criteria that are applicable to any successful action in negligence, that being a duty of care that was breached, a damage as a result, and a legal and factual causal relationship between the breach and the damage. The Supreme Court addressed the decision in Mustapha, and discussed in Saadati that it was:

implicit in the Court’s decision in Mustapha that Canadian negligence law recognizes that a duty exists at common law to take reasonable care to avoid causing foreseeable mental injury, and that this cause of action protects a right to be free from negligent interference with one’s mental health. That right is grounded in the simple truth that a person’s mental health — like a person’s physical integrity or property, injury to which is also compensable in negligence law — is an essential means by which that person chooses to live life and pursue goals. And, where mental injury is negligently inflicted, a person’s autonomy to make those choices is undeniably impaired, sometimes to an even greater degree than the impairment which follows a serious physical injury. To put the point more starkly, ‘[t]he loss of our mental health is a more fundamental violation of our sense of self than the loss of a finger’. Even though a specific and accurate diagnosis may be important for treatment purposes, a claim of mental injury remains focused on symptoms and their effects. There is no requirement that the mental injury match a specific diagnostic system. The court concluded that to establish

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73 Ibid
74 Supra note 68.
75 Supra note 70 at para 23.
mental injury, the plaintiff must show that the disturbance is “serious and prolonged, rising above the ordinary annoyances, anxieties and fears that come with living in civil society”. It is clear then that neurotechnology can only help to establish further that a plaintiff is suffering from a mental injury that is “serious” and above ordinary by providing visual evidence of harm to the brain and inferences of impairment to the psyche.

While the judgement was generally justified by the SCC as a prevention of the stigmatization of mental illness, the same principle can apply when discussing invisible injuries as well and it could be argued that these types of mental injuries, such as concussions and concussion related disease could fall under the same umbrella. Furthermore, as there is no longer a requirement to suffer from a medically recognized mental illness, neurotechnology can provide help in assessing an injury that is serious and goes above ordinary annoyances, by helping to visualize and see the injury/disease in a way not possible before. In his judgment in Saadati, Justice Brown suggests that contemporary medicine does not allow for this distinction between physical and mental injury as the distinction is becoming less and less viable as a matter of science and medicine. He refers back to the Supreme Court ruling in Mustpaha and comments that “the distinction between physical and mental injury is ‘elusive and arguably artificial in the context of tort’. … [I]n an age when medical knowledge is expanding fast, and psychiatric knowledge with it, it would not be sensible to commit the law to a distinction between physical and psychiatric injury, which may … soon be altogether outmoded.” This ruling signals the beginning of Canadian common law to come up to date with medicine and technology. Neuroscience technologies and the recent

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76 Ibid at para 37.
77 Ibid at para 21.
78 Ibid at para 35.
litigation on concussions can help bolster and affirm these recent decisions by providing an objective method of analysis of injury.

Similarly, in the United States, at least one court has already determined that objective proof of the physiological basis for emotional injuries can erase the distinction between bodily and emotional harm. In *Allen v Bloomfield Hills School District*, a Michigan appellate court held that the plaintiff’s psychological injuries could constitute a bodily injury, given a doctor’s affidavit that a PET scan “depicted decreases in frontal and subcortical activity consistent with depression and PTSD”. According to the court, “there should be no difference medically or legally between an objectively demonstrated brain injury, whether the medical diagnosis is a closed head injury, PTSD, … etc. A brain injury is a ‘bodily injury’. If there were adequate evidence of a brain injury to meet the requisite evidentiary standards, i.e., objective medical proof of the injury, summary disposition was improper”. This judgment represents a shift from past laws and a reflection of changing attitudes in relation to mental injuries and illness.

The law is not set in stone and is a product of the times, and should evolve with the times, based on the tools that are currently available. Some authors have nevertheless argued that this new view of mental injury is unsustainable because the court created a legal category of “bodily harm” that seems driven by concerns about whether an injury can be proven. This creates a dividing line between injuries that are measurable and those that are not and this line would subject the duties we owe to others to scientific constraints and progress. It has been argued

80 *Ibid* at 814.
81 *Ibid* at 816.
that this is problematic as tort law embeds “normative ideals about what harms are protectable, and therefore the line between an unprotectable harm should not be determined by the latest trends in scientific research”. Despite these potential limitations, however, it is clear from these cases that in both Canadian and American legal jurisdictions, there is a gradual shift away from a distinction between physical and invisible types of injuries.

4 Concussion Litigation

This section will primarily focus on current litigation on concussions. In particular, the section will outline cases made against the NCAA (National Collegiate Athletics Institution), the NFL (National Football League), the NHL (National Hockey League), and FIFA (Fédération International de Football Association) and will assess the outcomes of these current cases, how CTE and brain injury is a major part of the decision process, and what effects the outcomes have on issues of assumption of responsibility and who is to blame. Neuroscience has the potential to have huge implications on these issues in the future and have already played a major part in the decision-making process in these cases.

Much concussion litigation is based on accusations against professional leagues, such as the NFL and the NHL, for concealing or misrepresenting the potential for concussions and the dangers of sustained concussions and the impact on future health complications. Many argue that the professional leagues should be responsible for these alleged injuries based on liability and breach

\[83\] Ibid at 830.
of duty of care. The professional leagues retort these claims by responding that “there was no scientifically proven link between repetitive traumatic head impacts and later-in-life cognitive/brain injury”. Yet, at the center of this controversy, despite concerns regarding its speculative nature and scientific uncertainty, neuroscience knowledge can be used to support the weights of these cases against the position of the professional leagues. As the science grows and technology increases exponentially, what role does the ability to diagnose brain disease from concussions play in these cases and how does this affect the future of the law?

### 4.1 Some Current Issues in Concussion Litigation

Much of the current concussion litigation surrounds the role that neuroscience can play in providing proof of concussions and brain disease that have been caused by the sport in question. There is strong evidence that neuroscience plays a huge role in the outcomes and rationale behind concussion litigation.

The cases against these professional sports leagues all concern claims that professional leagues acted negligently and failed to warn about the risks of concussions. In the NFL litigation, a number of NFL concussion injury cases was centralized into *In re: National Football League Players’ Concussion Injury Litigation*. The plaintiffs argued that the NFL failed to protect its players, misrepresented that there was no link between concussions and later-life cognitive disorders or brain injuries, fraudulently concealed the risks of head injuries and other facts and information which caused them to be exposed to harm, failed to regulate the sport in a manner that would prevent brain injuries, conspired to discount and reject the causal connection between concussions and the long-term effects of those injuries, negligently failed to warn of risks, failed

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84 *In Re: National Football Player’s Concussion Injury Litigation*, MDL 2323 (3rd Cir) at 308.
to disclose risks, and failed to adopt and enforce rules to minimize risks to players.\textsuperscript{85} The case was settled but it was made clear that the science was still lagging behind at the time and it was difficult to prove causation that the NFL’s breach of duty, through failure to inform the players of the dangers of head injuries and concussions and ignoring the medical community, led to these injuries.\textsuperscript{86}

Similarly, in the cases against the NCAA and NHL, much like related litigation in the NFL, it was argued that the leagues acted negligently and breached their duty to its athletes by not taking reasonable steps to prevent head injuries despite knowing how severe the repercussions may be for an athlete who suffers a head injury.\textsuperscript{87, 88} Both cases involve the centralization of a number of similar concussion-related injury cases into \textit{In re: National Collegiate Athletic Association Student-Athlete Concussion Injury Litigation}, and \textit{In re: National Hockey League Players’ Concussion Injury Litigation}, respectively. The plaintiffs allege that the medical science community has long recognized the debilitating effects of concussions and other traumatic brain injuries and has noted on numerous occasions and in various studies that repeated impact to the head can cause permanent brain damage and increase the risk of long-term cognitive decline and disability. According to the plaintiffs, the leagues were aware of, but disregarded, the general consensus of the medical science community and the mounting scientific literature regarding the long-term effects of concussions and head trauma or the link between concussions and certain sports. In the case of the NCAA, it was argued that the NCAA failed to implement any

\textsuperscript{85} \textit{Ibid.}
\textsuperscript{86} \textit{Ibid.}
\textsuperscript{87} \textit{In Re: National Collegiate Athletic Association Student-Athlete Concussion Injury Litigation} No. 13-CV-9116 (N.D. Ill. 2014).
\textsuperscript{88} \textit{In Re: National Hockey League Players’ Concussion Injury Litigation} No. 0:14-md-02551-SRN (D. Minn. 2014).
guidelines or rules to prevent repeated concussions or educate players about their increased risk, refused to endorse any of the recommended return to play procedures (and instead continued to allow players to play on the days immediately following their receipt of a concussion) and failed to take any action to educate its student athletes on the risks of repeated head traumas. Much like the NFL, both cases have been settled, subject to appeals.

The first issue at play is whether the leagues owe their players a duty of care. The discussion of responsibility and who bears the legal responsibility for injuries suffered by athletes is often highly fact dependent. In Canada, in the absence of legislation with respect to concussion-related injuries and diseases, tort principles establish duties of care owed by teams to their players. A professional team is under a duty to exercise reasonable care for the health and safety of team members. In the case of Robitaille v Vancouver Hockey Club Ltd, Robitaille suffered continual neck, shoulder, and arm pains. Management and medical staff were continuously warned of “shocking sensations” and pain, but many were of the belief that they were the result of “psychological problems”. The trial judge, after reviewing the medical evidence found that there were many “warnings of a potentially serious problem” and the defendants (the team) had actual notice of a serious medical problem. The trial judge found that had reasonable attention been paid to Robitaille’s welfare, he would have undergone a full medical and neurological examination prior to the game in which he suffered the contusion. As a result, his injury would have been discovered and he would not have played in the subsequent game, in which the injury was severely aggravated. The trial judge held that the defendant owed a duty to take

89 Ibid.
91 Ibid at para 16.
reasonable care to ensure that its players did not suffer undue or unnecessary risk of injury, and this duty included the obligation to provide medical care. The defendant breached its duty of care in failing to react reasonably to Robitaille’s complaints and symptoms, in failing to provide appropriate medical care and in putting pressure on him to ignore his injuries, which resulted in the permanent damage. The defendant raised an issue with Robitaille’s claim based on the collective bargaining agreement (CBA) between the NHL and Players' Association and argued that because of the existence of the CBA, the common law was irrelevant and no duties or rights arose out of the employer and employee relationship except those set out in the CBA. However, the court held that the existence of a collective agreement does not affect or eliminate the duty of care imposed on the defendant by the common law. There was nothing in the CBA that addressed liability for breach of the duty of care, and it did not expressly or implicitly exclude liability in tort. It is clear that the Robitaille case did not arise in the context of a concussion-based injury or disease. However, the case is important as it recognizes the obligation to provide medical care in cases involving a professional athlete employed by a team. These main principles can assist courts in navigating key issues with respect to the applicable duty and standard of care owed to players by their professional organization.

From cases such as Robitaille, it can be seen that leagues do owe their players a duty of care. In ignoring signs and symptoms and not adequately protecting their players, they have also breached that duty. However, the difficult issue in question is one of causation and its

92 Ibid at para 45.
93 Ibid at para 64.
94 Ibid at para 29.
determination in mental injuries and disease. For each case brought forward, causation will be determined on an individual basis. The plaintiffs from these various concussion cases argue that the professional leagues should have foreseen that coaches and trainers might allow (or even encourage) athletes to return to play before they fully recovered from their head injuries or before all of their concussion symptoms had subsided. Based on the recent publicity regarding concussions, there may be sympathy for the argument that the leagues are in a unique position to legislate rules that would protect athletes, that they knew these types of rules were necessary, and that their failure to promulgate appropriate rules caused foreseeable injuries to athletes whose concussions could have been prevented or who were improperly treated after being injured. The difficulty in these cases lies in the fact that concussions and CTE are not physical injuries that are visible but rather are manifested in the mind in the form of the build-up of tau proteins and neurofibrillary tangles, with symptoms that only allow an approximate diagnosis of the problem. Therefore, claims for compensation under these suits are difficult, if not impossible. However, with the advent of in vivo imaging technologies, these cases will come under a new light and will be discussed extensively in the next section.

5 Neuroscience and the Future of Tort Law

5.1 How Neuroscience Impacts the Future of Tort Law

As mentioned previously, tort law and the discussion on duty of care deal with different types of injuries. Tort law and duty of care and injuries are more adept at dealing with physical injury rather than invisible or emotional injuries, which can be seen by the difference in successful claims depending on the injury. Concussions and CTE are examples of a non-physical injury
that are both invisible and have symptoms that affect a person emotionally. This difference in how the type of injury affects how claims are being viewed by the law is evidenced by concussion-related injury litigation in NFL, NCAA, and NHL. All these cases were settled because the main point against the plaintiffs was that the duty owed was difficult to prove due to the nature of the injury when dealing with concussions and CTE. It is difficult to show causation, especially in cases of CTE, as it is difficult to show symptoms of the injury.

Neuroscience and neuroscience technology would allow for in vivo imaging and diagnosing of concussions and CTE, thereby blurring the lines between physical injury and emotional/invisible ones. As they uncover how these types of invisible injuries work in the brain, direct imaging of the brain and neuroscientific concepts allow for diseases of the mind to be recognized as “physical injuries”, as in the case of concussions. Some have already argued that these advances in neuroscience should encourage the law to revise its approach to this category of injury.96

Separate types of harm when applying tort law will no longer be needed as emotional and invisible injuries can now be imaged and diagnosed much the same as a physical one. Neuroscience research provides support that these mental injury doctrines are no longer needed and mental injuries should be assessed under traditional negligence claims.

Many legal doctrines place great weight on whether a particular injury is classified as physical or emotional, generally giving greater protection to the former. Traditionally, legal doctrines reflect the principle that we have a greater duty to take steps to avoid causing others physical injury than emotional injury. Claims of physical injuries tended therefore to be more successful. In the courts and in legislature, the line separating physical and emotional harm is now blurring, with

96 Grey, supra note 59.
mental illness being de-stigmatized and treated as akin to physical harm. For example, Shen discusses the increasing sentiment among policymakers and the public that “illness of the brain must be treated just like illness anywhere else in the body”. Concussions and CTE litigation offers a unique perspective that allows for a hybrid where a physical injury also manifests in emotional and psychological symptoms. This helps to bridge the gap between physical and emotional injuries and contributes to unifying the two concepts for injury claims.

This novel understanding of the basis of distinction between physical and emotional harm has its foundation in scientific advances and knowledge of emotional processing and how processes in the brain work. Accordingly, it offers a framework for identifying a duty for individuals to use their rational faculties to overcome emotional disturbances and to seek assistance for their mental infirmities if they wish to use the force of law to obtain redress. The aversion to claims for emotional injury has been based on a variety of concerns, most notably of a fear of fraudulent claims due to the subjective and unprovable nature of emotional/invisible injuries, and a reluctance to open the floodgates of litigation to the potentially limitless set of plaintiffs who could experience emotional suffering from any incident. Although technology does not provide us with the capacity to conclusively demonstrate the existence or severity of psychiatric and mental injuries, a sustainable justification for the physical/emotional hierarchy must confront technology’s increasing capacity to do so. One can use fMRI to measure the effects of certain

98 Ibid.
99 Goldberg, supra note 82.
types of psychological harm. Using fMRI and PET scans, scientists can study the types of “invisible injuries” that are normally considered non-physical, like pain and emotional distress and can be used by plaintiffs to prove their emotional or invisible injuries. Functional brain scanning technology is also beginning to have the capacity to objectively measure and demonstrate the changes in neural circuitry that accompany serious emotional harm.

Professor Jean Eggen provides support for this notion by arguing that concerns of blurring emotional and invisible suffering are largely remedied by the introduction of neuroscience into the law. She states that neuroscience is “poised to provide courts – and by extension the general public – with more accurate information about mental conditions, thereby leading to more accurate results in individual cases”. Eggen as well supports the notion that the civil justice system should treat mental disabilities and injuries as equivalent to physical ones in regards to recognizing the duty that people have to others in assessing liability. Neuroscience and neurotechnology provide crucial support for reforming the negligence doctrine so as to create an improved standard for mentally disabled and mentally injured parties in tort actions. Neuroscience evidence, when appropriately admitted, may reduce guessing in the courtroom about the relationship between the person’s mental condition and his or her behaviour in the circumstances of the case.

104 Ibid at 628.
105 Ibid at 629.
In light of science’s increasing ability to measure emotional harm, some scholars argue that continued dedication to the rigid categories of physical and emotional harm reflects backward, unscientific thinking.\footnote{United States v. Scheffer, 523 US 303 (US March 31 1998) at 308.} For example, Betsy Grey proposes that the American system of evaluating emotional distress should conform to the English approach which abolishes the distinction between physical and emotional harm and treats emotional harm “as an aspect of bodily harm” if the plaintiff can show a diagnosable psychiatric illness.

Not only does research indicate that emotional and invisible harms are rooted in and detected by physiological changes, but it also demonstrates that emotional injuries, such as pain, loss, or mental health issues, are as damaging as physical harms.\footnote{Cass R. Sunstein, “Illusory Losses” (2008) 37 J. Legal. Stud. 157 at 164.} These findings refute the argument underlying some courts’ efforts to maintain the physical/emotional distinction that emotional harms are trivial when compared to physical harms. The pain and suffering from mental injuries are not inconsequential.

Some scholars, however, argue that scholars and scientists who contend that emotional injuries are the same as physical injuries in their ability to be demonstrated objectively overstate their case. For example, the use of fMRI has many scientific limitations and is expensive to administer.\footnote{Goldberg, supra note 82 at 829.} As well, the most difficult aspect of neuroscience is that each brain is highly individualized, so it is difficult to determine what a “normal” brain looks like and thus whether the plaintiff’s brain is functioning abnormally.\footnote{Cassin, supra note 102 at 945.} Additionally, subjects usually do not have baseline scans to reveal whether their brains have been altered after a distressing event,
presenting major problems for causation. However, on this issue, neuroscience and neurotechnology can, in fact, provide an effective baseline of a healthy brain versus one that has been diseased or injured. Whenever one assesses the magnitude of an injury, they must consider not only a person’s condition at some post-injury endpoint but must also examine his baseline condition. Kolber uses an example where if a plaintiff has 20 units of pain after a leg injury, his harm is 20 units in magnitude, provided that he had no pain in his baseline condition. But if the plaintiff already had 5 units of pain from a pre-existing chronic condition and has a total of 20 units of pain after the injury, then the injury caused him 15 units of pain, representing the amount of harm caused by the defendant’s negligence. This is an obvious oversimplification but the importance of a baseline in assessment of damages in tort cannot be overstated. Even with the possible technology to measure people’s experiential states after some injury, we cannot accurately assess the amount of harm caused by that injury unless we know the injured person’s baseline condition. This measurement challenge is not insurmountable, however. Presumably, we assume that injured people had normal, ordinary baseline conditions prior to injury. This normal baseline can potentially be effectively established with sufficient data from non-injured individuals. With the advent of neurotechnology and neuroimaging, the changes in baselines for mental injuries and brain trauma can be observed and measured. In the case of concussion litigation, it would also be possible to establish a pre-CTE baseline of healthy individuals before sustaining mental injuries.

110 Goldberg, supra note 81 at 829.
5.1.1 Making the Subjective Objective

Neuroscience and neurotechnology will thus have the ability to aid in changing how injuries are assessed in tort law by providing an objective assessment of subjective experiences. As shown previously, concussions and other brain trauma manifest in psychological, mental illness symptoms such as anxiety, and pain that are invisible and emotional. Despite their importance to both civil and criminal law, there is limited ability to measure these experiences, even though legal proceedings turn to such measurements. Neuroscience and neurotechnology hold promise to improve the ability to measure these invisible experiences and symptoms. Professor Adam Kolber is among some scholars that argue that as new technologies emerge that better reveal people’s experiences, various aspects of the law, including tort law, ought to change fundamental aspects that take better account of people’s experiences.\(^\text{114}\) It is clear that when the law was developing, there were very poor methods of making inferences about experiences of others. Especially in situations of concussions and concussion symptoms and other mental injuries, many people try to express their feelings and emotions, but their claims are often under suspicion, especially when they have financial incentives to lie or exaggerate. Even when speaking truthfully, the nature and intensity of one’s feelings are very difficult to convey. Our experiences, feelings, and emotions are important aspects of the law. However, they cannot be observed directly. Technological advances in neuroscience are beginning to provide more accurate methods of measuring these seemingly subjective experiences. For example, brain imaging techniques could be used to more objectively assess a litigant’s pain.\(^\text{115}\) Brain imaging evidence of pain was employed in a worker’s compensation dispute.\(^\text{116}\) As mentioned

\(^{114}\) Kolber, supra note 111.

\(^{115}\) Kolber, supra note 60.

previously as well, the ability to image and diagnose mental disease, such as using biomarkers and fMRI technology allows one to find objective, measurable correlates of the pathophysiological processes involved in these different mental injuries and diseases.

Kolber further argues that tort law must take into account these subjective experiences, such as the ones that manifest in mental injuries, as they are generally relevant to damage assessments. These technologies should change the law in dramatic ways by measuring these experiences more directly, rather than using proxy measures of subjective pain and subjective symptoms.117 Technology already currently exists that helps assess the experiences of pain of individuals with the injury. It is generally difficult to assess the pain and suffering one with a concussion or CTE is going through, as symptoms can only be described. But now, images would tell a more concise story of the nature and extent of the trauma.

In the past, the law has expressed concern that a subjective rule for persons with mental injuries would encourage others to feign the symptoms of mental disabilities to escape their own tort liability. This policy rationale may have had some force in an era when mental injury diagnosis functioned without the assistance of technology.118 With the evolution of technologies that examine the brain both structurally and functionally and that may be used as diagnostic tools to identify functional impairments in the brain, the possibility of widespread fabrication of symptoms is diminished, though not eliminated.119

117 Kolber, supra note 111 at 589.
118 Eggen, supra note 103.
119 Ibid.
5.1.2 Some Caveats of Neurotechnology – In Tortious Claims and in Changing Tort Law

Despite the promise of neurotechnology, it has also been heavily debated whether neuroimaging and neurotechnology can be truly valuable in the context of law. Many commentators also caution against an overly enthusiastic espousal of studies that may promise more than they can deliver.¹²⁰ Instead, the law must exercise caution in the implementation of neuroscience and neurotechnology. Commentators are not in agreement about either the meaning of information obtained from neuroimaging or the utility of neuroscientific information in determining legal issues.¹²¹ Moreover, individual results may vary from averages employed in interpreting scan data and identification of the precise brain processes involved may be speculative, which is problematic and relevant in relation to the kinds of normative judgements that the law makes.¹²² Commentators have also warned that the technology of brain imaging and brain data have issues of full reliability, for example, stating that “the neuroscience of cognition and interpersonal behaviour is largely in its infancy”.¹²³

Nevertheless, this does not mean that neuroscience and neurotechnology have no use or effect on tort law or the law in general. Martha J. Farah has called for a balanced approach to the shortcomings and vulnerabilities of neuroimaging studies. She argues that concerns about the accurate statistical analyses of brain imaging data are generally no different than concerns about

statistical information in other disciplines.\textsuperscript{124} It is clear that there is still much to learn from the relation between neuroscience or neurotechnology and the law, but the potential changes that it can bring coupled with a cautious approach can provide for a beneficial amalgamation of neuroscience and tort law.

5.2 The Future: Resolution of Future Claims, and Assumption of Responsibility

Neuroscience has the potential to be transformative in nature with regards to the future of sports-related concussion litigation. This transformative potential made possible through neuroscience knowledge is particularly significant for professional players, such as NFL players, who have received various degrees of media attention regarding violent and aggressive tendencies off the field; spectacular headlines regarding suicides of retired players, instances of domestic abuse, or of violent murders, such as in the case of deceased former NFL player Aaron Hernandez.\textsuperscript{125} Medical diagnostics provide a possible rationale for this behavior that sideline the individual athlete’s responsibility, placing the blame instead on the constitutive rules of the sport and the professional sports organizations themselves. Understood in the wider discourse of public health, ‘sport as courageous’ is transformed into ‘sport as dangerous’: “for the individual engaged in this transformation of society’s morality of sport, his or her behavior can be understood as a by-product of a more fundamental moral problem with the practices inculcated in sport.”\textsuperscript{126}

With respect to concussion-related injury claims, *in vivo* imaging will allow for further evidence of causation. The *in vivo* diagnosis of CTE allows one to prove the existence of the invisible disease/injury and furthermore, will allow for the diagnosis of brain injuries and related diseases right after games and concussions – thereby proving a causation that the sport caused the injury. Concussion litigation settlements would change as professional organizations would not be able to argue that there is no link between concussions and head injuries sustained during play, and CTE and other related diseases. Former athletes looking for the highest potential compensation from these settlements would be able to claim more easily as they would be able to sue for negligence under tort law and have greater ease in proving causation, and further strengthening the idea that they were owed a duty of care and that it was breached.

The result of this, however, means that invisible injuries and emotional claims will become more prevalent in the future, as neuroscience will allow them to be treated like physical injuries. For example, brain injuries and concussion claims will become more prevalent and causation will be easier to prove as well. In order to avoid a floodgates situation, legislation and policy would be needed in order to ensure claims are minimized, and if there is a breach, that there are clear guidelines that can be followed. Professional sports leagues would have an increased duty of care owed to the players to ensure that safety precautions are taken, such as following concussion protocols and policies on how quickly an athlete can get back on the field after a concussion, as well as informing and educating the players of the risks that come with head injuries from contact sports. In addition, professional leagues will not only have to look at ways to protect current players from head injuries, they will also have to assume responsibility for players who are in retirement who may be suffering from CTE or other chronic brain disease or mental injuries. Professional leagues would only stand to benefit from such legislation and guidelines
nationwide in order to tackle these critical health issues regarding concussions and mental injuries related to their sports.

Concussion legislation and policies at the provincial/state level would also be needed to prevent a floodgates situation and would ultimately bring increased health and safety to athletes participating in sports where head injuries are prevalent. As a result of an understanding of these increased risks, some states and provinces in the United States and Canada have already begun to implement such measures. For example, Ontario has recently passed concussion legislation called Rowan’s law, which is intended to protect amateur athletes and educate coaches on the dangers of head injuries and concussions. The Rowan's Law Advisory Committee Act, 2016 establishes a committee to review the recommendations, to "review legislation, policies and best practices from other jurisdictions" and to make recommendations on "how to prevent and mitigate head injuries in sports and how to create awareness about head injuries in sports". Following its approval in March 2018, the law established removal-from-sport and return-to-sport protocols to ensure players are removed from competition if a concussion is suspected. Similarly, in the United States, primary legislation linking guidelines for athletes under 18 years old has been implemented as the Lystedt law. The law requires education around concussions and traumatic brain injuries in sport, clear return to play rules, and when it is required for a player to be reviewed by a healthcare professional with expertise in TBI. In many communities

there is considerable confusion about how to manage concussions and traumatic brain injuries
and this varies between countries as well.\textsuperscript{130} One suggested method of tackling these issues has
been to increase education measures and community management through the force of law.

It has been acknowledged that even mild TBI and mild concussions are common in the context
of contact sports and guidelines in professional leagues have begun to present themselves,\textsuperscript{131,132}
as well as in amateur leagues to deal with any possible concussive injuries. With legislation and
guidelines, as well as education programs, the assumption of responsibility may slowly be
shifting. Athletes involved in contact sports with risk of concussions may have to assume the
risks involved, especially when knowledge of possible harm is made known and guidelines are
there to be observed and followed. Depending on the circumstances, this may potentially
alleviate liability from professional sports leagues and organizations in the future, although it
will not affect past tortious cases. The duty of care may not apply only to sports organizations
but may fall on the shoulders of athletes themselves. The nature of future litigations may
change.

Internationally, outside North America, there is often also a lack of clear guidelines or a failure
to enforce them in regards to concussion related injuries.\textsuperscript{133} This was evident, for example,
during the 2014 World Cup of Football where three players lost consciousness after head injuries
and brain trauma and continued to play despite being clearly unfit.\textsuperscript{134} Neuroscience knowledge

\textsuperscript{130} David J Sharp & Peter O Jenkins, “Concussion is confusing us all” (2015) 15:3 Pract Neurol 172.
\textsuperscript{131} NFL Concussion Protocol and Secondary Concussion Protocol, 2014,
\textsuperscript{132} IRB Concussion Management and Secondary IRB Concussion Management, 2015, online:
\textsuperscript{133} "Tackling the sports-related concussion crisis", (2014) 13:8 Lancet Neurol 747.
\textsuperscript{134} Ibid.
with resulting laws and legal guidelines could potentially lead to new global and international standards of concussion management. There is considerable value in developing consensus guidelines that apply across sports, in order to eliminate inconsistency, and across national and international lines.

6 Conclusion

It has been argued that the law has much to adapt to in regards to increasing neuroscience knowledge and that neuroscience can change the fabric of legal cases. Neuroscience has much to offer the law and presents a possibility for refining and adapting it to current understandings, as can be seen with the distinction in tort law between physical and mental injuries.

As neuroscience and neurotechnology continue to advance, the law should adapt accordingly. Neurolaw’s impact on tort law has wide ranging implications on future cases, as can be seen using the example of recent concussion litigation. Few activities and events grab the public’s attention like sports and, therefore, no injury currently produces stronger interest than concussions and to some lesser extent traumatic brain injuries. Headers in soccer, helmet-to-helmet hits in football and hockey, or intense combat in mixed martial arts are all potential mechanisms for brain injuries and concussions that are felt daily both in recreational sports leagues as well as professional ones. This epidemic has become increasingly noticeable within the public eye. The World Health Organization and others report that these types of traumatic brain injuries are becoming one of the top global causes of acquired disability and represent a
major public health issue.\textsuperscript{135} While concussion awareness has improved over the years and particularly over the past decade, understanding the nuances of these types of brain injuries, their severity, symptoms, and treatment options, are still a work in progress. Advances in how neuroscience and the law affect these cases will have an impact on future policies within the realm of sports and how organizations at all levels deal with these types of head injuries.

Tort law and the treatment of differing types of injuries is only one area that neuroscience can have an impact. Much like tort law, the nature of past rules could change in relation to advances in the science of the brain. In the future, there are many other areas of the law that can be further explored using neuroscience. An example is health law, and specifically mental health law, where neuroscience and neurotechnology can make potential significant contributions. Psychiatric disorders and mental illnesses have biological bases which neurotechnology can potentially present visually. Notwithstanding the possibility of affecting the de-stigmatization of issues such as depression, schizophrenia, alcoholism, substance abuse, eating disorders or other addictions, neuroscience and neurotechnology may impact how law cases arising from these conditions will be handled and judged based on the scientific/neural evidence that can be provided. Neuroscience and neurotechnology can bring a fresh, new perspective. Their impact on law can be far reaching.

The challenge to bringing the two disciplines – law and neuroscience – effectively together lies greatly in the extent to which those practicing in the two divergent fields understand and talk to each other. One immediate, promising area that can be explored, for example, is the linking of

\textsuperscript{135} Christopher C Giza et al, “It’s Not All Fun and Games: Sports, Concussions, and Neuroscience” (2017) 94:6 Neuron 1051.
current legal standards (in tort law related to injuries) with neuroscientific principles. This cannot be easily accomplished because each field has its own language and jargon that place major obstacles in the path to crossover with each other. Undoubtedly, more research in neuroscience, neurotechnology, and the benefits to law should be undertaken. But critically, in order to realize the full potential, each discipline needs to make the technical jargon more accessible and understandable for the other side. This would help with issues of translation of brain trauma and brain injuries principles within the law. A better dialogue between neuroscience and law will mean a better understanding of what is needed for the fullest contributions to be made.
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