APPLYING THE BRAIN-COMPUTER INTERFACE DISCOURSE TO NEGLIGENCE

SCOTT KIEL-CHISHOLM*

The incorporation of brain-computer interface ("BCI")—sophisticated bio-digital neural interface technologies—into the human body introduces new complexity in attributing liability for acts and omissions. This article argues that the BCI discourse in the science and philosophy disciplines, including ethics, psychology, technology, and artificial intelligence, will assist the courts in applying the law of negligence where a party has a BCI. This is achieved by examining the dynamics of BCI control and identifying the reasonable foreseeability of the risk of harm to others. The BCI discourse also provides insight into the precautions the BCI user could take against this risk of harm.

* Lecturer, Queensland University of Technology Law School and Researcher, Humans Technology Law Centre. I thank Dr. Kieran Tranter and Dr. Afshin Akhtar-Khavari for their invaluable guidance and feedback on prior versions of this paper.

INTRODUCTION

It has long been acknowledged, by courts at least, that law is "marching with medicine but in the rear and limping a little."[1] This is particularly the issue with brain-computer interface ("BCI"). BCI is "the successful sensing of neural activity to provide a command signal to control computers, machines, or any of a range of prosthetic devices that span from physical to biological elements."[2] As illustrated in Figure 1 below, the components of BCI include a neural sensor, a neural processor or decoder, and an assistive device. What were just human acts and omissions become an unprecedented combination of human brain and artificial device. Scholars in the science and philosophy disciplines, including ethics, psychology, technology, and artificial intelligence, actively engage in developing the BCI discourse. This BCI discourse, as an umbrella term, explores and debates how human action and responsibility can be determined in this evolving neural interface world.[3]

An understanding of the technical operation of BCIs is important for the analysis of the BCI discourse and negligence. For this purpose, a brief overview of the BCI technology is provided in Part 1. Recognizing that BCI malfunction gives rise to product liability issues, the analysis throughout this article is premised on the BCI operating in compliance with the Therapeutic Goods

1. *Mount Isa Mines Ltd v Pusey*, (1970) 125 CLR 383, 395 (Austl.).

2. John P Donoghue et al., *Assistive Technology and Robotic Control Using Motor Cortex Ensemble-Based Neural Interface Systems in Humans with Tetraplegia* 579(3) J. PHYSIOLOGY 603, 603–04 (2007).

3. While not exhaustive, the following articles of science and philosophy scholars generally address neural interface issues: Rutger Vlek et al., *BCI and a User's Judgment of Agency*, *in* BRAIN-COMPUTER INTERFACES IN THEIR ETHICAL, SOCIAL, AND CULTURAL CONTEXTS 193 (Gerd Grübler & Elisabeth Hildt eds., 12th ed. 2014); Ishan Dasgupta et al., *BCI Mediated Action and Responsibility: Questioning the Distinction Between Recreation and Necessity*, 11 AJOB NEUROSCIENCE 63, 65 (2020); Joseph Michael Vukov & Kit Rempala, *BCI-Mediated Action, Blame, and Responsibility*, 11 AJOB NEUROSCIENCE 65 (2020); Gerd Grübler, *Beyond the Responsibility Gap: Discussion Note on Responsibility and Liability in the Use of Brain-Computer Interfaces*, 26 AI & SOC'Y 377 (2011); Tom Buller, *Brain-Computer Interfaces and the Translation of Thought into Action*, 14 NEUROETHICS 155 (2020) [hereinafter Buller 1]; Birgit Nierula & Maria V. Sanchez-Vives, *Can BCI Paradigms Induce Feelings of Agency and Responsibility Over Movements?, in* BRAIN-COMPUTER INTERFACE RESEARCH: A STATE-OF-THE-ART SUMMARY 103 (Christoph Guger et al. eds., 2019); Tom Buller, *How to Do Things with BCIs*, 11 AJOB NEUROSCIENCE 70 (2020) [hereinafter Buller 2]; Andreas Kuersten, *Legal Ramifications of Brain-Computer-Interface Technology*, 11 AJOB NEUROSCIENCE 61 (2020); Stephen Rainey et al., *When Thinking Is Doing: Responsibility for BCI-Mediated Action*, 11 AJOB NEUROSCIENCE 46 (2020); Jan-Philip Van Acken, *Tracking the Sense of Agency in BCI Applications* 25 (2012) (unpublished Ph.D dissertation, Radboud University) (on file with ResearchGate).

Administration ("TGA") accreditation,[4] despite limitations inherent in BCI. For this reason, recourse under consumer protection legislation is not discussed. To assist with the analysis of the application of the BCI discourse to the law of negligence, a real-life scenario and a brief introduction to the law of negligence are provided in Parts I.A and I.B, respectively.

This article argues that the BCI discourse will assist courts in applying the law of negligence, that is, the Civil Liability Legislation[5] and common law in Australia, to circumstances where a party has a BCI. This is achieved by the recognition of the unique interplay between a human brain and a BCI that leads to identifying reasonable foreseeability of the risk of harm in the context of an inability to competently control the BCI, provided in Part II. Further, the BCI discourse provides insight into the precautions a reasonable person in the position of the individual with a BCI would have taken in the circumstances. These precautions include training of the person with the BCI to enable development of the skills in controlling the BCI and knowledge of the limitations of the BCI. This analysis is also provided in Part II.

For these reasons, the expertise provided by the BCI discourse will assist courts in resolving negligence actions.[6] Carolyn Sutherland recognized that Australian courts regularly draw upon social science evidence.[7] Kylie Burns, evidenced in judgments of the High Court of Australia, revealed how the court has applied other disciplinary perspectives to the law in negligence proceedings.[8] Burns identified statements made by the court about "the nature

4. *Therapeutic Goods Administration (TGA)*, AUSTL. GOV'T: DEP'T OF HEALTH & AGED CARE, https://www.tga.gov.au/ [https://perma.cc/YR9N-YPYK] (last visited Apr. 16, 2024).

5. *Civil Law (Wrongs) Act 2002* (ACT) [hereinafter *CLWACT*]; *Civil Liability Act 2002* (NSW) [hereinafter *CLANSW*]; *Civil Liability Act 2003* (Qld) [hereinafter *CLAQ*]; *Civil Liability Act 1936* (SA) [hereinafter *CLAS*]; *Civil Liability Act 2002* (Tas) [hereinafter *CLAT*]; *Wrongs Act 1958* (Vic) [hereinafter *WAVIC*]; *Civil Liability Act 2002* (WA) [hereinafter *CLAWA*]; (altogether, these Acts are referenced throughout this article as the "Civil Liability Legislation"). The Northern Territory does not have similar legislation, but the *Personal Injuries (Liabilities and Damages) Act* (NT) applies to personal injuries. The Long Title states "An Act to modify the law relating to the entitlement to damages for personal injuries, to clarify principles of contributory negligence, to fix reasonable limits on certain awards of damages for personal injuries, to provide for periodic payments of damages for personal injuries, and for related purposes."

6. *Law and Other Disciplines*, GEO. L., https://curriculum.law.georgetown.edu/jd/law-other-disciplines/ [https://perma.cc/9378-WME2] (last visited Apr. 16, 2024).

7. Carolyn Sutherland, *Interdisciplinarity in Judicial Decision-Making: Exploring the Role of Social Science in Australian Labour Law Cases*, 42 MELB. U. L. REV. 232, 244 (2018).

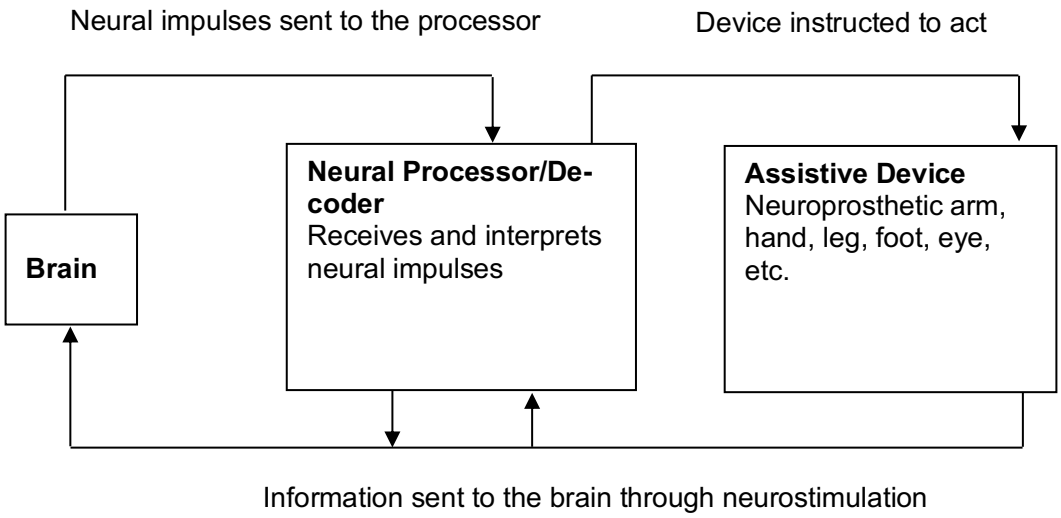
8. Kylie Burns, *The Australian High Court and Social Facts: A Content Analysis Study*, 40 FED. L. REV. 317, 318 (2012).

and behavior of people and institutions and the nature of the world and society."[9] These social facts appear in judicial reasoning, having been admitted into evidence as expert evidence or through "evidential rules dealing with documentary and other special forms of evidence."[10] As a result of these observations, the ways in which the human brain interacts with a BCI and the behavior of individuals with a BCI could become social facts that impact judicial reasoning in negligence proceedings.

I. BCI TECHNOLOGY

The ability to record, decode, and replicate neural impulses is limited,[11] so the integration of BCIs into a human being may present challenges for the application of the current law of negligence. BCI enables efferent (brain-to-body) communication known as "open-loop" communication, and afferent (body-to-brain) communication, known as "closed-loop" communication, between a human brain and artificial devices. This is captured diagrammatically in Figure 1.

Figure 1 The Closed-Loop Brain-Computer Interface Technology



There is a broad range of BCI devices being developed, each modified to the task of utilizing neural impulses to command an

9. *Id.* at 317.
10. *Id.* at 319.
11. XILIN LIU & JAN VAN DER SPIEGEL, BRAIN-MACHINE INTERFACE 137, 156–58, 162 (2018).

assistive device. These include the LUKE arm,[12] the bionic ear (or cochlear implant),[13] BrainGate,[14] the bionic eye developed by Bionic Vision Australia,[15] the Bionic Spine,[16] the mind-controlled exoskeleton developed by the Duke University Center for Neuroengineering,[17] and neuroprosthetic limbs developed by the Johns Hopkins University Applied Physics Laboratory.[18]

Interpreting neural impulses requires decoders to perform exceptionally complex mathematical computations and modelings.[19] This complexity results in a degree of inaccuracy when integrating the BCI with the neuron-dense brain.[20] In addition, communication from the assistive device to the brain may be less than 100 percent accurate, which contributes to a degree of unreliability.[21] This affects the instructions and feedback that are sent to and from the assistive device. Likewise, whilst neurons can be accessed for information, they can also be unreliable.[22] The mechanical network and mechanical waves that move along nerves and play a role in communication to and from the brain are so

12. *LUKE Arm Details*, MOBIUS BIONICS, http://www.mobiusbionics.com/luke-arm [https://perma.cc/G57G-Z8F5] (last visited Apr. 16, 2024).

13. *Products and Accessories*, COCHLEAR, https://www.cochlear.com/au/en/home/products-and-accessories?%2F2579.asp [https://perma.cc/9GUR-L7A3] (last visited Apr. 16, 2024); *Cochlear Implants: About This Life-Changing Technology*, MED-EL, https://www.medel.com/en-au/hearing-solutions/cochlear-implants [https://perma.cc/7L8Z-7EM6] (last visited Apr. 16, 2024).

14. *About Braingate*, BRAINGATE, https://www.braingate.org/about-braingate/ [https://perma.cc/HE7J-7N5D] (last visited Apr. 16, 2024).

15. *Bionic Eye Research*, BIONICS INST., https://www.bionicsinstitute.org/our-research/hearing-and-vision-research/bionic-eye-research [https://perma.cc/HJ8A-VUYK] (last visited Apr. 16, 2024).

16. Grant McArthur, *Australian 'Bionic Spine' Invention Brings Hope to People with Disabilities*, KIDS NEWS (Oct. 29, 2020, 7:00 PM), https://www.kidsnews.com.au/science/australian-bionic-spine-invention-brings-hope-to-people-with-disabilities/news-story/0a023897e6564305fb8645a629e8787f [https://perma.cc/9DB9-XNVN]; Bridie Smith & Science Editor, *Human Trials for Australian-made Bionic Spine to Start Next Year*, SYDNEY MORNING HERALD (Feb. 8, 2016, 10:21 PM), http://www.smh.com.au/technology/scitech/human-trials-for-australianmade-bionic-spine-to-start-next-year-20160202-gmjqdj.html [https://perma.cc/LE3Y-Q9ZR].

17. Miguel A. L. Nicolelis, *Mind in Motion*, 307 SCI. AM. 58, 58 (2012).

18. *Quadriplegic Patient Uses Brain Signals to Feed Himself with Two Advanced Prosthetic Arms*, JOHN HOPKINS UNIV. APPLIED PHYSICS LAB'Y (Dec. 14, 2020, 4:50 PM), https://www.newswise.com/articles/quadriplegic-patient-uses-brain-signals-to-feed-himself-with-two-advanced-prosthetic-arms [https://perma.cc/7QNE-4AMD].

19. Sung-Phil Kim et al., *Point-and-Click Cursor Control with an Intracortical Neural Interface System by Humans with Tetraplegia*, 19 IEEE TRANSACTIONS ON NEURAL SYS. & REHAB. ENG'G 193, 196 (2011).

20. *Id.* at 194, 196, 201; Warren M Grill et al., *Implanted Neural Interfaces: Biochallenges and Engineered Solutions*, 11 ANN. REV. BIOMEDICAL ENG'G 1, 10 (2009).

21. Liu & Van der Spiegel, *supra* note 11, at 156–58, 162.

22. MALCOLM GAY, THE BRAIN ELECTRIC: THE DRAMATIC HIGH-TECH RACE TO MERGE MINDS AND MACHINES 16 (2015).

small—only ten micrometers[23]—that it is difficult to research the phenomenon.[24]

A. The Scenario

For the purposes of applying the BCI discourse to the law of negligence in this article, the following scenario is used:

A person with neuroprosthetic legs (BCI driver) is driving a regular motor car along a side street and fails to stop at an intersection that has a "Give Way" sign facing the BCI driver, which requires the BCI driver to give way to all other road users. As the BCI driver moves through the intersection, a vehicle that has the right-of-way passes in front of the BCI driver, and the BCI driver's car collides with the side of the other vehicle.

B. Introduction to the Law of Negligence

While most of the Civil Liability Legislation recognizes what duty of care and negligence mean,[25] the cause of action in negligence is at common law, so the duty of care is also at common law. The range of circumstances in which a duty of care is owed by one to another (fellow road users, employer and employee, and the like) is very well traversed. Whether or not a person has a BCI is unlikely to affect the existence or application of a duty of care owed to others in respect of existing, recognized established duties of care. This is because the relationship between the person with a BCI and others that give rise to the duty of care does not differ as a result of the BCI's existence.

In respect to the above scenario, as the driver of a motor car, the BCI driver has an established duty of care to other drivers and

23. "A 'micron' is an abbreviated term for 'micrometer', or a millionth of a meter (1/1,000,000 meters). For size comparison, a human red blood cell is about 5 microns across. A human hair is about 75 microns across (depending on the person)." *How Big Is a Micron?*, BACTERIA WORLD, http://www.bacteria-world.com/how-big-micron.htm [https://perma.cc/8TRV-9A37] (last visited Mar. 16, 2024).

24. Anil Ananthaswamy, *Like Clockwork: The Cogs and Wheels That Drive Our Thoughts*, NEW SCIENTIST, Aug. 31–Sept. 6, 2013, at 33, 34.

25. "***Duty of care***" means a duty to take reasonable care or to exercise reasonable skill (or both duties): *CLAQ* Schedule 2; ***Duty*** means – (a) a duty of care in tort; or (b) a duty of care under contract that is co-extensive with a duty of care in tort; or (c) another duty under statute or otherwise that is co-extensive with a duty of care referred to in paragraph (a) or (b); *CLAT* s 3 (Austl.); "***negligence***" means failure to exercise reasonable care and skill: *CLANSW* s 5; "***Duty of care***" means a duty to take reasonable care or to exercise reasonable skill (or both): *CLA*S s 3 (Austl.); "***Negligence***" means failure to exercise reasonable care: *WAVIC* s 43 (Austl.); "***negligence***" means failure to exercise reasonable care and skill': *CLWACT* s 40 (Austl.). There is no equivalent provision in the Northern Territory or Western Australia.

those alongside the road.[26] The scope of the duty "is to use proper care not to cause injury to persons on the highway or in premises adjoining the highway."[27] To determine whether or not the BCI driver was negligent, courts consider the foreseeability of the risk of harm and the negligence calculus[28] by applying the Civil Liability Legislation.[29] This will establish whether or not the BCI driver breached the duty of care to other road users when they went through the "Give Way" sign and hit the oncoming car. The following analysis considers how the expertise provided by the BCI discourse will assist in determining a breach of duty of care, in particular, the reasonable foreseeability of the risk of harm and the precautions the BCI could have taken against those risks.

II. BREACH OF DUTY OF CARE

The Civil Liability Legislation modified the common law by providing a framework to determine breach of the common law duty of care, and in doing so, the legislation substantially reflected the common law.[30] In applying the Civil Liability Legislation to determine breach of the duty of care, the court will look to common law, through the lens of the legislation.[31] The first step is to determine what standard of care is expected of the BCI driver. In establishing whether a person has breached the duty of care, in terms of a failure to take precautions against the risk of harm, the risk must be foreseeable—that is, a risk an ordinary person foresaw or ought to have foreseen.[32] That risk must have been not insignificant[33] and in the circumstances, a reasonable person in the position of the defendant would have taken precautions.[34]

26. *Imbree v McNeilly* (2008) 236 CLR 510 (Austl.).

27. *Bourhill v Young* [1943] AC 92, 104 (Scot.); *see also id.* at 9.

28. DAVID IPP ET AL., REVIEW OF THE LAW OF NEGLIGENCE FINAL REPORT 102–03 [7.7] (2002).

29. *CLWACT* s 43; *CLANSW* s 5D; *CLAQ* s 9; *CLAS* s 34; *CLAT* s 13; *WAVIC* s 51; *CLAWA* s 5C.

30. *CLWACT* ss 43, 45(1); *CLANSW* ss 5B, 5D(1); *CLAQ* ss 9, 11(1), *CLAS* ss 32, 34(1); *CLAT* ss 11,13(1); *WAVIC* ss 48, 51(1); *CLAWA* ss 5B; 5C(1).

31. *CLWACT* s 43; *CLANSW* s 5D; *CLAQ* s 9; *CLAS* s 34; *CLAT* s 13; *WAVIC* s 51; *CLAWA* s 5C.

32. IPP ET AL., *supra* note 28, at 102.

33. *Id.* at 105.

34. *CLWACT* s 43; *CLANSW* s 5D; *CLAQ* s 9; *CLAS* s 34; *CLAT* s 13; *WAVIC* s 51; *CLAWA* s 5C. There is no equivalent provision in the Northern Territory. For example, in the *CLAQ* s 9:

Chapter 2 Civil liability for harm
Part 1 Breach of duty
Division 1 General standard of care

A. Standard of Care

The court applies an objective test when determining the standard of care.[35] The court must establish what a reasonable person would have done in the particular situation by taking into account all the circumstances of the matter at hand. Courts have generally been reluctant to consider the individual characteristics of a person.[36]

The general rule, which applies in determining cases where the plaintiff is seeking damages for negligence, weighs against the court taking into account the specific characteristics of the defendant.[37] However, it could be argued that a defendant with a BCI falls within a specific class of person for whom the court should recognize a different standard of care from that of the objective, reasonable person, because the BCI cannot be considered identical to a biological limb. The ability of the device to interpret neural impulses, whilst very good, is not functionally equivalent.[38] The BCI discourse recognizes this.[39] There are circumstances in which the standard of care expected of a person takes account of some matters or activities that require a standard of care different from that of some wholly general and objective community ideal.[40] For example, a different standard of care has been recognized by the courts for various classes of defendants including children,

9 General principles
(1) A person does not breach a duty to take precautions against a risk of harm unless—
(a) the risk was foreseeable (that is, it is a risk of which the person knew or ought reasonably to have known); and
(b) the risk was not insignificant; and
(c) in the circumstances, a reasonable person in the position of the person would have taken the precautions.
(2) In deciding whether a reasonable person would have taken precautions against a risk of harm, the court is to consider the following (among other relevant things)—
(a) the probability that the harm would occur if care were not taken;
(b) the likely seriousness of the harm;
(c) the burden of taking precautions to avoid the risk of harm;
(d) the social utility of the activity that creates the risk of harm.

35. *See* Glasgow Corporation v. Muir [1943] AC 448 at 454 (UK); Bolton v Stone [1951] AC 850 at 860 (UK); Paris v Stepney Borough Council [1951] AC 367 at 384 (UK); *see also CLAQ* s 9; *CLAT* s 11; *CLAT* s 5B; *CLAWA* s 5B; *CLAS* s 31; *WAVIC* s 58.

36. JOHN G. FLEMING, THE LAW OF TORTS 107–13 (Carolyn Sappideen & Prue Vines eds., 10th ed. 2011).

37. OLIVER WENDELL HOLMES JR., THE COMMON LAW 108 (1881); *Nettleship v Weston* [1971] 2 QB 691, 707–09 (Eng.); *McHale v Watson* (1966) 115 CLR 199, 228 (Austl.) citing *Glasgow* AC 448 at 454 (UK); *Imbree v McNeilly* (2008) 236 CLR 510 (Austl.).

38. Kengo Ohnishi et al., *Neural Machine Interfaces for Controlling Multifunctional Powered Upper-limb Prostheses*, 4(1) EXPERT REV. MED. DEVICES 43, 43 (2007).

39. Rainey et al, *supra* note 3, at 49.

40. *Imbree v McNeilly* (2008) 236 CLR 510, 527 (Austl.).

professionals, and persons with a physical disability.[41] These different standards of care highlight the court's willingness to consider the special circumstances that exist with a specific class of individuals, and courts can apply this consideration to those with a BCI.

Courts might establish a new standard of care: a reasonable person with the same or similar BCI in the same or similar circumstances. The new standard of care recognizes that the *functioning* of BCI—the brain, the neural processor, and the assistive device—is different from that of an able person with no BCI. This functioning is highlighted by the BCI discourse.[42] It is the ability of the person to act in unison with the BCI that will determine the appropriate standard of care that the defendant with a BCI owes to the public, regardless of what task is being undertaken—be it driving a car, building a house, transplanting a kidney, or any other task. Applied to the scenario, it could be argued that the standard of care of the BCI driver would be that of a reasonably competent driver with the same, or similar, neuroprosthetic legs in the same, or similar, circumstances.[43] However, whether courts will determine that a different standard of care should be applied to a person with a BCI remains uncertain,[44] so the analysis below regards the BCI driver's standard of care as the same as a driver without a BCI.

In considering the reasonable person in the position of the BCI driver, the BCI discourse provides valuable insight. Rainey et al. use the analogy of driving a car and assert that the person with a BCI is like an untrained driver.[45] They assert that this difference in operation means the action of the person with a BCI is device control, or tool use, rather than controlling the actions of the body.[46] They explain:

> Driving is not simply an ensemble of discrete events, ordered in time. Driving is a skill that can be acquired, that can be

41. *See*, *e.g.*, *McHale v Watson* (1964) 115 CLR 199 (Austl.) (children); *Rogers v Whitaker* (1992) 175 CLR 479 (Austl.) (medical practitioners); *Heydon v NRMA Ltd* (2000) 51 NSWLR 1 (Austl.); *Badenach v Calvert* (2016) 257 CLR 440 (Austl.); *D'Orta-Ekenaike v Victoria Legal Aid* (2005) 223 CLR 1 (Austl.); *Butcher v Lachlan Elder Realty Pty Ltd* (2004) 218 CLR 592 (Austl.) (lawyers); *South Australian Ambulance Transport Inc. v Walhdeim* (1948) 77 CLR 215 (Austl.); *CLAS* s 31(2) (physical disability).

42. Marcel van Gerven et al., *The Brain-Computer Interface Cycle*, 6(4) J. NEURAL ENG'G 1, 2 (2009) (quoted in Vlek et al., *supra* note 3, at 193).

43. *Imbree v McNeilly* (2008) 236 CLR 510, 521 (Austl.).

44. The possibility of a different standard of care was explored by the author of this article in Scott Kiel-Chisholm & John Devereux, *The Ghost in the Machine: Legal Challenges of Neural Interface Devices*, 23 TORTS L. REV. 32 (2015).

45. Rainey et al, *supra* note 3, at 50.

46. *Id.* at 51–52.

> reduced to simple, discrete actions. But the reduction would miss the point—driving as a patterned activity in itself. How this is seen affects how we can assess the foreseeability of outcomes from the perspective of the controller. In terms of the car example, this is like the distinction between the trained and untrained driver. In the case of BCI action, the themes are similar and will condition how we ought to ascribe responsibility to specific BCI-mediated acts.[47]

There are many cases in negligence regarding tool use, including cars.[48] However, a learner driver will be held to the same standard of care as any other driver in fulfilling the learner's duty to take reasonable care to avoid injuring other road users.[49] It is clear, then, that the BCI driver will have a standard of care of a reasonably competent motor vehicle driver. The court will apply the standard of care to the BCI driver and then determine, on the facts, whether the BCI driver achieved that standard. If the BCI driver did not achieve the required standard of care, they will be considered to have breached their duty of care.

B. Determining Whether or Not the Standard of Care Is Achieved

The BCI discourse contributes significantly to the foreseeable risk of harm, the first of the legislative provisions in determining whether there is a breach of duty of care.[50] The other provisions consider the precautions the person with the BCI would have taken.[51] If the risk is not foreseeable in the circumstances, then the law will not find negligence: "[A] person cannot be liable for failing to take precautions against an unforeseeable risk."[52] The discussion in Part II.B.1 reveals insight into the functionality of BCI that will assist the court in finding that a risk of harm is foreseeable. Parts II.B.2 and II.B.3 complete the review of breach of duty of care.

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47. *Id.* at 51.

48. *See, e.g.*, *Caltex Oil (Aust) Pty Ltd v The Dredge Willemstad* (1976) 136 CLR 529) (Austl.) (dredging equipment); *Fortuna Seafoods Pty Ltd (As Trustee for the Rowley Family Trust) v The Ship 'Eternal Wind'* [2008] 1 Qd R 429 (Austl.) (fishing trawlers); *Fallas v Mourlas* (2006) 65 NSWLR 418 (Austl.) (firearms); (*Perisher Blue Pty Ltd v Nair-Smith* (2015) 295 FLR 153 (Austl.) (ski resort lifts); *Imbree v McNeilly* (2008) 236 CLR 510, 510 (Austl.) (cars).

49. *Id.*

50. *CLWACT* s 43(1)(a); *CLANSW* s 5B(1)(a); *CLAQ* s 9(1)(a); *CLAS* s 32(1)(a); *CLAT* s 11(1)(a); *WAVIC* s 48(1)(a); *CLAWA* s 5B(1)(a).

51. *CLWACT* s 43(1)(c); *CLANSW* s 5B(1)(c); *CLAQ* s 9(1)(c); *CLAS* s 32(1)(c); *CLAT* s 11(1)(c); *WAVIC* s 48(1)(c); *CLAWA* s 5B(1)(c).

52. Ipp et al., *supra* note 28, at 103 [7.7].

In determining whether the BCI driver has achieved the standard of care expected, the Civil Liability Legislation provides that the BCI driver does not breach their duty of care unless: (i) the risk was foreseeable;[53] (ii) the risk was not insignificant in the circumstances;[54] and (iii) a reasonable person in the position of the BCI driver would have taken the precautions.[55]

In deciding whether a reasonable person would have taken precautions against a risk of harm, the court is to consider, amongst other relevant things: (i) the probability that the harm would occur if care were not taken;[56] (ii) the likely seriousness of the harm;[57] (iii) the burden of taking precautions to avoid the risk of harm;[58] and (iv) the social utility of the activity that creates the risk of harm.[59]

1. Foreseeability of Risk of Harm

From a negligence perspective, it is the foreseeability of the risk of harm to others that is considered when determining if the standard of care has been achieved.[60] Vokov and Rampala argue that as a result of the complexity of BCI functionality, there will be difficulty determining the foreseeability of risks: "[I]ndeed, before the advent of BCI technologies, philosophers had long wrestled with which standards for control and foreseeability are necessary for holding someone morally responsible."[61] Despite this uncertainty, it is reasonably foreseeable that if the BCI driver does not achieve the standard of care of a reasonably competent driver, the person or property of others will be at risk of injury or damage, respectively.

53. *CLWACT* s 43(1)(a); *CLANSW* s 5B(1)(a); *CLAQ* s 9(1)(a); *CLAS* s 32(1)(a); *CLAT* s 11(1)(a); *WAVIC* s 48(1)(a); *CLAWA* s 5B(1)(a).

54. *CLAQ* s 9(1)(b); *CLWACT* s 43(1)(b); *CLANSW* s 5B(1)(b); *CLAS* s 32(1)(b); *CLAT* s 11(1)(b); *WAVIC* s 48(1)(b); *CLAWA* s 5B(1)(b).

55. *CLWACT* s 43(1)(c); *CLANSW* s 5B(1)(c); *CLAQ* s 9(1)(c); *CLAS* s 32(1)(c); *CLAT* s 11(1)(c); *WAVIC* s 48(1)(c); *CLAWA* s 5B(1)(c).

56. *CLWACT* s 43(1)(a); *CLANSW* s 5B(1)(a); *CLAQ* s 9(1)(a); *CLAS* s 32(1)(a); *CLAT* s 11(1)(a); *WAVIC* s 48(1)(a); *CLAWA* s 5B(1)(a).

57. *CLAQ* s 9(2)(b); *CLWACT* s 43(1)(b); *CLANSW* s 5B(1)(b); *CLAS* s 32(1)(b); *CLAT* s 11(1)(b); *WAVIC* s 48(1)(b); *CLAWA* s 5B(1)(b).

58. *CLWACT* s 43(2)(c); *CLANSW* s 5B(2)(c); *CLAQ* s (2)(c); *CLAS* s 32(2)(c); *CLAT* s 11(2)(c); *WAVIC* s 48(2)(c); *CLAWA* s 5B(2)(c).

59. *CLWACT* s 43(2)(d); *CLANSW* s 5B(2)(d); *CLAQ* s 9(2)(d); *CLAS* s 32(2)(d); *CLAT* s 11(2)(d); *WAVIC* s 48(2)(d); *CLAWA* s 5B(2)(d).

60. *CLWACT* s 43(1)(a); *CLANSW* s 5B(1)(a); *CLAQ* s 9(1)(a); *CLAS* s 32(1)(a); *CLAT* s 11(1)(a); *WAVIC* s 48(1)(a); *CLAWA* s 5B(1)(a).

61. Vukov & Rempala, *supra* note 3, at 65.

To better foresee the risks of harm in the use of BCI, the BCI discourse applies the concept of "agency." "[I]n social science, agency is the capacity of individuals to act independently and to make their own free choices."[62] Buller questions whether a movement by a person with a BCI can accurately be regarded as action that attracts liability because, "[a]ctions are the product of a complex interplay of dispositional and occurrent, conscious and unconscious, psychological states."[63] Additionally, "[t]he novelty and limited functionality and sensory feedback of present BCIs challenge this equation."[64] Buller states that "BCI-mediated behavior fails to meet the conditions of intentional physical action as proposed by causal and non-causal theories of action."[65] The person is not responsible because the action "was not brought about by the required type of brain activity and the underlying causal process is unreliable."[66] BCI movement, argues Buller, "remains qualitatively quite different from 'ordinary' behaviour."[67] It could be argued that this interpretation of BCI movement results in a responsibility-gap between the user and the action.[68]

However, Grübler argues that such a responsibility-gap for BCI is not plausible.[69] Through examples and metaphors, Grübler asserts "that description of agency and responsibility does not, even in simple cases, require that people be in causal control of every individual detail involved in an event."[70] Likewise, Dasgupta et al. argue that "responsibility should be determined according to various features, such as the level of control associated with particular BCIs, the level of training the user has received and whether the user is acting in a way that can be deemed negligent or reckless."[71] Van Gervan et al. agree and state that "[c]ontrol is achieved through the classification of the detected activity and the mapping of this activity to an action."[72] Vlek et al. assert that BCI is a technique where "brain activity is measured, analyzed in real-

62. CHRISTOPHER BARKER, CULTURAL STUDIES: THEORY AND PRACTICE 448 (2005).

63. Buller 2, *supra* note 3, at 71.

64. Buller 1, *supra* note 3, at 1.

65. *Id.*

66. Buller 2, *supra* note 3, at 70.

67. Buller 1, *supra* note 3, at 10.

68. Federica Lucivero & Guglielmo Tamburrini, *Ethical Monitoring of Brain-Machine Interfaces*, 22 AI & SOC'Y 449, 457 (2008); Christoph Bublitz et al., *Legal Liabilities of BCI-Users: Responsibility Gaps at the Intersection of Mind and Machine?*, 65 INT'L J.L. & PSYCHIATRY 2, 10 (2019).

69. Grübler, *supra* note 3, at 377.

70. *Id.*

71. Dasgupta et al., *supra* note 3, at 65; *CLWACT* s 43(1)(c); *CLANSW* s 5B(1)(c); *CLAQ* s 9(1)(c); *CLAS* s 32(1)(c); *CLAT* s 11(1)(c); *WAVIC* s 48(1)(c); *CLAWA* s 5B(1)(c).

72. Vlek et al., *supra* note 3, at 193.

time and used as a control signal for a device. Control is achieved through the classification of the detected activity and the mapping of this activity to an action."[73] In relation to the element of control, Rainey et al. state that achieving competent control over a BCI requires accurate identification and decoding of the neural command or "implementational trigger."[74] This implementational trigger is "the detectable, identifiable, neural artifacts associated with specific decisions to act."[75] Buller asserts that the resulting action can be legitimate if the BCI user incorporates the differences of using the BCI into their beliefs about action.[76] This incorporation of differences is "learning a new language" to control a device.[77]

This analysis of BCI functionality by the BCI discourse provides a substantial understanding of the combination of artificial hardware with technological capability to enable interoperability with the human brain. Knowledge of the implementational trigger by the person with the BCI, and incorporation by the BCI user of the differences between BCI-mediated action and non-BCI-mediated action, enables the allocation of responsibility to the person with the BCI. The BCI discourse recognizes the complex interplay of biological and technological components to facilitate action that impacts control of the BCI. Achieving competent control of the BCI will be like mastering a new language, so the risk of injury to others or damage to the property of others is foreseeable. However, when determining a breach of duty of care, the foreseeable risk of harm must not be an insignificant risk before the court considers the precautions that should have been taken. In the context of the BCI driver, the foreseeable risk of harm to other road users must not be an insignificant risk to other road users.

2. Significance of the Risk

In relation to the significance of the risk of harm to others, the BCI driver having a motor vehicle accident and causing harm to another road user is not insignificant[78] because the result could be serious property damage, bodily injury, or death. The significance of this risk is reinforced by the statistics of high numbers of

73. *Id.*
74. Rainey et al., *supra* note 3, at 47.
75. *Id.* at 51.
76. Buller 2, *supra* note 3, at 71.
77. Rainey et al., *supra* note 3, at 51.
78. *CLWACT* s 43(1)(b); *CLANSW* s 5B(1)(b); *CLAQ* s 9(1)(b); *CLAS* s 32(1)(b); *CLAT* s 11(1)(b); *WAVIC* s 48(1)(b); *CLAWA* s 5B(1)(b).

collisions and road deaths in Queensland.[79] The BCI driver will need to develop competent control of the neuroprosthetic legs whilst taking precautions[80] to avoid the risk of harm to the other road users if competent control of the neuroprosthetic legs is not achieved.

3. Precautions

Following recognition of agency, the implementational trigger and control with BCI-mediated action by the BCI discourse as essential factors in determining the foreseeability of the risk of harm, the practicability of, or burden of taking precautions must also be considered.[81] Vukov and Rempala assert that in both BCI and non-BCI mediated action, "there are contextual factors that intuitively and appropriately influence the proportion of blame we assign."[82] They consider precautions, such as the training the person received or did not receive, as impacting responsibility. [83]

For the BCI driver, training should include knowledge of the reliability of the neuroprosthetic legs to operate as intended. In relation to the reliability of BCI discussed above in Parts I and II.B.1, Rainey et al. identify the challenge of accurately recording and decoding neural activity to send control signals to an assistive device.[84] They believe that significant training and mental discipline are required to use these systems reliably.[85] They identify many possible factors that could affect the reliability of the BCI, including system processing and user inconsistency.[86] By operating the BCI, the defendant will gain skill or knowledge in the procedures necessary to achieve the desired BCI action—that is, competent control.

79. *See, e.g.*, QUEENSLAND DEPARTMENT OF TRANSPORT AND MAIN ROADS, REPORT NUMBER 1371 QUEENSLAND ROAD CRASH WEEKLY REPORT, (May. 12, 2024) 3 https://cars.tmr.qld.gov.au/Static/documents/RoadCrashReport/Weekly/WeeklyReport_Latest.pdf [https://perma.cc/D56D-3YZK] (stating the following total fatalities on Queensland roads: 247 in 2017, 245 in 2018, 220 in 2019, 278 in 2020, 274 in 2021, 297 in 2022 and 253 in 2023 to Nov. 30, 2023).

80. *CLWACT* ss 43(1)(a), (c); *CLANSW* ss 5B(1)(a), (c); *CLAQ* ss 9(1)(a), (c); *CLAS* ss 32(1)(a), (c); *CLAT* ss 11(1)(a), (c); *WAVIC* ss 48(1)(a), (c); *CLAWA* s 5B(1)(a), (c).

81. *CLWACT* s 43(2)(c); *CLANSW* s 5B(2)(c); *CLAQ* s 9(2)(c); *CLAS* s 32(2)(c); *CLAT* s 11(2)(c); *WAVIC* s 48(2)(c); *CLAWA* s 5B(2)(c).

82. Vukov & Rempala, *supra* note 3, at 67.

83. *Id.*

84. Rainey et al., *supra* note 3, at 49.

85. *Id.*

86. *Id.*

The following examples of what could have occurred in relation to the BCI driver incident highlight the complexity of BCI-mediated action and reinforce the need for training and mental discipline:

- The neural impulse sent from the brain to apply the brakes before the intersection was not detected by the decoder.
- The neural impulse sent from the brain to apply the brakes before the intersection was misinterpreted by the decoder as an instruction to apply the assistive device, the neuroprosthetic leg, to the accelerator.
- The neural impulse sent from the brain to apply the brakes before the intersection was correctly communicated by the decoder to the neuroprosthetic leg, but there was insufficient time for the neuroprosthetic leg to respond before entering the intersection.
- The neural impulse sent from the brain to apply the brakes before the intersection was correctly communicated by the decoder to the assistive device, but insufficient pressure was applied to the brakes.
- Sensing information sent from the neuroprosthetic leg to the decoder that the neuroprosthetic leg had not made contact with the brake pedal was not communicated to the brain.
- Sensing information sent from the neuroprosthetic leg to the decoder that contact had been made with the brake pedal was communicated to the brain but was misinterpreted by the person as failure to contact the brake pedal.
- Sensing information sent from the neuroprosthetic leg to the decoder regarding the pressure being applied to the brake pedal was communicated to the brain, but insufficient pressure was applied to the brakes.
- Power within the decoder was less than necessary for the normal processing speed, and this interfered with the speed of decoding neural impulses, delaying instructions being sent to the neuroprosthetic leg.
- The computing capacity of the neuroprosthetic leg could not enable the device to act as quickly as a biological leg, so the application of pressure to the brake pedal was not as effective.[87]

87. Scott Kiel-Chisholm, *Neural Interface Devices and Negligence*, 26 TORT L. REV. 104, 110–11 (2019).

The probability of harm occurring if care was not taken to counter the effects of any one or more of these circumstances is arguably high.[88] For example, if the decoder does not interpret the neural impulse or neurostimulation correctly, and care had not been taken by the BCI driver to avoid such a situation, action or omission will probably result in harm. As neuroprosthetic legs become available to consumers, the statistics of BCI neural impulse or neurostimulation interpretive issues will assist in evaluating the probability of harm occurring. The gravity of harm occurring because of an alleged breach of the BCI driver's duty of care is arguably serious since the result could be a substantial financial cost, death, or serious/permanent injury.[89] Both the probability and the gravity of harm will affect the precautions that should have been taken.

The precautions the BCI driver might have taken, or should have taken, to avoid the risk of harm would be incorporated into the training of the BCI driver. It would be relatively easy, not overly inconvenient, and not excessively expensive for the BCI driver to avoid the risk of harm to other road users by undergoing training in the use of the neuroprosthetic legs, ensuring the BCI driver understands the limitations of the BCI and the steps to address these limitations when engaged in BCI-mediated action. The BCI driver would need to take reasonable steps, such as allowing time to take alternative action to achieve the desired result should the combination of the neural impulses and neurostimulation fail to operate the neuroprosthetic legs as desired.[90] The court may very well conclude that competent control of the neuroprosthetic legs was not achieved and will include this finding, together with other relevant factors, to decide whether or not the BCI driver achieved the required standard of care.

Additionally, the BCI manufacturer may provide precautionary functionality. For example, a physical override mechanism to enable the BCI driver to operate the neuroprosthetic legs using hand controls rather than neural impulses may be provided. Those facilities should be understood and used when needed. The court will consider expense, difficulty, and convenience to determine if these, or other steps taken, should be considered

88. *CLWACT* s 43(2)(a); *CLANSW* s 5B(2)(a); *CLAQ* s 9(2)(a); *CLAS* s 32(2)(a); *CLAT* s 11(2)(a); *WAVIC* s 48(2)(a); *CLAWA* s 5B(2)(a).

89. *See Rds & Traffic Auth of NSW v Dederer* (2007) 324 CLR 330, 340 (Austl.); *CLWACT* s 43(2)(b); *CLANSW* s 5B(2)(b); *CLAQ* s 9(2)(b); *CLAS* s 32(2)(b); *CLAT* s 11(2)(b); *WAVIC* s 48(2)(b); *CLAWA* s 5B(2)(b).

90. *See Rds & Traffic Auth of NSW v Dederer* (2007) 324 CLR 330, 407 (Austl.).

reasonable precautions.[91] Other mechanisms the BCI may have to minimize the risk of harm might be available in the future. For example, as BCI continues to develop, customary standards, such as BCI industry guidelines from organizations like the Institute of Electrical and Electronics Engineers,[92] might eventuate. These industry guidelines may require specific tasks to be undertaken in the design and manufacture of BCI that minimize BCI miscommunication or other adverse outcomes. Accreditation requirements by the TGA may also impact the design and manufacturing of BCI. These guidelines and accreditation standards should be factors the court considers when determining whether the BCI driver breached their duty of care.[93]

In summary, the training of the BCI user by medical physicians, occupational therapists, physiotherapists, psychologists, and BCI technicians would lead to the BCI user gaining knowledge regarding the limitations and possible adverse responses the BCI may have. This would enable the BCI driver to appreciate the need to take precautions to minimize the risk of harm to other road users. Despite the training undertaken by the BCI user, there will remain a degree of uncertainty as to how, or if, the BCI will respond or operate in accurate compliance with the neural impulses. Liability for any damages caused by the inaccurate operation of the BCI will involve a determination of whether the user of the device is aware of the limits of their control over the device due to inaccurate decoding or incorrect neurostimulation occurring, or if the individual engaged in activities without considering any limitations of the device.

CONCLUSION

This analysis has applied the BCI discourse to the law of negligence where the legal issues center upon the concepts of reasonable foreseeability of the risk of harm and the precautions the individual would have taken in the circumstances.[94] The BCI

91. *Romeo v Conservation Comm'n (NT)* (1998) 192 CLR 431, 446–47 (Brennan CJ) (Austl.); 454–56 (Toohey and Gummow JJ); 480–81(Kirby J).

92. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, https://www.ieee.org/ [https://perma.cc/V6WR-TZRT] (last visited Apr. 28, 2023); *see, e.g.*, *IEEE Launches New Standard to Address Ethical Concerns During Systems Design*, IEEE SA (Sept. 15, 2021), https://standards.ieee.org/news/ieee-7000/#:~:text=PISCA-TAWAY%2C%20NJ%2C%2015%20September%202021,Ethical%20Concerns%20During%20System%20Design [https://perma.cc/UAW8-62HK] (outlining the 7000–2021 Standard Model Process for Addressing Ethical Concerns During System Design).

93. *Rds & Traffic Auth of NSW v Dederer* (2007) 234 CLR 330 (Austl.).

94. *CLWACT* ss 43(1)(a), (c); *CLANSW* ss 5B(1)(a), (c); *CLAQ* ss 9(1)(a), (c); *CLAS* ss 32(1)(a), (c); *CLAT* ss 11(1)(a), (c); *WAVIC* ss 48(1)(a), (c); *CLAWA* ss 5B(1)(a), (c).

discourse recognizes the unique interplay between the human brain and BCI that has never before been achieved[95] and the foreseeable risk of harm to others in the context of a user's inability to competently control the BCI. Precautions the BCI discourse recommends include training of the person with the BCI to enable the development of the skills and knowledge necessary for competent control of the BCI. Achieving competent control of the BCI is an ability that both the BCI discourse and the law recognize as vitally important.[96]

There is every reason to expect that the BCI discourse will play an important role in assessing the foreseeability of risk and precautions under Civil Liability Legislation to determine a breach of the duty of care and determination of liability for BCI-mediated action. For these reasons, the BCI discourse will be a valuable contribution to the application of the law of negligence.

95. *See* Buller 2, *supra* note 3, at 71; *see also* Buller 1, *supra* note 3, at 11; *CLWACT* s 45(1)(a); *CLANSW* s 5D(1)(a); *CLAQ* s 11(1)(a); *CLAS* s 34(1)(a); *CLAT* s 13(1)(a); *WAVIC* s 51(1)(a); *CLAWA* s 5C(1)(a).

96. *See* Buller 2, *supra* note 3, at 70–71; *see also* Buller 1, *supra* note 3, at 11; Kuersten, *supra* note 3, at 62; *CLAWA* s 5C(1)(a); *CLWACT* s 45(1)(a); *CLANSW* s 5D(1)(a); *CLAQ* s 11(1)(a); *CLAS* s 34(1)(a); *CLAT* s 13(1)(a); *WAVIC* s 51(1)(a); *CLAWA* s 5C(1)(a).