Concussion killjoys: CTE, violence and the brain's becoming

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Abstract CTE, or chronic traumatic encephalopathy, is caused by repetitive head trauma and detected by a distinctive stain for a protein called ‘tau’ in autopsied brain tissue. While the number of diagnosed patients is only in the hundreds, the cultural footprint of the disease in North America is huge, both because those diagnosed are often celebrity-athletes and because millions of children, adolescents and young men and women play collision sports like football and hockey. We argue that the widespread attention to CTE provides a useful wedge to crack open another, heretofore neglected public health concern: repetitive acts of violence in and around hypermasculine sports create subjects whose brains—and characters—are materially shaped by that violence. Brains change materially when delivering blows as well as receiving them, when participating in degrading hazing rituals as victim or assailant, when belittled or assaulted by a coach, when approaching an upcoming game riddled with fear. We adopt a biosocial model of the brain's becoming to intervene in a linear discourse around CTE that medicalizes and oversimplifies violence, a story that prematurely dissects one slice of the problem from a noxious whole.

Keywords Critical neuroscience · Biosocial · Chronic traumatic encephalopathy (CTE) · Violence · Masculinity · Concussion · Feminism

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Introduction: vulnerable brains

Seemingly out of nowhere, brains have come to matter more since the turn of the twenty-first century, especially in the context of sports. Postmortem diagnoses of the brain disease CTE (chronic traumatic encephalopathy) in celebrity athletes have flooded North American news, and the fragility of the brain entered our collective consciousness. Dr. Bennet Omalu discovered CTE in the brain tissue of a retired football player in 2005. The moral panic surrounding concussion, repetitive sub-concussive hits, and brain injury in sport hit its zenith around 2009 when further cases began to mount. Wives and widows of ex-football players with premature dementia pressured the United States Congress to host a series of hearings on the issue. Over the next five years, concussions and CTE dominated headlines in sports and mainstream news, while researchers founded brain banks and the general public took a crash course in the brain's vulnerability, tau proteins and neurofibrillary tangles. Experts now agree that concussions per se aren't the only concern, but also the repetitive sub-concussive hits jostling the brain over a period of time in sport; the longer one plays, the worse the damage (Tagge et al. 2018). The congressional hearing on head injuries in football turned up the heat on the NFL (National Football League); class action lawsuits ensued; tragic suicides of celebrity athletes—some, like Junior Seau and Dave Duerson elected gunshots to the chest in order to preserve their brains for study—piled up; and the co-ordinated release of the book and documentary, *League of Denial* by brothers Steve Fainaru and Mark Fainaru-Wada in 2014 caused significant cultural reverberations. The Hollywood hit film *Concussion* (Landesman 2015), starring Will Smith as Dr. Bennet Omalu, solidified star status for the fragile brain. Sports-related concussions and CTE have, in the past decade, been a magnet for enormous capital investment (economic and cultural) in the service of mitigating certain kinds of risk to certain kinds of people.

This article is an STS-inflected history of the making of CTE as both a matter of fact and a matter of concern (Latour 2004). It is also an intervention in well-established narratives¹ that figure CTE in a linear neuroreductive framework where mechanical blows to the head cause brain damage, which then produces memory loss, erratic behaviour, depression, aggression and violent behaviours. This view is ubiquitous in CTE discourse, sometimes explicitly and sometimes more tacitly. Terry Long is a former NFL player who committed suicide, and whose brain was found to have the tell-tale pattern of tau staining. In the film *Concussion*, Smith-as-Omalu states the uncomplicated linear formula: "Football gave him CTE and CTE told his brain to drink antifreeze" (Landesman 2015). Dynamic and distributed models of the brain and nervous system are all but absent from CTE discourse and practice, which is instead dominated by the ancient method and epistemology of

¹ Our empirical archive is derived from the most significant medical literature and popular media on the topic in the key period (2008–2015) during which CTE became an epistemic thing. We also draw from transcripts of the Hearings before the U.S. Committee on the Judiciary House of Representatives (2009–2010) and Subcommittee on Sports-Related Concussions in Canada of the Standing Committee on Health (2018–2019).

anatomy. Bringing CTE into conversation with newer strains of neuroscientific and biosocial thinking about violence yields a worrisome picture of the socio-material realities of *becoming* in the context of hypermasculinity and collision sports. This picture encompasses, but is not limited to, brains colliding with the insides of skulls.

Hypermasculinity is a sociological concept “denoting exaggerated forms of masculinity, virility and physicality” (Craig 2019). Its characteristic strains include “(1) the view of violence as manly, (2) the perception of danger as exciting and sensational, and (3) callous behavior toward women and a regard toward emotional displays as feminine.” It is no secret that American football and ice hockey are prototypical sites for the performance of hypermasculinity. CTE has forced us to reckon with some of the toll exacted by the pleasures of violent sporting cultures, but this article asks us to go further. For at least a century, ‘getting your bell rung’ was a routine side effect of collision sports, purposely down-played. A constellation of events, which we review in the first part of the paper, have recast concussion as a dangerously neglected source of real injury, in and out of sports. In the latter half of the article, we use Sarah Ahmed’s figure of ‘the feminist killjoy’ (2010) to follow the tracks laid down by this CTE-inspired moment of re-evaluation. We take an uncompromising look at a wider swath of embodied and embrained effects of hypermasculinity and sporting violence.

As will become clear throughout the article, the subject population under consideration here is not all people who get concussions, nor even all who become diagnosed with CTE, but the ways in which young men in violent sports² become particular kinds of subjects in brain and body, and the toll that takes, including on their intimate partners. We home in on which risks hold public and political attention, and which don’t. While narrowing the subject population with which we are concerned to boys, adolescents and young men, we simultaneously broaden the scope: Where interest in CTE is almost exclusively paid to happenings on the field or ice, we imagine the sporting milieu, or ‘sportsworlds,’ of these subjects to include locker room hazing rituals, bus rides, hotel rooms, as well as spectator participation in the stands and TV-rooms.

To foreshadow a major theme in the article, we find that once a player is deemed to have been in the grip of CTE (a complicated retroactive attribution, given that the disease is only definitively diagnosed postmortem), the man’s behaviours are described in uniformly reductive terms. The diseased parts of the brain become the man, and his actions—particularly those which are aggressive or otherwise nefarious—are attributed directly to CTE pathology. In what follows, we speculate about why this is, while also proposing that a more empirically and ethically satisfying picture can be painted if we broaden the frame. We are inspired in this task by the emergent field of critical neurosciences that invites “a degree of critical rigour through provocation—that is, by illuminating blind spots and by questioning assumptions” (Choudhury and Slaby 2011, p. 354). A biosocial model of becoming

² Because of their market share of attention in Canada and the US, and our familiarity with the specificities, we focus herein on American football and ice hockey. Much of the analysis could also apply – to greater or lesser degrees—to sports like rugby, lacrosse, soccer, boxing, mixed martial arts and so on.

insists that players' brains and bodies are shaped, physically and materially, by the contexts in which they are immersed in the years and even decades in the lead-up to becoming celebrity athletes in violent sports. By blows to the head, yes, but not only by those blows.

Medicalization of head injury in sport is a useful wedge: it pries open a faulty popular understanding of brains as innate unidirectional sources of thoughts and behaviour. Concussions and CTE are acquired through experience and thus 'environmental' in a stark genes vs. environment dichotomy, a point that even the strongest advocate of nature over nurture must concede. As odd as it sounds, acquired brain injury is on the 'nurture' end of this (questionable) dichotomy. But there is no reason to suppose that *only* blunt force hits to the head shape the thoughts, feelings and actions of participants in violent sports and their sportsworlds in ways that are worthy of public and scientific concern. Violence begets violence, and, although sporting cultures often pretend otherwise, the effects of violence cannot be easily shaken off after a game or a career because, like concussion damage, they happen inside the body.

Why didn't brains matter before now?

CTE made a relatively sudden appearance as an epistemic thing in the first decade of the twenty-first century. If we imagine that a disease has a career, CTE has been effective, in a short time, in enrolling heterogeneous infrastructures of advocates, money, laws, sentiment and science—all in the face of resistance by well-heeled naysayers at the helms of professional sports organizations. It's not accurate to say there is no contestation, or that all ambiguities are resolved once and for all, but we do feel confident in claiming that 'closure' has been achieved, in most corners of medicine and public opinion, around the fact of CTE as a diagnosable entity, with repetitive blows to the head its cause.³ Because of how the 'discovery' of CTE played out, and its subsequent dramatizations, its received story is that a lone scientist (Bennet Omalu, a Pittsburgh coroner) made a revelatory discovery of a new disease during the autopsy of a down-and-out former NFLer ('Iron' Mike Webster). However, an STS reading suggests that disease entities aren't simply there in the world awaiting discovery by a single intrepid scientist. They are constellations of time, place, matter, evidence, credibility, serendipity and—perhaps most importantly—receptive audiences both inside and outside of the labs and corridors of biomedicine. The establishment of a disease as a credible and stable entity requires a campaign, a network of humans and nonhumans, an assemblage (Latour 1993). CTE is a brilliant example of the need for a concatenation of events in the making of a disease.

Why didn't jostling brains matter so much before now? At some times and in some places, apparently they did. While the degree of damage is perhaps exacerbated in recent decades by the increasing size and speed of competitors, historian

³ Matthew Ventresca (2018) provides an excellent description of the material complexities of CTE, and the multiple discourses at play in recent media, including contestations over certainty.

of science Emily Harrison (2014) dispatches with the notion that prior to the twenty-first century either concussions were not happening in football or they were not considered a health hazard. Harrison revives a pre-history of CTE that doesn't much circulate in the popular press. American-style football originated as a pastime of (male) students at elite colleges in the 1880s and 1890s and from the beginning "what set football apart from other team games was that violence and bodily risk were constitutional in the appeal of the game" (p. 824). The inherent risk of the sport, and its "barbarous ethics of warfare" caused Harvard University to impose short bans on the game in 1885 and again in 1895 (p. 824). By 1906 medical professionals formed part of a coalition critical of football, partly on the grounds that concussions are dangerous. A number of on-field fatalities in the first decades of football prompted technical fixes—rule changes and padding for example—but critics remained aware of the toll of concussions. A 1911 article in the *Journal of the American Medical Association (JAMA)* provides a description remarkably similar to the current medical profile of concussion and its sequelae, especially if untreated. It includes both the latency of symptoms and the mood effects:

The patient may not even lose consciousness, but walk to his home and apparently not be the worse for the experience, until later—sometimes weeks and even months later—he begins to show a very noticeable change in his psychic total. His entire mental make-up changes, he becomes easily tired, is incapable of any prolonged mental effort, is forgetful, irritable and distractible. He complains of vertigo, pressure sensations in his head, migraine, noises in the ears; he experiences a sort of general benumbed feeling and shows a marked tendency to outbreaks of violent temper on the least provocation (Gluek quoted in Harrison 2014, p. 828).

Likewise, the doctors articulated the possibility of cumulative damage over time as a result of repetitive blows (Harrison 2014).

In 1928, Harrison Martland famously coined the phrase 'dementia pugilistica' in *JAMA*, giving medical legitimacy to a boxing-induced condition colloquially known as 'Punch Drunk.' Martland connects early physical signs—unsteadiness in gait or tremors for example—with "marked mental deterioration [that] may set in necessitating commitment to an asylum" (p. 1103). In addition to lay and clinical observations of disordered behaviour, Martland speculates about causes of the pathology that occur through "multiple concussion hemorrhages." He cites a contemporaneous study in which the authors Osnato and Giliberti concluded that:

It is no longer possible to say that "concussion is an essentially transient state which does not comprise any evidence of structural cerebral injury". Not only is there actual injury in cases of concussion but in a few instances complete resolution does not occur and there is a strong likelihood that secondary degenerative changes develop" (Quoted in Martland, 1928, p. 1103).

In spite of this clear evidence that medical communities were concerned about concussion long before now, the prevailing idea in the twenty-first century is

that for athletes and the public, awareness is something new. For example, during a recent inquiry into concussions in sport Dr. Shawn Marshall, a Canadian researcher and department head said:

[P]reviously, concussions were dismissed, and it wasn't even conceivable that people could actually have persisting symptoms.... We're actually asking the question, whereas you were almost vilified before if you actually said you had symptoms afterwards. It was almost blaming the patient for saying they had ongoing symptoms, because no one would ever believe them. We have many examples of this through health care and through the insurance industry trying to minimize these things. (Subcommittee on Sports-Related Concussions in Canada 2019)

It is tempting to wring our hands about the lost century in which, it seems, better understanding and treatment of concussion were within reach. The contradiction at least begs the question of why the danger that was once known *became unknown*, or why knowledge of it didn't pass beyond a small medical cadre and reach a tipping point of societal concern?

Harrison suggests a number of convincing reasons why the 'first concussion crisis' didn't catch on. As football became more popular, the financial stakes grew (in the form of betting, the boon to college recruitment, and eventually, in 1920, a professional revenue-generating league). Economic interests were buttressed by cultural ones; football "tapped into a cultural penchant for strength and stimulation in a society tolerant of violence" (p. 829). In his book *Football and Manliness*, Thomas P. Oates concurs with Harrison's assessment of the cultural stakes in the early days of football: "The game was explicitly framed as a means of countering the creeping specter of effeminacy by identifying and nurturing qualities deemed essentially masculine, thereby shoring up uncertainties about sexual identity and providing a stable and visible symbol of men's strength" (2017). Colleges, most of which were sex-segregated, viewed their role not just to provide education, but to "turn boys into men" (Harrison 2014, p. 829). In a change from its cautionary stance in football's first decades, by the 1930s Harvard closed ranks around football and deliberately—under direction from University leadership—refrained from fueling public interest in football's injuries. Coaching staff were prohibited from writing for the press, and all involved were urged to show loyalty to the game itself. Secrecy about injury became the norm, and it's a norm that has become deeply entrenched in competitive sports organisations. The cat was put back in the bag because, in Harrison's estimation, "work was done by football's supporters to reshape public acceptance of risk" (2014, p. 822).

Like American football, ice hockey is a product of the late nineteenth century. Both arose in the calm after the American Civil War, and apace with industrialization, a vast societal change that created more leisure time. These sports were characterized by physical contact and fierce team competition among men who were self-consciously simulating war (Oates 2017). "The ultimate challenge to building and implementing good policy" writes Harrison "may be that football became popular not despite its violent aspects, but because of them" (2014, p. 831). In the century between the first and second concussion crises, these combative sports have grown

enormously in North America, with vast networks of leagues for children and adolescents, and a large share of the TV viewership. Public displays of masculine violence are not just allowed but endorsed, underwritten by governments and respectable institutions like colleges and universities, where, in some regions, coaches are the highest paid employees on campus. This entanglement of capitalist success and cultural programming about desirable masculinity (and simultaneously femininity as its opposite) has had outstanding success. The Faustian bargain of the twentieth century, in which a predictable level of damage to some bodies was traded for pleasure, profit and gender modeling, seems imperilled by a threat to brains that we're newly ready to comprehend.

Why now? Agent Tau

The question 'why did sports-induced brain damage become a matter of concern now when it hadn't before?' surely has a complex answer. The David and Goliath story of Omalu, the truth-telling Nigerian scientist, standing up to racism and to the NFL's machine of denial is a compelling one, and it has captured the lion's share of attention. Its first full hearing was in an article by Jeanne Marie Laskas published in *GQ* (2009), and both *League of Denial* (2013) and *Concussion* (2015) brought the plot-line to a much wider audience. Identification with fallen heroes (however well-paid they were) against a scheming multi-billion-dollar business is appealing to audiences already familiar with the script from the scheming of the Tobacco Industry and Big Oil (Oreskes and Conway 2011). The comparison is a repeated trope in activist-scientific literature about CTE, and it seems warranted.

This narrative would not have gotten far, though, without compelling evidence of the disease and spokespeople for that evidence. Visuality has played an undeniable role, a theme we explore further in this section. Microscope slides showing malformed tau proteins in the brain are the major token of persuasion in bringing about closure around CTE. In the height of reportage these were regularly singled out as directly showing the reason why former players 'went crazy.' For example:

Brown and red splotches. All over the place. Large accumulations of tau proteins. Tau was kind of like sludge, clogging up the works, killing cells in regions responsible for mood, emotions, and executive functioning.

This was why Mike Webster was crazy. (Laskas 2009)

Other metaphors describe the misfolded tau proteins more vividly: like "skeins of unraveling yarn" or "IEDs [Improvised Explosive Devices]," and with repeated trauma the tau proteins are said to become "like a guerrilla force, occupying and killing more and more of the brain" (Leavy 2012). What happens, the coverage uniformly implies, is an insurgency of misfolded, rogue proteins. The evidence does not speak for itself, but rather by way of images *made persuasive* through a complex series of transformations and juxtapositions.

Dr. Ann McKee, a neuropathologist at Boston University, became and remains the major medical spokesperson for CTE after Omalu's brief and troubled time in the limelight (Fainaru and Fainaru-Wada 2013). Her testimony before the U.S.

Fig. 1 Dr. Ann McKee uses a split-screen technique, comparing ‘normal’ to CTE pathology in ex-NFLer John Grimsley. Photo credit: Chris O’Meara/Associated Press

Congress in 2009 illustrates the pattern we see again and again: histories of football-derived concussions, biographies of cognitive decline, deaths often arrived at by violent means, and then visuals of brain tissue, comparing the patients to ‘normals’ (see Fig. 1). Her first case, she told Congress, was John Grimsley, a former linebacker for the Houston Oilers who died at age 45 while cleaning his gun. In his brain, McKee “found a massive buildup of tau protein as neurofibrillary tangles. The neurofibrillary tangles were distributed in a unique pattern, a pattern not found in any other neurodegenerative condition except CTE” (Legal Issues 2009, p. 153). While speaking, McKee projected slides showing slices of brain tissue. In Grimsley’s brain, she both tells and shows the members of Congress,

there were massive numbers of tangles so many that you could see the abnormalities on the glass slides without the use of a microscope, as you can see in the middle panels of the figure that is being presented...All the brown pigment you see is abnormal. And please compare what you see in the middle panel, John Grimsley’s brain, to the brain of a normal man on the left, where you see absolutely no brown pigment. (Legal Issues 2009, p.153)

This longstanding split-screen technique of visual rhetoric delineates the normal and the pathological into two distinct ‘human kinds,’ a move that simplifies the complexities involved in the making of these categories (Dumit 2004).

The rhetorical repertoire of CTE requires and includes reproducibility. One case would not a disease make. In a very short time period, both McKee and Omalu racked up cases, finding characteristic tau patterns in player after player, changes

that they report that they do not see in non-players' brains. In addition to projecting slides at hearings, conferences and press releases, and circulating glossy images of stained brain tissue in sports reportage, representatives of CTE made some persuasive in situ demonstrations to reporters. For example, in 2009, Malcolm Gladwell wrote a pivotal exposé for *The New Yorker*. In it, he describes following Dr. McKee into her laboratory:

In one of the rooms, there is an enormous refrigerator, filled with brains packed away in hundreds of plastic containers. Nearby is a tray with small piles of brain slices. They look just like the ginger shavings that come with an order of sushi. Now McKee went to the room next to her office, sat down behind a microscope, and inserted one of the immunostained slides under the lens.

Reporters like Laskas and Gladwell amplified their experiences of witnessing to much wider audiences, bringing the lab to the world and building legitimacy for the new fact of CTE (Shapin and Schaffer 1985).

Not all science or medicine has such lay-friendly graphics. Often the patterns that health researchers find are in subtle biomarkers that translate into graphs and small but statistically significant percentages. Those wishing to persuade funders, politicians, and the public that some pattern represents a serious health concern are left with the tenuous task of translation. They may, for example, have a many-stepped high-tech procedure to coax visible difference from blood, or genetic tendencies that yields small statistical margins of difference. Their audience inevitably has a short attention span and little training in biology. Instead, CTE was blessed with a signifier that—while hidden for over a century—is now amenable to a revelatory visual politics. The stain is obvious, yes, but how does it come to equal a tidy constellation of symptoms in lives that are invariable messy? How exactly are we contemporary subjects able to see, in those splotches, memory-loss, confusion, anxiety, depression and violent behaviours? And what happens when we do?

The meaning of these brain sections would be incomplete without a consistent behavioural description, matching up pathology with a clinical profile. Beginning with Mike Webster's story of homelessness, addictions and mental instability, reports of CTE have been accompanied by biographies of late-in-life erratic behaviour, memory loss, impulsivity and aggression. Experiences and behaviours both innocuous and extreme are interpreted as symptoms. The biographies are both true and *partial* insofar as the telling anecdotes represent a fraction of the time in which the men inhabited lives that also featured less newsworthy differences from each other, moments of clarity, and expressions of love. As with other diseases marked by cognitive deterioration, the actions of these deceased athlete-celebrities are seen retrospectively through the prism of their acquired brain pathology. For example, in the documentary *Head Games* (James 2012), the mother of an 18-year-old football player speaks of the tiny stain of tau that marked the beginnings of CTE: "So when the results came through, I can't say it was a relief, but it was like 'Oh my gosh there is the reason right there that [my son] would commit suicide.'" No doubt, the apparent objectivity is a comfort, enabling grieving family members to make sense of a loved one's decline and death. The brown splotch also seems to explain away incidents of violence that they themselves may have endured at the hands of the

same man. It is an absolution of the man who—once the blows were delivered to his brain—could not have prevented the pain that ensued.

With the agency of tau, a shift occurs wherein men who *were violent as a job*, and whose violence sometimes (often?) exceeds the field of play, become the victims of the drama (see also Henne and Ventresca 2019). Postmortem narratives are consolidated in some ways and not others, by the tellers, the journalists who selectively re-tell a story, and the scientists and doctors who speak on behalf of facts. Framing in an explicit context focuses attention and people's capacity to remember on some stories and not others, some behaviours and not others. In this case, the context for bringing this private suffering into the light was entwined with the career of CTE, including evidence-based activism, class-action lawsuits, and celebrity hagiography. This is not a condemnation of this narrative honing, which seems to have been a necessary and effective strategy to force powerful institutions to take notice and act in the face of mounting evidence. It is, however, a suggestion that we do not need to get stuck in that partiality, in that framing, in that one and only story of causes and effects.

The concussion killjoy

Sarah Ahmed's figure of the feminist killjoy has been widely taken up by feminist scholars and activists. The charge of solemnity, of refusing to smile, has often been levelled at feminists in the midst of a 'fun' happening. The killjoy is a way of reclaiming, rather than being silenced by, this charge. "Whilst hearing feminists as killjoys might be a form of dismissal, there is an agency that this dismissal rather ironically reveals. We can respond to the accusation with a 'yes'" (Ahmed 2010). The feminist killjoy interrupts—often in awkward or risky ways—the affable social encounter in which happiness is sought, shared, guffawed into being. Happiness itself is not the target, rather the kind of joy that is bought with the currency of sexism, racism, homophobia and other well-worn comedic or 'joyful' gambits that serve the double purpose of prompting a laugh and establishing the order of things. Ahmed writes: "To be willing to go against a social order, which is protected as a moral order, a happiness order, is to be willing to cause unhappiness, even if unhappiness is not your cause" (2010).

Given that nobody is 'for' brain damage, this might seem an odd entry point for Ahmed's concept. The joy, though, is in the status quo, or a romantic ideal of the time when men were men, and the most popular sports in North America contained elements of naked brutality. In ice hockey this means a scrappy and violent game, at least at the higher levels: hard hits, impromptu or calculated fistfights and occasional bench-clearing brawls. And yet, in the wake of CTE, the role and desirability of fighting in hockey has come into question more frequently and fervently than it had before. A version of the killjoy—the *concussion killjoy*—appears in the guise of former professional players and Canadian stalwarts like Ken Dryden and Eric Lindros, both of whom testified at the recent Government hearing on the topic, passionately urging changes to the game and culture of hockey (Subcommittee 2018). Although their efforts are not always well received, concussion killjoys are emboldened by

the new realities of brain injury to challenge the status quo. Football is undergoing a similar reflexive exercise prompted by the spate of prominent suicides and the scourge of CTE. The bargain mentioned earlier in the article—damaged bodies in exchange for entertainment and masculine role modeling—is no longer in balance because the brain has lately come to mean so much.

The concussion killjoy has been effective in the past decade: from professional leagues down to little leagues, rules have been altered to reduce head contact and penalize it more strictly. Widespread public health campaigns teach coaches, players and parents in football and hockey to recognize the signs of concussion and some regions have implemented legislative change to mandate all of the above.⁴ Enormous financial resources have been channeled towards research into helmet sensors, innate propensities for developing CTE (not all players develop it), symptoms of post-concussion syndrome including mental health sequelae, brain banks, baseline testing of players at all levels and effective treatment regimens. Most of all, well-funded research seeks to find the 'Holy Grail' in the CTE world: a test that could diagnose the disease in living players (Fainaru and Fainaru-Wada 2013). However, the majority of pundits, doctors and sports administrators remain focussed on tau: remove the debilitating stain by reducing the number and force of hits to the head, and players can come out of a stint or a life in collision sport with the predictable bum knees, but unsullied in their essence-equals-brain.

Concussion killjoys face a delicate balancing act: Being critical from within the sport requires that while rocking the boat, one must pay respect to the boat itself. Because of the prominent cultural and economic, even political, stature of these sports (particularly football in the US and hockey in Canada), approaches that seek to dismantle the boat or tip it over do not fly. A place at the table, and a voice that is taken seriously, seems to require an oath of loyalty to the sport itself. Ken Dryden, for example, began his highly critical testimony before a Canadian federal committee with the words: "I love sports. I love playing and I love watching, and I have all my life" (Subcommittee on Sports-Related concussions, 2018, 2-1). Likewise, most articles and profiles of Ann McKee mention her status as a tomboy and 'Cheese-head' (fan of the NFL's Green Bay Packers), thus neutralizing the potential threat she poses to football (e.g. Leavy 2012). The concussion killjoy seeks to save athletes' brains, but salvage the sport and its overall moral economy, including the gendered performance of violence.

A secondary killjoy discourse—that of the violence killjoy—is creeping alongside the sports-friendly one described above, and it poses more of an existential threat to combative sports. Purveyors of this line of argument pause, in the wake of the serial tragic suicides, to consider violence writ large in contact sports like football and hockey. A widely read representative of this discourse is Malcolm Gladwell's polemic in the *New Yorker* titled "Offensive Play: How different are dog-fighting and football?" (2009). In it, Gladwell artfully draws an analogy between

⁴ In Ontario, Canada, for example, 'Rowan's Law' was passed on June 7, 2016 in response to the death of a young rugby player, Rowan Stringer after she sustained repeated blows to the head. See <https://www.ontario.ca/page/rowans-law-information-sports-organizations-and-schools>.

dogfighting (for which an NFL player, Michael Vick, had recently been apprehended) and former players suffering from catastrophic post-football damage to body and brain. Gladwell argues that most Americans find dogfighting morally reprehensible because innocent dogs are subject to “suffering and destruction. And why? For the entertainment of an audience and the chance of a payday.” After Junior Seau’s death, prominent American writer Ta Nehisi Coates announced, in *the Atlantic*, that it was time for him to walk away from football fandom, as difficult it was to thereby cut “something that binds me to friends and family” (Coates 2012). Coates (an unapologetic killjoy about racism in America) is also a rare voice who is willing to write candidly about the allure of violence endemic to the game: “I can remember cheering when seeing an opposing quarterback writhing on the ground” (2014). Both Gladwell and Coates expand the circle of moral responsibility for the ‘epidemic’ of brain injuries to include fans, who lap up the violence and tacitly, with their dollars, approve of the League’s actions and inactions on the problem of brain injury in football. In the remainder of the paper, we throw in our lot with these violence killjoys, using the tools of critical neuroscience studies to move beyond CTE.

Critical neuroscience meets CTE

Our intervention into the field of CTE discourse, at this moment of wide-spread reconsideration of the harms of football and hockey, is to adopt a biosocial model of becoming in hypermasculine contact sports. This line of thinking has become more possible through recent empirical-theoretical work in the critical neurosciences (Choudhury and Slaby 2011; Rose and Abi-Rached 2013; Pitts-Taylor 2016; Fitzgerald and Callard 2015) as well as theoretical positions that enmesh the biological and social (Meloni et al. 2018; Niewöhner and Lock 2018; this journal *BioSocieties*). In what follows, we turn our attention to critical neuroscience, an academic subfield which has followed nearly the identical timeline to the career of CTE, though as far as we can tell, they run on parallel tracks. We use the insights and orientations of critical neuroscience to consider the biosocial subject in a milieu of competitive violence.

The causal picture painted above—where environmental factors in contact sport (hits to the head) cause material changes (brain disease)—is the beginning, not the end, of this story. Psychiatrist Laurence Kirmayer and philosopher Ian Gold identify “a trend in mainstream Western psychiatry to employ increasingly narrow construals of mental suffering that neglect the situatedness of patients in distorted social environments and direct the focus away from cultural embeddedness—including politically problematic societal arrangements—towards assumed ‘neurological underpinnings’ of illness, agency and personhood” (Quoted in Choudhury and Slaby 2011). The flood of medical, media and policy attention to CTE draws attention to a single aspect of the distorted environment of contact sport: the long-neglected vulnerability of brains in a milieu rife with their jostling. We seek to hijack the focus being paid to the brain in sport to expand the aperture to other “politically problematic societal arrangements” in violent sports like football and hockey. Physical blows to the head, on the one hand, and violent socialization through hyper-masculine sport, on the

other, are currently seen as ontologically distinct problems (if seen as problems at all). The first has, in the wake of CTE, a new physical address in the body. The second is a more ephemeral entity that cannot be so easily localized. The disciplinary divide of those working to address these two social problems more or less breaks out into allocating mechanically induced brain trauma to the (generously-funded) biosciences, and masculinity studies to the (less well-resourced) social sciences. With other biosocial researchers, we contend that both of these phenomena, as they live in the world, are simultaneously social and biological.

The object of study for CTE researchers and attendant publics is a particular kind of brain we call 'the thing brain.' The thing brain is as though in a jar, separate from the body and its social world, no matter if it's dead or alive. The thing-brain functions somewhat like a ball itself. It's a fairly robust ball, like a baseball or golf ball perhaps. A ball with something other than air in it. Through long use, the ball can become battered, take on a colour other than white, nicks and tears accumulating until it no longer performs as it should. Or it can have a single collision of unusually strong force or at an unusual angle, that takes a chunk out of it and renders it immediately unusable. The main features in this analogy that strike us as useful for thinking through extant CTE discourse are (1) the ball requires significant physical force to be changed at all and (2) it is not going to change back.

Thankfully, brains are not baseballs or golfballs. Critical neuroscience is developing a vocabulary for finding our way out of an entrenched habit of thought and practice that attributes to the brain a misplaced concreteness (Whitehead 1929). The subfield insists that "biology and culture are mutually constraining and dynamically co-constitutive, such that they are each conditions of the other's determination and development" (Choudhury and Slaby 2011, p. 34). A dynamic biosocial model of the brain's becoming understands that when an idea—or a taunt— 'sinks in', it is a literal happening rather than 'merely' metaphoric. For example, although we know that bullying or sexual assault (or both combined) can lead to lasting trauma or even suicide, we do not routinely think of the sequelae of bullying as brain injury, or physical damage at all, beyond the parts of the physical body that may be injured in the encounter. Newer models of the brain's ontology dwell in the meeting place of brain and mind; both are enacted together. At some level, experiences of all kinds, and perhaps especially of extreme kinds, land somewhere in the body. Memory, trauma and PTSD are all biological *and* social; carving apart the biological and social, while handy from the perspective of academic disciplines, leads to spurious compartmentalization and thus stunted understanding. Because they are with us for so long, traumatic and mundane assaults cannot be nowhere. They sink in.

This insight about the materialization of trauma in the body has plenty of research traction with regard to stress, bullying, sexual assault, wartime violence and so on. We find, though, that violent sports that are sewn into the cultural fabric of national identity (such as hockey in Canada) do not bear the same level of scrutiny. Like Henne and Ventresca (2019) we see "a functionalist conceptualization of sport; that is, sport goes unquestioned as a positive and progressive force...Sport, at least within the U.S. cultural imaginary, is often envisioned as enabling individual transformation through nurturing values of masculine strength and toughness and as fostering positive character development by promoting determination, discipline,

and respect for authority.” The underside comes to light when video cameras capture icons from North America’s favourite sports beating up their girlfriends or when high school and college athletes are caught engaging in group assaults. While there are undeniably social and physical goods that come from participation in sport, the bargain struck for the past century (which we have crudely described as bodily integrity exchanged for entertainment and economic gain) relies on a degree of collective blindness, a reluctance to fully appreciate the extent to which violent sports and/as hypermasculinity do lasting harm. It is the killjoy’s job to press this point. Our next move is to bring into the conversation scientific research about where trauma materializes in bodies. This move requires that we unflinchingly name these sports as sites of quotidian violence, as killjoys Gladwell, Coates and others have done. We say simply: if there is blood, if there are broken bones, if there is brain damage and occasional death, it’s violent. If participation in an activity makes one more likely to perpetrate sexual and domestic violence (these do), then the activity is violence-making.

Where violence sinks into the body

Researchers of many stripes are following leads to localize and quantify material effects of trauma experienced in early and adolescent life. As we mention above, sports are conventionally sorted out of what constitutes ‘real’ violence, but we propose to read these literatures sideways for what they might tell us about plausible embodied effects in those who stay in sport, and those who leave. An article in the journal *Developmental Psychopathology*, authored by a long list of experts who gathered for a meeting on “childhood exposure to violence and lifelong health” summarizes the state of the field at that time (Moffitt 2013). The authors cite numerous studies that measure physical traces of such adverse experiences as bullying, dating violence, physical maltreatment and assault, and witnessing adults’ domestic violence. They find several areas where there is a critical mass of science connecting childhood exposure to violence with bodily change that lasts into adulthood. Adults with a history of physical or emotional neglect or abuse as children are more likely to experience: chronic inflammation; shortening of telomere length; and altered cortisol production of the hypothalamic-pituitary-adrenocortical (HPA) axis.

Vaillancourt et al. (2013) look specifically at physical manifestations of peer victimization (bullying). They confirm the earlier findings regarding HPA axis dysregulation—specifically a pattern to under-produce the hormone cortisol—in adults who were bullied as children. They conclude that “the experience of being bullied by peers becomes biologically embedded in the physiology of the developing person, which in turn modifies his or her health and, perhaps, learning trajectory.” A review article by R. J. Blair (2019), published in the journal *Aggression and Violent Behaviour*, gathers up current thinking about the cognitive neuroscience that underpins violent actions. Again, violence committed within sport is given a free pass by omission. Blair reports that there is significant evidence that “at least some violent individuals show impairment in processing the emotional expressions of others generally and perhaps distress cues in particular” (p. 159). Furthermore, “amygdala

and or insula responses to the distress of other individuals, particularly their fear, is reduced in some violent individuals" (p. 159). It is easy to imagine that decreased sensitivity to the fear or pain of others is an asset in competition, as in war, and that it might garner the attention of a talent scout, and be actively cultivated in the brains and bodies of players. When anti-social behaviour (hurting someone) is applauded in some contexts (the field), and ostensibly abhorred in others (the bar or the bedroom), it may be asking too much of fleshy, material, embodied processes to distinguish the difference, in some athletes, at least.

There are obviously specificities to the performance of sporting violence that make it different to witnessing domestic abuse, for example, or being a victim of chronic bullying. If a child participates in or witnesses violence, how it registers in their embrained body surely varies by context—a domestic assault within a child's home is not the same as a hockey game—but the differences may be of degree rather than kind. Notably a peculiar form of consent exists in these sports that (officially) exonerates many acts which, if performed 'on the street' would constitute violent crimes (Anderson 2014). Although endemic violence is sanctioned in these sports, and entangled with valorized masculinity, this clearance does not thereby render repetitive assault without cost to the biology and psychology of the developing human. Although shame makes such costs more difficult to speak of, it seems safe (if unwelcome) to propose that years or decades of participation in violent sports and associated sportsworlds leaves bodily traces beyond just tau.

We are motivated to point to some of these areas of emergent science—without pretending to be comprehensive or competent to evaluate which areas of study have most merit—because the juggernaut of research into concussions and lasting damage seem so relentlessly brain-centric. We observe that the evidentiary weight of tau protein has been a game changer. Policy makers, governments, funding bodies and guardians of the game(s) did, in the early decades of the 2000s, reach a tipping point where outside and inside, nurture and nature were no longer held apart, and the carnage could no longer continue unchecked. The science we've glossed above, from cognitive neuroscience, psychology and other fields, provides hints and samples of the sorts of biosocial investigation that is possible when violence, experienced or threatened, is taken seriously. Whether or not we should require physical proof of damage or change in order to take something seriously is an important debate, but our aims here are more pragmatic. As Moffitt et al. write: "We have noticed that listeners who seem inured to news of maltreated children's emotional problems, in contrast, are surprised and fascinated when told that maltreated children have elevated blood proteins that convey risk for heart disease" (2013, p. 2).

The examples above have an important element we wish to underline: bodily change, and particularly neurological becoming, is not a one-time event. Rather the external environment is constantly made internal, and then humans (and others) make and remake the world around us, thus impinging on internal becoming and so on. In *Sexing the Body*, Anne Fausto-Sterling elaborates this ontology of becoming gendered, using the figure of the never-ending mobius strip (2000). In neuroscience, a common word for this dynamic model is the brain's 'plasticity', a concept that has had much traction in popular culture and neuroscience alike (Bates and Bassiri 2016; Malabou and Jeannerod 2008). "Plasticity refers to the brain's ability

to biologically change and be changed ... It means that the brain is not hardwired, but rather constantly developing and changing in response to experience” (Pitts-Taylor 2016). One mechanism that Victoria Pitts-Taylor describes to account for how plasticity happens in practice is called ‘pruning’. The brain contains special kinds of cells called ‘neurons’, many billions of them. Areas of use grow physically larger over time, and lack of use can result in their diminishment. Specific developmental time periods—a child’s early years and again in adolescence—are characterized by “pruning of unused synapses, which seems to buttress the efficacy of remaining ones” (Pitts-Taylor 2016, p. 33). It follows that those neurons most useful to success in hypermasculine violent sportsworlds are selected and cultivated in the constant performances required for success, especially in an elite athlete who has devoted innumerable hours, over many years, to their sport.

Like repeated subconcussive blows to the head, iterative injunctions to ‘man up’ and eschew weakness *physically* shape boys and men during games, practices, in locker-rooms, hazing rituals, pep talks and long bus rides. Pruning of brain cells in players occurs simultaneously with another pruning: certain kinds of boys, judged as ‘too soft,’ leave the sport(s) as the ante is upped in ever more intense leagues. In the wake of CTE, another, disturbing, pattern of pruning has been identified: kids from privileged backgrounds (read: white) are spurning sports dangerous to their brain-as-future while boys and men from ever lower socioeconomic classes are called to the make the sacrificial Faustian bargain for collective entertainment (Semuels 2019).

Violence as talent, and symptom

In December of 2011, John Branch of the *New York Times* published a feature story with three lengthy installments (2011a; b, c). It was about the short life of deceased Canadian NHL hockey player Derek Boogaard, a 28-year-old who died, while on furlough from rehab, of an accidental drug overdose. He was later diagnosed with CTE. Branch delved deeply into Boogaard’s life, including interviews with family, friends, co-players, teachers and coaches. He also compiled interviews of Boogaard and included passages from Boogaard’s journals. It is an intimate portrait that goes beyond the typical celebrity-tragedy obituary. It is a thick description of the life and death of a small-town Canadian boy who landed his dream job as an ‘enforcer’ in the NHL, a player who fights in order to protect more skilled players. Boogaard’s big turning point and gateway out of small-town hockey and into the vaunted Western Hockey League (WHL) came, Branch tells us, in a singular performance:

Exactly what happened that winter’s night has been left to the rusty memories of the few dozen in attendance. This much is clear: Melfort [Boogaard’s team] was losing badly, and 15-year-old Derek Boogaard was suddenly inside the other team’s bench, swinging away at opposing players. “It felt like I had a force feild [sic] on me,” Boogaard wrote. Players scattered like spooked cats, fleeing over the wall or through the open gates. “He had gone ballistic,” [Derek’s father] said. “It was something I hadn’t seen before” (Branch, 2011a).

The display earned Boogaard both a suspension from the game and the notice of scouts of the WHL, who immediately recruited him to the next level up.

Branch makes a big deal of Boogaard's fists. They were his ticket to the NHL. His brain, though, was absent from pre-CTE accounts of either his prowess or his pain. After his death, his spoiled brain came into the spotlight. And yet, surely fists are part of a complex amalgam of brain, emotion, memory and reflex that was present in Boogaard, already, at age 15. They are connected to his brain through his nervous system, and he can neither do the damage that he did to others, nor get recruited to the NHL, without the combination. Branch writes: "Any boy's dream of the NHL intersects with the reality of skill, usually in the teens. For a few, fading hope depends on a willingness and ability to give and absorb beatings" (2011b). It was, crucially, Boogaard's impulsivity, aggression and capacity for violence—highly desirable attributes in the circumstances—that won him the job in which his brain became even more vulnerable to damage. His brutality was a source of respect and status, and of damage to other players' brains, before, during and after the further material changes in his brain that we now call CTE. If, after his death, Boogaard becomes simply a victim of CTE, we miss a large chunk of the problem, and thus possibilities for better solutions. Young men in combative sports are honed for physical skill, yes, but also as instruments in the delivery of punishing blows to opponents.

Killjoy journalism in the wake of CTE reveals confessions, by players, that fear is a constant companion of a hockey enforcer. In particular, they are speaking up about sleepless nights in anticipation of both what they have to do and what might be done to them.

Fans never saw enforcers curled up in a ball on the hotel room floor. They didn't see the food left on the plate during the pre-game meal. They didn't know that the enforcer tried to take his mind off of the fight with an afternoon movie or a long walk, and later had no idea what he had seen or where he had been.

Don't have the appetite to fight that night? Move aside. There are plenty of others who would love your job (Branch 2015).

While enforcers are likely an extreme case, it is plausible that fear is a not uncommon embodied response to prospective 'play' that involves both doing violence and absorbing it into your body as pain. Fear, too, is a complex embodied and embrained biosocial experience, and while we see glimpses in specific reportage, it is far from a dominant discourse. Those players who speak out about fear or addictions are swiftly chastised by the anonymous hordes on twitter and reddit, and by guardians of the game like Don Cherry, a bombastic broadcaster who held court on *Hockey Night in Canada* for almost 40 years.⁵ Fear is anathema to hegemonic masculinity,

⁵ Cherry was fired by *Sportsnet* on Nov 11, 2019 after making racist on-air comments. For decades his popular mid-game show 'Coach's Corner' (founded in 1980 by CBC, the national public broadcaster) featured rants that downplayed the risks of concussions, belittled critics of fighting in hockey, and modeled a version of old-school anti-PC masculinity that is rabidly popular among a swath of Canadians. Like the termination of Cherry's show, the precipitous decline in fist-fighting in professional hockey may signal welcome winds of change.

Fig. 2 2001 photo of hockey enforcer and CTE victim, Bob Probert. And a young adorer, whose brain also matters. Photo credit: Fred Jewell/Associated Press

or athletic prowess, so it remains a mostly invisible blow to most athletes-in-the-making, boys and girls alike. In contrast, contemporary neurosciences recognize fear as a material force in the brain's constant shaping (Johnson 2016).

Again and again the biographies of CTE sufferers point to impulsivity and aggression as traits exhibited only in the disease state, uncharacteristic of the man 'in his right mind.' Husbands, fathers and boyfriends lash out at loved ones in surprising ways belied by their pre-disease selves. Meanwhile, these same men have a demonstrable history of thousands of hours of brutal relations with other humans, admirable and rewarded in the context of collision sport and its attendant culture of masculinity (Fig. 2). The containment of that behaviour to its 'proper' sphere spills over (for some) into other relationships, as stories of domestic violence, rape, homophobia and hazing rituals attest. The ubiquity of video cameras, and gradual destigmatizing of speaking up about damage at the hands of powerful men is enhancing public awareness of the degree of intimate partner violence among athletes. Sociologists of sport have long attended to the connection between harmful masculinities and sport, a package that Michael Messner (2005) unfurls to include competitive homophobic misogynist talk and joking; voyeuristic participation in dominance-bonding through group sex acts; suppression of empathy towards others; and a culture of silence among peers, families and communities.

While we could, alarmingly, pick from any number of group assaults by male athletes, a horrific example loomed large during the writing of this article. In the fall of 2018 at an elite boys school in Toronto, a number of students on the

highschool football team sexually assaulted (at least) two other adolescent boys with a weapon (a broomstick), and videos of the incident were circulated on social media. The consistent overlap of hypermasculine social milieus and abusive performances of dominance is instrumental rather than coincidental, and we can expect that the silencing apparatus of shame and gendered power prevents many of these cases from coming to light. 'Cumulative exposure' to blows has taken centre stage in concussion science and policy. Similarly, hypermasculine spaces are characterized by cumulative exposure to violence, rewards and punishments, verbal and physical discipline, calculated and spontaneous violence (Messner 1990; Young 2019). While this is no revelation, the point we want to make is that neither the purposeful enactment of violence in and near sport, nor the toll it takes on (male and female) victims has been 'brainified' to the same extent as concussions have, and perhaps it would be politically and biologically useful if they were. What we can *see as damage* becomes more easily grasped and acted on. For example, a plausible explanation for the 'symptom' of aggression described in the biographies of CTE sufferers is that over time, a complex entanglement of damage by physical blows *and* biosocial habituation to aggression molds the man and his extended nervous system. Changes over time could be the unmasking of an attribute—aggression or lack of empathy—that had, through selective 'pruning' grown ever stronger in subjects who harbored the propensity to begin with.

Conclusion

Since CTE has become a matter of concern, brains of athletes in violent sports have come to matter, but they have done so in very circumscribed registers. The whittled-down one-way message, where tau is the chief agent in the story, lays the groundwork for an overbearing focus on *mechanical causes* of violent tendencies as though they appear only *after* sport-induced brain trauma. In some alarming cases, violence committed by athletes outside of sport—assaults and murders, often of women—is being read as a symptom of CTE in the perpetrator (Henne and Ventresca 2019). This is neuro-reductionism par excellence. It is also an abrogation of individual responsibility and blindness to the biosocial toll of immersion in violent sport cultures sustained by a larger economy and fan appetite for violence. We hope to have shown that dominant CTE discourse misleadingly renders the brain as a nearly-static thing, rather than a responsive node in an extremely complicated set of contexts inside and outside of bodies. Going on in this way threatens to miss the mark on deeply entrenched, repetitive, mundane ways that violence is inculcated into the bodies and brains of boys and men who engage in violent sporting cultures.

To prevent a misreading of our work: we are not saying that collective investment in prevention, diagnosis and treatment of concussions in and out of sport is misguided or overblown. People in our immediate circles have sustained concussions in fleeting moments of everyday life and subsequently had their lives go seriously off-track for months or even years. If anything, the efforts to understand and mitigate head trauma should expand beyond sport, and certainly loved ones, family doctors and ERs need to get better at recognising the signs and knowing what to do next. We

do not have stakes in debunking concussion science, and even less in scrutinizing individual stories of pain, loss and tragedy with suspicion. Our cautious posturing here is telling: That any whiff of critique about how the issue is playing out in North America might be read as dismissive of its importance is, in itself, a symptom of the impoverished dichotomy that frames this particular public health issue. In *League of Denial*, Fainaru and Fainaru-Wada tell a compelling story that positions the NFL as ‘merchants of doubt,’ taking a page from the playbook of Big Tobacco and Big Oil by deliberately burying evidence and skewing medical consensus about brain injuries in players and retirees (Oreskes and Conway 2011). Successful class action lawsuits have confirmed nefarious actions and inactions on the part of the protectors of NFL profits. The moral economy of CTE has been clear from the beginning: to open the black box of its medical reality—to say maybe the facts aren’t all in—is to align oneself with Big Sport and its sometimes unsavoury spokespersons. Why, though, do we have to pick a team? In the foregoing, we have tried to simultaneously acknowledge the very real stakes of cavalier treatment of head injury in sport and elsewhere, while also asking commentators, scientists, politicians and critical theorists to think harder about how brains, bodies and societies work.

Recent findings and theories from critical neurosciences have led us to conjecture that the making of boys and men (and to a much lesser degree, girls and women) in and around combative sports—the ‘socialization’—alters the matter of their embrained bodies, much like concussion does. The very specific context in which CTE diagnosis occurs—after death and in the public spotlight—constrains the stories that get told. Victimhood is part and parcel of the recent medicalization of repetitive head trauma, as though the men in question only *received* blows, but never *delivered* them. A more nuanced, complex and multiple account—of masculinity and of the science of becoming violent in specific cultural milieux—has ethical and political consequences that extend far beyond fields and ice rinks.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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