"The Trauma of Losing Your Own Identity Again": The Ethics of Explantation of Brain–Computer Interfaces

Paul Tubig and Frederic Gilbert

1 Introduction

Clinical trials are underway to investigate the effectiveness of implantable neurotechnologies to treat a range of serious and confounding medical conditions, such as epilepsy, treatment-resistant depression, paralysis, dementia, and severe enduring anorexia nervosa [1]. Such trials will be more frequent so long as implantable neurotechnologies are still held as promising modes of therapy and enhancement. Yet the involvement of research participants to test these experimental technologies raises a panoply of ethical quandaries. One prominent issue is identifying and weighing the moral risks of implanting a neural device in participants, which has inspired a robust neuroethics literature. [1] There are also broader ethical and societal concerns that arise from the development and use of invasive neurotechnologies for therapeutic and enhancement purposes, such as how they could exacerbate social

[1] The neuroethical literature focuses on various topics. We know, for example, brain implant technologies, such as Deep Brain Stimulation, raise a series of ethical issues, including (a) user safety and risk-benefit analysis [2], (b) implications on notions of identity and autonomy [3, 4], (c) research ethics and informed consent, (d) justice issues [5], (e) general placebo-controlled surgical trial concerns [6], and (f) the impact of enhancement via DBS [7], ethical consequences linked with increased life expectancy of patients [8].

P. Tubig
Department of Philosophy and Religious Studies, Georgia Southern University, Statesboro, GA, USA
e-mail: ptubig@georgiasouthern.edu

F. Gilbert (✉)
Philosophy Program, University of Tasmania, Hobart, TAS, Australia
e-mail: frederic.gilbert@utas.edu.au

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inequalities, intrude on mental privacy, and create novel forms of exploitation. [2] But one ethical question that is currently underexplored is the ethical implications of neural device explantation. By explantation, we mean the procedure of removing an implanted neural device from a user, which is an option that may be open, offered, or even required after a clinical trial is completed or discontinued. Some have already raised important ethical questions related to neural device explantation, such as who should pay for the costs of explantation when research participants want the device removed, or whether researchers and clinicians ought to honor the requests of patients for their devices to be explanted when doing so would threaten their life or health [14, 15]. With the increase of neural device implantations, ethical issues of neural device explantation become increasingly more pressing since a large number of implantations may call for their removal.

This chapter focuses on the ethics of neural device explantation [16, 17]. What are the possible moral harms that could come from removing a neural implant, and what are the post-trial responsibilities of researchers to prevent or mitigate such harms? We are particularly concerned about the effects of explantation to a participant's personality, identity, autonomy, authenticity, agency, and/or self (or PIAAAS for short). [3] [29] There are some empirical findings of participants perceiving the explantation of their neural device as a serious threat to important features of who they are. These testimonies call for ethicists and researchers to be more attentive to the PIAAAS-related harms that may result from explantation and develop practices that properly recognize and attend to these harms. Here, we argue that implanted persons have a strong moral claim to their devices when they support or constitute their PIAAAS. This should be considered in the overall individual assessments of whether a device ought to be explanted. If explanting a device is a live option after a clinical trial ends, then we argue that researchers have a post-trial obligation to provide ancillary care to participants to reduce the anticipated negative effects of explantation, including any serious PIAAAS-related harms.

[2] Many neuroethicists have raised important justice concerns regarding the distribution of benefits and burdens of neurotechnology in a socio-historical context of inequality and bias. For example, Sara Goering and Eran Klein raise a range of justice concerns for people with disabilities, including equitable access given how disabled people are historically marginalized while bearing the burdens of novel neurotechnology research [9]. Another major worry is that neurotechnologies may only be readily available to higher socioeconomic classes, which will likely exacerbate existing inequalities, especially when such technologies are used for capability and opportunity enhancement purposes [10–13].

[3] In this chapter, we will primarily use this acronym as an all-encompassing term for personality, identity, agency, authenticity, autonomy, and self. One reason is that these terms are often conflated with one another in the neuroethics discourse. The imprecision of how these terms is used and their close relations with one another lead to a certain lack of clarity regarding what critical aspect of the person is really threatened by their use of neurotechnologies. Many neuroethicists seek to disentangle the concepts to better explain the morally troubling changes to the person that are brought about by neurotechnologies [18–28]. Here, we will sidestep this issue and use the term PIAAAS to broadly refer to the important, intertwined aspects of our ways of being and acting in the world while recognizing the inexactness of the language used to refer to them.

This chapter will proceed as follows. In Sect. 2, we will explain what explantation is and the reasons for doing it on research participants who have been implanted with a neural device for research purposes. In Sect. 3, we will consider the perspective of a research participant whose neural device will be explanted and how it could lead to troubling PIAAAS-related changes. Then in Sect. 4, we will discuss how serious PIAAAS changes are widely appreciated as important moral considerations of whether to proceed with neural device implantation. We argue that such reasoning should also extend to neural device explantation, given that such interventions can also make participants vulnerable to troubling PIAAAS-related changes. We conclude in Sect. 5 by arguing that clinicians and researchers have responsibilities toward their patients and research participants to avoid or mitigate the serious negative effects of explantation, including any concerning PIAAAS-related changes. This includes recognizing that explantation can be experienced as a traumatic event and major disruption of their sense of self and the ethical imperative to provide support—like developing exclusion criteria for explantation and providing counseling to explantees—in response to it.

2 Explantations and Why They Are Done

Neural device explantation is the removal of a neural device that has been inserted and fixed to a person's brain or part of their central nervous system for therapeutic or investigational purposes. There are various reasons for explanting a device. One reason is that the device's continued presence may endanger the physical or psychological health of the user. Neural implantation involves introducing a foreign material into the body, which then brings risks of biocompatibility. Eran Klein maps out the various safety risks of implantable brain–computer interfaces (BCI), describing how BCI components—electrodes, power systems, and data processing systems—could cause tissue damage or adverse changes in the brain [30]. Furthermore, a device may bring about undesirable psychiatric after-effects [31]. These effects include dramatic alterations in a participant's mood, troubling emotional instability, depersonalization, and feelings of alienation. When a neural device proves to be unreasonably unsafe to the user, the principles of beneficence and nonexploitation call for its removal to protect the user's health.

Another reason for explantation is that a neural device proves to be inefficacious. If a device was designed to provide therapeutic benefit and it is not demonstrating this, then there is no therapeutic or exploratory reason for leaving these devices in the participants. Yet this may not in itself be a sufficient or weighty reason to explant a device, and other reasons may have to be coupled with it since explantation is an invasive procedure that brings its own risks to persons undergoing it. Without other confounding reasons, it may more preferrable to leave the implant in the body even if it may not be functioning properly or producing the desired result.

A third reason is that the clinical trial has ended. Investigational neural devices are only useable and manageable within the research trial. During the trial, participants are supported by interdisciplinary teams that monitor and maintain their devices, gather data, recalibrate treatment parameters, and

observe participants' health. Beyond the temporary setting of the research trial, there is no established infrastructure to provide ongoing support and care. This conundrum is exemplified in the case of Rita Leggett, which was profiled in *Nature Medicine* and *The New Yorker* [32, 33]. Leggett, who struggled with epilepsy, participated in a research trial to explore the use of a neural implant to detect upcoming seizures. The device was effective in helping Leggett manage her epilepsy. But the trial abruptly ended because the researchers could not sustain funding and the company eventually folded. Leggett and her husband sought to purchase the device, but they were denied, in part because there was no infrastructure in place to handle the complications of the device, such as adjusting its settings and replacing its batteries. This contrasts with other implantable devices, such as cardiac pacemakers, where there are many institutions that can support its continued use. As Joseph Fins notes, any hospital with a cardiology service can provide technical support to people with implanted pacemakers. This is not the case for people with implanted neural devices since the technology is still novel, maturing, and not yet sustainable, so support is limited to highly specialized centers [34].

A fourth reason is the legal ownership of the device. As implied from the previous reason, industries that sponsor the neural device trials play some role in the ability of research participants to continue to have access to investigational neural devices. The level of control that a company has on when and how their devices are used is unclear and likely vary according to the terms agreed upon by all stakeholders in a research program. Neurolaw, a burgeoning field of law that seeks to address the legal implications of innovations in neuroscience and neural engineering, is still catching up to address difficult legal situations brought about by the practice of explantation. It raises a pressing ethical question of whether the private ownership of neural devices integrated in the bodies of research participants violate the bodily autonomy of participants who want to keep them. Although the physical removal of neural implants requires the consent and cooperation of implanted persons, the discretionary power of companies sponsoring the trials to deny providing support to research participants to continue using their investigational neural devices is a weighty consideration for explantation.

In summary, the major reasons for explanting a neural implant range from beneficence, futility, to proprietary rights of the device [14, 35, 36]. The principle of beneficence may call for the explantation of a device when it inflicts physical and psychiatric harms on the participant. Explanting a device may also be justified by concerns of futility, both in terms of the device not producing any kind of therapeutic or informational benefits and such devices lacking the background institutional support to use and maintain them properly. Lastly, there may be proprietary motivations for explanting a device. Here, we want to argue that the decision to explant a device from a participant should also take into account the adverse effects of explantation. One such effect is the PIAAAS-related harm that may result from explantation. In the next section, we will discuss some initial empirical findings of participants' views on the possibility of PIAAAS-related changes induced by explantation.

3 "You Are Experiencing That Trauma of Losing Your Own Identity Again": The Testimony of An Expected Explantee

The ethics of explantation is complicated by the potential harm of altering the PIAAAS states of participants and patients. As explained in the previous section, there may be positive reasons for removing an implanted device from a user. But this should be weighed against some of the moral risks associated with explantation. We would like to bring attention to a particular risk that has been underrepresented in the neuroethics discourse. It is the potential link between explantation and its effects on participants' PIAAAS states. In contrast to discussions about psychological disruptions linked with DBS implantation, which appeared as early as 2002 [37], discussions about psychological adversities related to explantation were not reported till more than 15 years later [38]. We turn to a particular testimony of a BCI user to underscore the point and to raise awareness of the ramifications of BCI explantation to a person's PIAAAS.

A patient with quadriplegia volunteered to be implanted with the first-in-human, experimental brain-computer devices [39]. He was implanted with a BCI device to send signals from his brain to his muscles, which would allow him to regain some movement in his right arm, hand, and wrist. We interviewed this patient as part of a project to gain novel insight in the phenomenological impacts of BCI on users' perceived sense of self through their first-person experiences. We used qualitative methodological tools grounded in phenomenology to conduct in-depth, open-ended, semi-structured individual interviews. Interviews were based on an adapted version of the qualitative instrument first developed and tested in earlier iterations [38, 40–42] and further elaborated in [43]. Interviews were transcribed verbatim. Here, we will focus on two extracts relevant to explantation.

Interviewer: With other technologies (Neurovista, Broaden trial, etc.) we observe patients refusing and resisting getting these devices out of their body or head. What do you think goes through these patients mind when refusing?

Patient #1: I understand, I think anything that is going to help a patient to experience a better quality of life, if that system is still working, they would be extremely hesitant to give that up. Because they understand what it is like without and they do not necessarily want to go back at it, because if it is a benefit to their life, they want to sustain these benefits. For me, it has been quite something different, because as you know, going into it [trial] this wasn't a forever device, I knew it wasn't going to be something I'd be able to always use… although I couldn't prepare for that, if I was at the other end thinking it is a forever device, repairing my lost abilities, and then someone telling me: "Oh no, we're going to have to take that away from you" it would be almost the same amount of trauma as if I had my spinal cord injury all over again. Losing this ability completely again.

Interviewer: Yes, you are right, it would be another trauma, clearly a psychological harm. Some of the patients we're talking about, with the device they find themselves, they find these new capacities [...].

Patient #1: You are experiencing that trauma of losing your own identity again and try to figure out who you are; because, you know, if you really do identify with the device it becomes a part of you, and when that change […] it would be just very similar to the trauma and the adjustments I had to make after my initial spinal cord injury.

This patient's perspective brings attention to a serious moral cost of explantation. It may bring about a significant psychological harm, especially in circumstances where users think that they'll be able to have access to the device for a long period of time. This harm, in the words of the patient, would be a loss of identity, experienced as reliving the trauma of becoming disabled in the first place.

From the patient's testimony, one can then draw the source of the identity harm. First, the identity harm may be related to re-losing the valued abilities that may have sustained or been constitutive of that patient's identity. A person's sense of autonomy or self-conception may be intimately tied to certain roles, activities, or ways of living. Accomplishing these aspects about themselves may require the possession or exercise of certain capacities. Thus, it is understandable that losing or re-losing these capacities will likely lead to serious negative disruptions to a patient's PIAAAS states.

Second, the identity harm may be related to the integration of the implanted device to their sense of self or bodily integrity. The introduction of interactive prosthetics has blurred our bodily boundaries. Studies have shown that people can and do extend their bodily representations to include wheelchairs, exoskeletons, and protheses, where these devices aren't perceived as tools separable from their users, but as an integral part of themselves [44, 45]. Today, "cyborg" is a growing identity that is gaining wider recognition, or at least, increased calls for its recognition [46, 47]. Persons with neural implants can perceive their devices as integral to their sense of self. Removing the device can then be experienced as a dramatic alteration of their way of being to the extent that it requires a difficult readjustment or re-creation of the identity, like the kind of coping and readjustment period to a newfound embodiment resulting from spinal cord injury. This reaction was acutely felt by explantee Rita Leggett, stating, "The device and I were one. We were successful. It was like taking away that part of myself that made me complete" [32].

From the various ways in which identity harms induced by explantation could be articulated, it is at least clear that explantation can be experienced as deeply traumatizing, a dramatic rupture of a lived embodiment deeply entwined to an explantee's sense of being. When a neural implant enables a patient to regain some function, like the ability to walk, explantation is, in important ways, re-inducing a patient's disability, like quadriplegia. As such, explantation can involve the serious discontinuity of a lived embodiment that bounds a patient's identity and agency. When a person is in a symbiotic relationship with their neural device, explantation can be

experienced as an intrusive, and even violent, way of taking away the patient's capacities or violation of their intimate sense of being.

These cases suggest that explantation can threaten the stability of a person's PIAAAS states. It is poignantly described by the patient as undergoing the trauma of losing their identity again. This kind of vulnerability should be recognized and factored in when assessing the benefits and risks around neural implant removal from research participants and the responsibilities of researchers to their participants when their devices are indeed removed. In the next section, we will elaborate how PIAAAS-related change has been widely regarded as a serious moral concern when considering the ethics of neural device implantation. We argue that if it is a serious moral consideration when it comes to whether, when, and how we proceed with neural device implantation, then it should also be a serious moral consideration when it comes to whether, when, and how we proceed with neural device explantation.

4 Implantation, Explantation, and PIAAAS Change

Putative PIAAAS changes from the application of neurotechnologies have garnered considerable attention in the neuroethics discourse. This moral concern follows from a growing body of empirical findings of implantees experiencing dramatic changes of their psychological characteristics while going through DBS treatment. Some of these cases are extreme, such as implantees undergoing total transformations of their psychological profile to the extent that they seem to be wholly different persons. One classic case, which is described by Walter Glannon, is of a patient with advanced Parkinson's disease (PD) who received DBS treatment to mitigate his motor disorder [48]. Although the stimulation helped restore his motor functions, it also made him manic and megalomaniacal, invoking the specter of Phineas Gage [4] and how intervening in the activities of the brain could lead to dramatic revisions of the self. In response, Karsten Witt and others argue that the risk of "becoming another person" is one of the most urgent ethical problems facing DBS treatment for conditions like PD. [50] Another set of cases involve implantees having difficulties adjusting to their newfound embodiment, feeling estranged or distant from the kind of being they've become from their neural implant. For example, PD patients have reported that they don't feel like themselves during DBS treatment, acquiring abilities, or psychological and motivational states that they can't identify with. Other patients reported felt experiences of inauthenticity and heteronomy, some

[4] Phineas Gage was a railroad foreman who in 1848 suffered a severe head injury from a construction accident. An errant explosion caused an iron rod to pierce through his brain. He miraculously survived the event, but his personality changed dramatically. Prior to the accident, Gage was known to be a reserved, even-tempered person. But after the accident, he was outgoing, impulsive, and profane. His personality transformed so dramatically that Gage's friends and acquaintances described Gage as "no longer Gage" [49].

describing themselves as robots since their neural devices seem to be major springs of their thoughts, desires, and action. [5]

These kinds of potential psychological changes and feelings of alienation and depersonalization from their neurotechnology-enabled embodiment are undoubtedly disturbing because they seem to amount to PIAAAS change, where fundamental components of the self that give persons their sense of individuality, psychological and narrative continuity, and autonomy are violated. Though the point of neurotechnological intervention is to alter the physical and psychological states of persons undergoing it, there may be certain accompanying changes that are perceived as serious affronts to their integrity, one being the revision or removal of important properties that are tied to persons' self-constitutions. Persons could incur a loss due to their neural implants, namely a loss of key aspects that may be unreasonable to accept. For this reason, neurotechnological intervention could be perceived as a serious harm even though it may fulfill its intended therapeutic purpose. Thus, the risk of PIAAAS change is a key question around the ethics of implantable neurotechnologies, generating a robust discourse on the nature of this harm, its normative significance, and what are the appropriate responses to this type of vulnerability.

Here, we argue that if PIAAAS change is an important consideration in the ethics of implanting a neural device in the embodiments of persons, then this consideration should also be extended to the ethics of explanting a neural device from the embodiments of persons. So far, the concern over PIAAAS change following the excision of a neural implant has not had the same kind of moral attention as it does in the context of neural device implantation. There could be a variety of reasons for the discrepancy. One reason is that PIAAAS change from neural device explantation is under-recognized. As noted earlier, psychological disruptions linked with DBS implantation appeared as early as 2002, and yet discussions about psychological adversities related to explantation were not reported till more than 15 years later [38]. Thus, neuroethicists may still be catching up to the empirical studies of the after-effects of explantation. When wider acknowledgment is achieved, then PIAAAS change would expectedly be taken into greater account when determining the morality of neural device explantation.

A second reason may be that certain presumptions are operating in the background, like that there is a crucial moral difference between implantation-induced PIAAAS change and explantation-induced PIAAAS change. One possible explanation is that PIAAAS change from implantation is due to the intrusion and artificial influence of a foreign device, whereas PIAAAS change from explantation stems from people returning to their original, biophysical state after the cessation and removal of a foreign device. One can then ground the normative significance in the idea that the former does direct harm, whereas the latter only allows harm to occur. [6]

[5] For further discussions on the putative postoperative impact of DBS on patients' PIAAAS, please refer to footnote 3.

[6] This plays on influential doing/allowing harm distinction that have shaped numerous ethical discourses, such as the euthanasia debate and whether there is a moral difference between active and passive euthanasia.

We do not think such lines of argumentation for the moral asymmetry of implantation and explantation will be successful or even relevant. What seems to matter ultimately is whether such procedures bring about distressing PIAAAS change. Though the class of psychological changes exemplified in cases of implantation may be qualitatively different from the class of psychological changes exemplified in the cases of explantation, the normative significance is whether the psychological changes can be reasonably characterized as serious disturbances to a person's PIAAAS states.

Since PIAAAS change is morally troubling, and explanting a neural device puts people undergoing the procedure at risk of experiencing these changes, it is important for researchers to be more considerate of this vulnerability when assessing whether, when, and how to proceed with neural device explantation. There is no reason to think that PIAAAS change is only morally relevant in the context of neural device implantation. The possibility of PIAAAS change generates post-trial responsibilities on researchers toward their patients and research participants to avoid or mitigate the serious negative effects of explantation, including any concerning PIAAS-related changes. In the next section, we will propose some recommendations on how researchers should proceed when it comes to explantation.

5 Recommendations

Given the prospects of patients and research participants experiencing troubling PIAAAS change if their neural implants were removed, we propose the following recommendations for clinicians and researchers for consideration to respond appropriately to this vulnerability:

The development of exclusion criteria. We believe that there are cases where explantation may not be a permissible option. Certain harms following the excision of a neural device, including PIAAAS-related harms, may be so severe that they outweigh other moral considerations, disqualifying certain persons with implants from becoming subjects for explantation. The degree of the harm will be dependent on a variety of factors, such as the nature of the illness that is being treated, the patient or participant's history with the device, and certain life circumstances. An adequate specification of the exclusion criteria will be sensitive to these features of the person being considered for explantation. One factor that should be weighed is the length of time that the participant had the device. The length of time that a neural implant is kept likely correlates with the degree in which a person's PIAAAS-related states are bounded to their neural implant. The longer a person lives with a neural device and is immersed in the physical and psychological life it enables, the more likely the person's self will be intertwined with their device. Therefore, removing the neural implant after this level of human-machine merger will likely lead to serious harms extended to the patient or participant.

Another factor is the nature of the condition or limitation that the BCI was ameliorating. If removing the device is going to dramatically diminish the quality of life the explantee, then this is a strong reason against explantation. Yet this also has to be weighed against the possibility that extended BCI use or treatment could also

lead to a diminished quality of life. Additionally, we should be attentive to how long-term DBS treatment could also bring about advanced, novel stages of a disease that were never encountered before, a ramification of extending a patient's life through the implantation of DBS [8].

A third factor is the psychiatric history of the person being considered for explantation. It is common for researchers to disqualify prospective users from receiving a neural implant because they have a history of depression or other psychological conditions, making them unfit for implantation since these conditions could be exacerbated when undergoing invasive neurotechnological interventions. Similar exclusion criteria should also be extended to determinations for explantation. If a participant has a past clinical record of depression or suicidal ideations and excising their device would likely arouse or intensify these internal states, then the participant should not be eligible for explantation. What is to be avoided is imposing a range of serious traumas, including PIAAAS-altering traumas, on patients and participants. This moral consideration may require re-thinking certain values, like the strength of proprietary rights of neural devices when they are intertwined in people's physical and psychological being.

One could argue that the exclusion criteria for explantation should be involved in the process of selecting participants for neural implant research trials. If we can reliably predict in the recruitment phase which volunteers are susceptible to harmful PIAAAS change if they had to undergo explantation and exclude these volunteers from participation in clinical trials, then this would avoid the explantation-related dilemmas raised in this chapter.[7] We agree that susceptibility to harmful explantation-induced PIAAAS change should be part of the individual assessment of who is eligible as research subjects in neural implant research. Part of our argument is that exclusion criteria that appropriately recognize the vulnerabilities of serious PIAAAS-related harms from explantation should be involved in the decision-making of neural researchers, whether it is involved in the initial recruitment stage or at the end of a clinical trial so long as the well-being of participants from the threats of difficult PIAAAS change from explantation is considered. Also, whether exclusion criteria for explantation are unnecessary depending on whether it is always possible to reliably predict in the initiation stage who will experience the troubling effects of PIAAAS change if they undergo explantation. We cannot rule out the possibility that a participant could change in some new way that was not anticipated, given that implantable neurotechnologies can lead to transformative experiences, or experiences that are radically novel to the implanted person and may alter their identity in some fundamental way [51, 52]. Given the dynamic experience and changing relationship a participant may have with their neural device, there may be cases where prior risk assessments may become invalid, and researchers will have to re-evaluate whether an implanted person should be subjected to explantation.

Access to counseling for explantees. If neurotechnologically implanted persons consent or are required to undergo explantation, then we hold that clinicians

[7] We thank the two anonymous reviewers for raising this point.

and researchers, as well as funders and institutions, have a responsibility to provide post-trial or ancillary care to explantees to mitigate any PIAAAS-related harms that may follow from explantation. Currently, the lack of provision of care indicates a lack of acknowledgment and anticipation, if not lacking a sense of beneficence and justice, to the PIAAAS-related harms accompanying the removal of neural devices. Leggett, for example, described how she felt abandoned after the research trial ended. There was no expression of gratitude for her years-long participation or no offer of counseling to help her transition back to a life without an implant. As Liam Drew describes Leggett's experience in his article on explantation, "The day she travelled to the hospital to return the handheld device that had become an essential part of her life, she anticipated a poignant, reflective conversation with the trial coordinator who had accompanied her throughout the process. However, he was not there. Rita had to hand her device over to a stranger, who told her she could leave a note if she wanted" [32]. Researchers have an obligation to research participants, either generated from their relationship of trust and vulnerability or from the principle of reciprocity given the contributions of participants. Also, it is irresponsible not to provide explantees with support to reconceive themselves in ways that help them move on with life without an implant. Losing a cherished, meaningful identity and valued form of living is excruciating. Making peace with an estranged or unwelcoming embodiment and its attendant physical and psychological life is a very difficult, unsure process of acceptance, adjustment, and re-creation of a new identity. It is an unreasonable burden for explantees to face on their own without expert counseling support.

Further research on the PIAAAS-related effects of explantation. The PIAAAS-related effects of explantation are underexamined areas of neuroethical research. To develop clinical and research practices and therapies that are appropriately responsive to the risks of PIAAAS change from explantation, we need to have a better understanding of the phenomena. This investigation includes probing the phenomenological aspects of explantation. Elucidating the lived experience of loss of a neural device and the specific goods it provided will have valuable practical application in the clinical and research context. For instance, therapists can assist explantees in transitioning to embodiments they initially did not want, helping them to construct or repair their identity and meaningful pattern of living within that embodied context. This may require what Hilde Lindemann Nelson calls "narrative repair" when experiencing an injured identity, an approach that Marya Schechtman suggests for helping DBS users feel less alienated from themselves after the activation of their implanted device [53, 54]. This approach could also be extended to people having adjustment difficulties after going through neural device explantation.

6 Conclusion

The impetus of this chapter is to examine the ethics of neural device explantation from the normative lens of PIAAAS. PIAAAS change is an often-overlooked aspect of explantation, which then translates to how the option of explantation is perceived

and judged. We push back against the characterization that explantation is a relatively benign resort with impacts only affecting physical health. The neuroethical discourse around PIAAAS change from neural device implantation has illuminated the normative significance of PIAAAS change, why it is morally concerning, and why this moral consideration should be integrated in how the development and use of implantable neurotechnologies are approached. Given empirical findings of troubling PIAAAS change following explantation, we argue that the moral analysis applied to neural device implantation should also be applied to neural device explantation. Thus, our approach to neural device explantation should be appropriately responsive to the vulnerability of PIAAAS change of explantees.

Although this chapter focuses on the difficult PIAAAS-related harms following neural device explantation, we do not think that this is a concern unique to implantable neurotechnologies. In some ways, the concern we highlight is distinctive to neural implants given the ways in which the brain is widely regarded as the principal seat of the self, the level of invasiveness of the device in the body, and how intervening in its activities can have wide-ranging effects on users' core aspects of their identity. But in many other ways, the concern of troubling PIAAAS change following explantation is also applicable to a broader range of implants, where people have integrated these devices to their sense of self, bodily integrity, and autonomy. Thus, the argument we present here can also extend to other types of explantation and speak to a larger set of concerns around the option of removing implants that have been supporting people's PIAAAS-constituting states after the end of research trials.

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