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Worldwide Cryonics Attitudes About the Body, Cryopreservation, and Revival: Personal Identity Malleability and a Theory of Cryonic Life Extension

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Abstract

This research examines the practice of cryonics and provides empirical evidence for an improved understanding of the motivations and attitudes of participants. *Cryonics* is the freezing of a person who has died of a disease in hopes of restoring life at some future time when a cure may be available. So far, about 300 people have been cryopreserved, and an additional 1200 have enrolled in such programs. The current work has three vectors. First, the results of a worldwide cryonics survey ($n = 316$) carried out as part of this research are discussed. Second, a theoretical model is developed from the survey results to propose a Theory of Cryonic Life Extension which explains an individual's decision to select cryopreservation. Third, the most distinctive survey result, a conceptualization of personal identity malleability, is extended with a philosophical formulation. Personal identity is found to be emergent, not fundamental, and thus may continue to evolve in concept and application, particularly in the longer time frames implicated by cryonics. The potential consequences of this work are that the conceptual norms materializing in the cryonics community could be forerunners of wider societal trends of how humans understand themselves as subjects in an era increasingly configured by science and technology.

Keywords Cryonics · Corporeality · Cryopreservation · Revival · Biostasis · Personal identity

'Death is something I can live without'—Cryonics Survey respondent, July 2017

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Introduction

The starting point for this research is addressing the gap that there are few dedicated empirical studies of cryonics. There is only one other previously known study of persons enrolled in cryonics programs. Rievman's (1976) survey (n = 89) investigated the attitudes of cryonics association members. Another recent study (n = 1000) explored general public attitudes towards cryonics in Germany (Kaiser et al. 2014). The study found that 53% of the general public would like to participate in the latest medical technological advances, and that 22% would consider cryonics. The current study (n = 316) contributes by providing a detailed contemporary investigation of the attitudes of worldwide cryonics community members (those enrolled in cryonics programs or otherwise supporting the endeavor).

The topic of the special journal issue is Posthuman and Transhuman Bodies in Religion and Spirituality. Therefore, it makes sense to consider the views of the cryonics community. This is because persons enrolled in cryonics programs not only have strong opinions about the future, they have committed to these ideas in the form of financial arrangements and legal contracts with cryonics providers regarding what is to happen in the final moments of their current physical body. This is more proactive responsibility-taking than many people may have considered or are willing to contemplate. Only 37% of Americans have advanced directives for end-of-life care if they become seriously ill or unable to make health care decisions (Crist 2017), and only 42% have estate planning documents such as a will or living trust (DiUlio 2017).

Outline of Current Work

This paper has several sections. "Cryonics Background" provides an introduction to cryonics including the definition, status, rationale, and technical feasibility of the practice, along with the results of other cryonics studies. "Cryonics Study and Results: a Theory of Cryonic Life Extension" discusses the survey methods and results, and develops a theoretical model to explain the findings. "Cryonics Views Regarding Personal Identity Malleability" explores one of the most prominent results of the survey, an element of malleability in the way respondents consider personal identity. "Philosophical Conceptualizations of Personal Identity" draws from philosophical literature to support the notion of personal identity malleability found in the survey results. "Implications of Personal Identity Malleability for Cryonic Futures" relates the philosophical findings to the theoretical model and discusses the further implications, risks and limitations, and conclusion of the work.

The novel contribution of the paper is articulating an empirical and philosophical formulation of personal identity malleability that substantiates the theory of cryonic life extension also contained in the work (explaining an individual's decision to select cryopreservation). *Personal identity malleability* is a concept of personal identity that includes some degree of openness as to how the future self is to be instantiated, both the brain (memories) and the body (incorporeality), and how the notion of self is reflected conceptually (as a continuity mechanism for ordering the events in a person's life).

Cryonics Background

Cryonics Definition and Status

Definitionally, *cryonics* is the practice of freezing a person who has died of a disease in hopes of restoring life at some future time when a cure has been developed (Merriam-Webster 2018). *Cryonicists* are those who are enrolled in cryonics programs or otherwise support cryonics. The practicing community may favor the slightly different definition that *cryonics* is the science of using ultra-cold temperature to preserve human life with the intent of restoring good health when technology becomes available to do so (Alcor 2018; Minerva and Sandberg 2017, 526). According to one source, 270 patients have been cryopreserved and are currently existing in a state of 'cold sleep' (Kaiser et al. 2014, 1). The largest provider, the Alcor Life Extension Foundation, lists 159 patients as having been cryopreserved, and 1198 additional persons being registered for cryopreservation (Alcor 2018). KrioRus lists that they have cryopreserved 63 patients (KrioRus 2018). There are five known providers. Alcor, the Cryonics Institute, and Oregon Cryonics are based in the USA; KrioRus is located in the Moscow region of Russia, and Southern Cryonics/Stasis Systems Australia is based in New South Wales, Australia.

The Cryonics Wager

The argument in favor of cryonics can be summarized as the Cryonics Wager, by analogy to Pascal's Wager (Shaw 2009, 520). The Cryonics Wager is the premise that even small chances of success are sufficient to make cryonics a rational choice. The current alternatives to cryonics are burial or cremation, which would result in certain and irreversible death. What is known about cryobiology and the possible trajectory of scientific advance suggests that cryonics may have a non-zero possibility of future success (Moen 2015, 677).

Cryopreservation Process

One method of cryopreservation is described as follows, although there may be variations. Immediately upon the pronouncement of legal death, the body is rapidly cooled to just above 0 °C while respiration and heartbeat are maintained artificially. A substance such as heparin is injected to avoid coagulation and protect cells from the ischemic damage that would otherwise occur shortly after death. The patient is then perfused with cryoprotectant chemicals to prevent ice-crystal formation and subsequent fracturing when the body is further cooled to below 0 °C. The body's cellular fluids are partially replaced with cryoprotectant chemicals so that instead of freezing and fracturing, the fluids become gradually more viscous until a glassy state is reached at approximately − 120 °C. The body is then submerged in liquid nitrogen, at − 196 °C, and stored in the hope that one day medical technology will have advanced sufficiently to make it possible to repair the freezing damage and to cure the patient of the condition that resulted in death (Moen 2015, 1).

Technical Feasibility

The scientific objectives of cryonics are twofold, to store organs and tissue for centuries if necessary without decay and to reanimate them later. One early paper discusses the vision and technical feasibility of cryonics (Merkle 1992). The work evaluates the known and extended limits of what medical technology might be expected to achieve, based on chemistry and physics, and proposes that the repair of frozen tissue could be within those limits.

Advances in the more traditional field of cryobiology underlie and facilitate progress in cryonics. *Cryobiology* is the branch of biology that studies the effects of low temperatures on living things. The preservation of organs under hypothermic conditions for transplantation is a primary research focus. One of the first empirical demonstrations occurred in 1955, when a rat was reanimated after having been cooled to just above 0 °C and having a full cessation of brain activity (Lovelock 1955). Similar kinds of experimental validations continue, most recently in a successful example with pigs (Alam et al. 2006). There can be an overlap between cryonics and cryobiology research methods and applications. One example is that of emergency rooms using cryonics techniques to stabilize victims of severe trauma. Blood is replaced with a cold saline solution that rapidly cools the body and stops virtually all brain activity (Thomson 2014). This process gives surgeons more time to treat the damage, after which the patient's blood is transferred back and the body reheated.

One crucial advance in cryonics in the last 15 years is the vitrification approach as an alternative to freezing (Fahy and Wowk 2015). A challenge with freezing cells is that when water turns to ice, it expands, which can result in damage to cellular walls and other structures. Instead, vitrification (from *vitrum*, the Latin word for glass) replaces more than 60% of the water inside cells with protective chemicals (cryoprotectants, conceptually similar to antifreeze). With cryoprotectants, vitrification can transform hydrated living cells (molecules, cells, tissues, organs, and possibly whole organisms) into a vitrified (glass-like) state such that ice crystals do not form. Early examples of vitrification have been demonstrated in worms and rabbit kidneys (Fahy et al. 2009). More recently, a rabbit brain was frozen and thawed for the first time (Wowk et al. 2018). The technique consisted of draining the blood and replacing it with a chemical fixative (glutaraldehyde) to prevent instantaneous decay (McIntyre and Fahy 2015). Cryoprotectants were then infused more slowly to prevent dehydration, and the brain was cooled to − 135 °C. Samples were thawed a week later, and appeared to be in uniformly excellent condition when examined with electron microscopy. The technique was awarded a milestone prize by the Brain Preservation Foundation (Thompson 2016).

Legal Consequences

Legal precedents need to be established in any new domain and cryonics is no exception. To further the development of cryonics, Minerva and Sandberg (2017) propose the concept of cryothanasia. *Cryothanasia* is the notion of causing the death of a terminal patient in the hope of extending that person's life in the future. Cryothanasia is different from *euthanasia* (the practice of intentionally ending a life to relieve pain and suffering, without cryonics as the further consideration). The

potential benefits of cryothanasia are reducing pain and suffering, and delivering the body in an improved condition for the cryopreservation process. Without a legal designation and a treatment protocol, the only alternative for terminally ill cryonics patients at present is to undergo the voluntary refusal of food and fluids (VRFF) to bring about clinical death. VRFF requires close monitoring and care for the patient, who may become agitated and distressed. For Kim Suozzi, a 22-year-old diagnosed with glioblastoma and cryopreserved in 2013, the VRFF process took 11 days (Ibid., 526). In 1993, a related cryothanasia case was decided against by a California court, deeming it to be assisted death, for Dr. Thomas K. Donaldson, a 46-year-old patient diagnosed with a malignant brain tumor (Pommer 1993).

Results of Other Cryonics Studies

There are at least three detailed studies of cryonics. Two focus directly on cryonics participants, the current study (n = 316), and one conducted by Rievman in 1976 (n = 89). Kaiser et al. (2014) study (n = 1000) investigates general public attitudes towards cryonics. All studies were conducted by survey or questionnaire.

In the Kaiser study, data were collected in an online survey of 1000 German citizens aged 16–69. Respondents were generally open to participating in the latest medical technological developments (53%), and almost a quarter, 22%, could imagine having their bodies 'cryonized' after their deaths. *Cryonization* was defined as the freezing of a corpse to revive it in the future. Almost half, 47% of respondents, had previously heard of cryonics. Participants supporting cryopreservation were average earners and had some but not necessarily advanced formal education (Ibid., 100). This finding is in accord with the current study, and contra Rievman (pp. 76–8).

Rievman's (1976) study solicited what was estimated to be the total population of members of cryonics societies in the USA, Australia, and Europe (organized by state in the USA and by country internationally). Of the 155 persons contacted, there were 93 respondents. The findings were quite similar to the current study in terms of the motivations for enrolling in cryonics, beliefs regarding the possibility of scientific advance, and religious views. The top hobbies of enrollees were outdoor activities and reading. The study included an assessment with the Rosenberg Self-Esteem Scale (1965) and found that cryonicists were likely to be more optimistic than controls (p. x), a finding also confirmed in the current study (though not measured quantitatively by an instrument).

The results of these two studies and the current study indicate that it may be too early to make general assumptions about cryonics attitudes because the numbers are simply too small. For example, what might seem to be distinguishing characteristics of the cryonics population (e.g., higher earners with advanced education) found in Rievman's study was not necessarily found in Kaiser's study or the current study. Cryonics demographics could continue to become more representative of the population at large as the group of those interested in the practice grows. Likewise, another analysis (Romain 2010) sees cryonics as being emblematic of the American values of pragmatism and individualism. This may be true; however, data now suggest that cryonics is a global phenomenon. This is evidenced by the fact that there are cryonics facilities in Russia and Australia, and Alcor and other providers have always had a strong global

membership. Several participants in the current study said they would enroll if a facility were more convenient, wondering, for example, 'When are you coming to Italy?!'

Cryonics Study and Results: a Theory of Cryonic Life Extension

Worldwide Cryonics Community Survey and Methods

To obtain the attitudes of *cryonicists* (cryonics program enrollees and supporters), a worldwide survey was conducted July–August 2017. The survey was carried out through an open call to several cryonics community social media outlets such as email lists, forums, and social networking interest groups. KrioRus translated the survey into Russian for their members. The stated aim of the survey was to identify the key themes and composite views of worldwide community members. 'Community members' are self-designated as those being interested in and supportive of cryonics. Seventy percent of survey respondents indicated that they are enrolled members of a cryopreservation service (Table 24 in the Appendix). Enrolled respondents are with Alcor (65%), Cryonics Institute (22%), KrioRus (11%), and other (2%). The format of the survey was 37 questions with suggested multiple-choice answers plus 'other' and write-in comments available for all questions.

Summary of Survey Results

A summary of the survey highlights is provided as follows and the detailed results are available in the Appendix. One surprising finding is that although the 316 worldwide participants reflect perhaps more demographic diversity (in terms of age, career, education, and length of time supporting cryonics) than is sometimes attributed to cryonicists, and had many opinionated comments in the write-in responses, answers on the biggest issues clearly track into opinions that are consistently agreed upon by the group. These opinions got established quickly, for example, not changing markedly between 200 and 300 respondents.

The biggest motivation for cryonics is the possibility of future revival (74%), with the primary motivation for revival being a desire to experience the future world (89%). For 75%, it is crucial to cryopreserve one's own brain as opposed to creating a 'digital twin' of oneself from photos, correspondence, or other artifacts. Fifty-seven percent believe that only 'my actual brain' can be 'the real me.' Ninety percent are most concerned about obtaining a good-quality cryopreservation in the final moments of their current physical body. Eighty-seven percent would like to revive all memories. Forty-four percent would like to be revived in a biological flesh-based body and 40% in whatever form is recommended at the time.

The principle concerns regarding revival are impairment or loss during cryopreservation and the technical feasibility of revival (both 61%). Sixty-eight percent indicate that 'non-religious' is a term that describes their views, although religious views are not incompatible. Seventy-seven percent think that cryonics brings more choice to current societal approaches to death. Regarding cost, 76% think that individuals selecting cryopreservation should pay for it themselves. Fifty percent think that the first revival might be possible in the 2075–2100 time frame. There is a diversity of concerns about

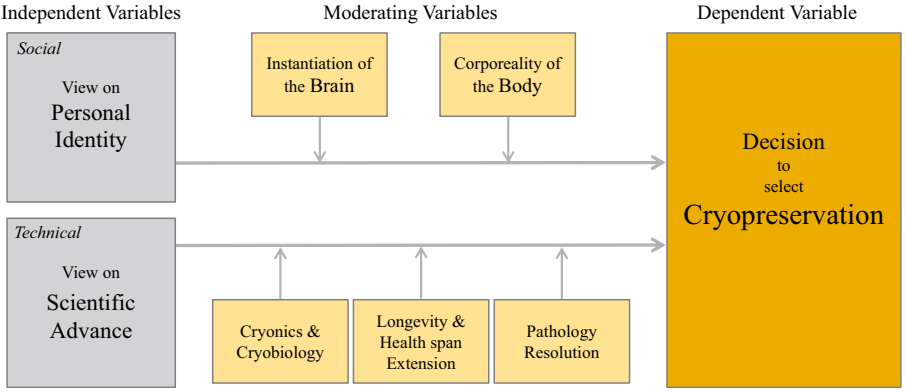

Fig. 1 Theory of cryonic life extension to explain the cryopreservation decision

revival including the future state of the world and the ability to habituate mentally, socially, and economically, and in general to 'feel like myself.' Only 5% are troubled by the possibility of boredom upon revival.

For respondents, what happens when you are cryopreserved is that it is like being in a temporary off-state, suspended animation, deep sleep, stasis, or deanimation. Degradation and decay is halted. It is like being on hold, paused, anesthetized, hibernating, or being in a coma.

Theoretical Model Development

The themes from the survey results are developed into a Theory of Cryonic Life Extension to explain the factors involved in an individual's decision to select cryopreservation (Fig. 1). The dependent variable to explain causally is the decision to select cryopreservation. Two independent variables, social and technical, are proposed that could influence the dependent variable. 'Social' is meant in the sociological sense of the individual's self-perception. The main factor in the social trajectory is one's attitude toward personal identity. The main factor in the technical trajectory is one's opinion about the possibilities of scientific advance.

The model examines the relationship between social and technical factors and how they may causally lead to a cryopreservation decision and could be implemented as a regression. An individual's attitude toward personal identity may be further influenced by the moderating variables of the instantiation of the brain and the corporeality of the body. *Corporeality* refers to being embodied, the sense of having a physical material body. An individual's opinion about scientific advance may be further influenced by the moderating variables of progress in both near-to-medium-term areas such as cryonics and cryobiology, longevity and health span extension,[1] and pathology resolution, as well as longer-term prospects such as medical nanorobots (Swan 2019). Regarding the two trajectories, respondents are likely to have positive opinions about the possibility of scientific advance. Attitudes toward personal identity are more diverse and therefore are developed in greater depth in the next sections.

[1] Health span: the period of a life during which someone is generally healthy and free from serious or chronic illness (https://www.macmillandictionary.com/us/dictionary/american/healthspan).

Cryonics Views Regarding Personal Identity Malleability

Identity, Body, and Brain

An important survey result is an element of malleability in the consideration of personal identity. Respondents indicate that they consider personal identity to be first and, primarily, a matter of the brain and, second and more distantly, a matter of the body. The brain is the indispensable 'source of me' (memories, intellect, personality). The body, though, is more expendable.

Various uncertainties regarding the potential preservation and revival of personal identity are noted. First, there is no biologically defined concept called 'personal identity' in the present scientific characterizations of the human organism, although 'memories' seem to be an assumed or close proxy. Second, the extent to which a purported quantity called 'personal identity' might be preserved in the current technological process of cryopreservation is unclear. Third, it is also unknown the degree to which reanimation of the quantity called 'personal identity' would be possible in the future. Respondents anticipate that more advanced future technologies might bring greater clarity and resolution to these issues over time.

My Brain Is the Source of 'Me'

For respondents, 75% think that it is crucial to cryopreserve one's own brain as opposed to creating a 'digital twin' of oneself from artifacts such as photos or writing, or other methods (Fig. 2), and 57% believe that only 'my actual brain' can be 'the real me' (Table 1). Digital twins might be a supplement, but not a substitution (Chamberlain & Chamberlain 2011). Cryonics ecosystem services such as LifeNaut and CyBeRev are designed to provide exactly this kind of 'digital twinning' service as a support resource. The possibility that artifacts might be used to constitute some portion of personal identity might be more realistic in the future (Kurzweil 2012). The survey results indicate a strong vesting of personal identity in the actual brain. It has to be the memories, experiences, and emotions as they are stored in 'this physical brain.' If possible, 87% would like to revive all memories, and intellect (89%), personality (87%), skills (77%), and emotion (76%).

The perceived benefits of having the actual brain cryopreserved are highlighted in Table 1. Fidelity is paramount, as seen in that for 57%, only the actual brain can be 'the real me,' and for 43%, the actual brain is 'closest to the real me.' Other reasons given for why it is important to cryopreserve one's actual brain are to capture memories as directly as possible (44%), to have more information than is offered by digital facsimile or other methods (40%), and to capture emotional content (37%) and intellectual capabilities (27%).

My Body Is Part of Me Now

The current physical body is thought of as being 'part of me' now, in other words, as part of personal identity (68%), as shown in Fig. 3. The body is also considered temporary (57%), a platform (47%), a current necessity (45%), and something useful but fragile and in need of repair (42%). Some respondents express appreciation,

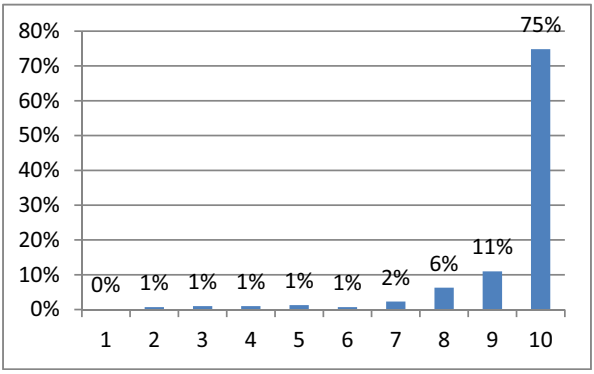

Fig. 2 Survey question (Q6): How essential is it to cryopreserve your brain versus create only a 'digital you' from artifacts such as photos, email, essays, papers? Inessential (1) to Essential (10)

gratitude, and enjoyment of their physical body. Others point to the fact that they have not known any other form of experience other than the one based in this physical body. The current physical body is the only option at present. Others discuss the body as a machine, mechanism, shell, hardware platform, vessel, vehicle, transport, infrastructure, and life support system. A prevalent theme is the awareness of the limitations and fragility of the physical body. The body has a temporal structure that is given to aging, ailing, and decay. Several anticipate the possibility of being able to upgrade, replace, modify, and enhance the current physical body.

My Corporeality in the Future

Although the body is 'part of me' now (68%), there is a further distinction as to whether 'my body is *crucially* part of me,' both now and in the future, and to what extent the term 'me' strongly includes the current physical embodiment. Only 14% of respondents indicate that 'my current physical body is necessary to be crucially me' in the future. Eighty-six percent contemplate technological evolution and the difficulty of knowing now what the farther future might hold for corporeality. Table 2 illuminates these thoughts in the context of the form of potential revival. The top categories are that 44% would prefer a biological flesh-based body (though not necessarily their own former body), and 40% would like whatever is standard, recommended, or feasible at the time.

Table 1 Survey question (Q7): What is the benefit of having your actual brain cryopreserved (versus photos, writing, etc.)?

	Response (multiple responses allowed)	%
1	Fidelity: ONLY my actual brain can be the real me	57
2	Memories	44
3	Fidelity: my actual brain is closest to the real me	43
4	More information	40
5	Emotional content	37
6	Intellectual capabilities	27

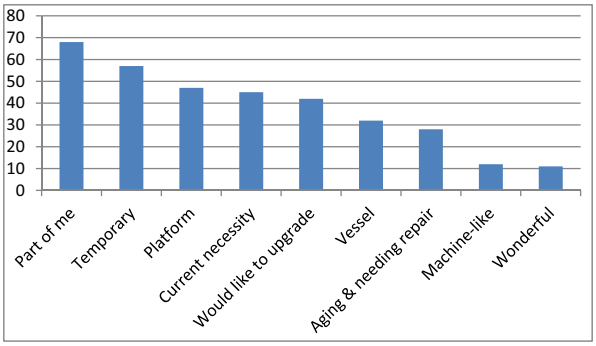

Fig. 3 Survey question (Q4): How do you think about your physical body right now? My body is… (e.g., part of me, a platform, temporary, a current necessity)? (multiple responses allowed)

Related to standards and feasibility, a third (33%) think that the form of revival might depend on the trade-offs between platforms (for example, cost, fidelity, social norms, and legal status). Considering the virtual domain, 13% contemplate revival as a digital avatar and 12% as some other form of digital upload.

Who I Am in the Future: Personal Identity Malleability

The survey results regarding personal identity are mapped into the causal model for factors that may influence an individual's decision to select cryopreservation (Fig. 4). Personal identity relates to how individuals conceptualize their identity as instantiated in the brain and the body, currently and in the future. The main results are that on the topic of the brain and personal identity, *this* physical brain must be the 'source of me' now (75%), and in the future, 87% require *these* specific memories to be the 'source of me' in a potential revival. Regarding the topic of the body and personal identity, 68% have the sense that *this* physical body is 'part of me' now (part of my personal identity), but in the future, only 14% require *this* physical body. Forty-four percent would prefer *a* physical body, and 40% favor whatever is standard and feasible at the time. The overall indication is some degree of malleability in the notion of personal identity, extensively regarding the body, and also the brain.

Table 2 Survey question (Q5): In what form would you like to be revived?

	Response (multiple responses allowed)	%
1	Biological (flesh-based) body	44
2	Whatever is recommended/feasible/standard at the time	40
3	Depends on factors such as quality of experience, maintenance cost, convertibility between forms	33
4	Wake me up mid-process and ask (provide information about current norms)	24
5	Digital avatar (corporeal)	13
6	Digital upload (not necessarily corporeal)	12
7	Whatever other persons (revived or still living) who know me recommend	8
8	Whatever becomes available first	7
9	Whatever is less costly	1

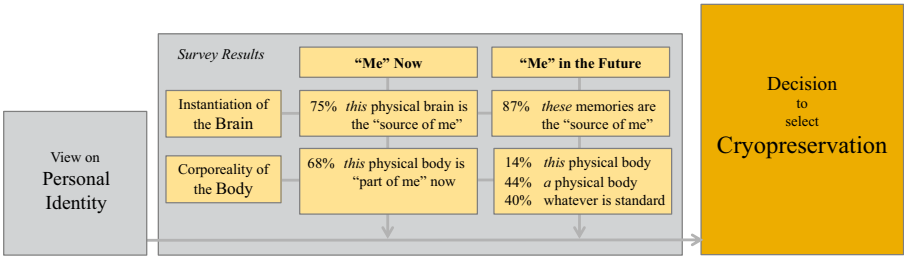

Fig. 4 A sense of personal identity malleability influences the cryopreservation decision

Neuroscience, Philosophy, and Corporeality

Perspectives from neuroscience and philosophy help contextualize the survey responses regarding corporeality. Neuroscience continues to illuminate the relationship between the body and the brain by establishing the neural correlates of bodily awareness. Positron emission tomographic (PET) scans have identified the brain areas involved in perceiving and representing the body (Berlucchi and Aglioti 1997). Corporeal awareness relies on a large neural network with different brain areas playing different roles (particularly the somatosensory cortex, posterior parietal lobe, and insular cortex (Melzack 1990)). Some brain regions are permanently committed to representing corresponding body parts in conscious awareness, while others exhibit plasticity, such as when natural inputs from body parts are not available, but the brain still senses pain (such as from phantom limbs).

Turning to philosophy, it might seem that a claim of dualism could be levied at cryonicists, since brain and body are seen as being separate, and the brain has greater importance. However, this is not a dualism in the Cartesian sense of body and mind being made of different substances. Body and mind could still be made of the same substance and be part of the same processes. The survey findings underline a point also being made by systems biologists and philosophers, namely that a simple materialist or essentialist view of the body is too reductionistic to capture the lived sense of embodiment. To support a broader conceptualization of embodiment, Grosz develops the idea of the *incorporeal*, a multi-faceted definition inspired by the Greek Stoics (Grosz 2017). As a more complex form of embodiment, the incorporeal includes aspects related to the bodily sense of occupying space and time, and having a narrative of the body's own genesis and events (Grosz and Hill 2017, 10).

Another expansive conceptualization of embodiment is suggested by the extended mind hypothesis developed by Clark and Chalmers (2010). The *extended mind* is the idea that objects in the environment function as a part of the mind. This is similar to the way a car's driver or a ship's captain might have a sense of the vehicle as being part of their own body, due to being so closely in synchronization with controlling it. A smart phone can be seen as such an object, as a neuro-prosthetic of the extended mind. Devices are as much a 'part' of the modern individual as Merleau-Ponty's (1962) blind man's stick is an extension of his biological senses. For Barad (2007, 160), even virtual technologies take on a sense of embodiment. Considering other issues related to 'non-natural' embodiment, Jean-Luc Nancy (2008) examines the intimacy of accepting another human's organ into the body as a heart transplant, which Derrida (2005) further explores as the body being an integration of human and technology. Given the lack of

empirical data of what it might be like to wake up after being cryonically suspended, one can look to science fiction for imagined accounts. Characters awake, aware that some of their memories have been redacted (Wright 2002) or are simply absent (Hamilton 2007).

Philosophical Conceptualizations of Personal Identity

This section highlights the philosophical trajectory of the concept of personal identity. Notably for this paper's thesis development, porosity in personal identity is indicated even in the initial Enlightenment formulations (Descartes, Locke, and Hume), as well as more recently in modern philosophy (Parfit).

The Enlightenment Concept of Personal Identity

The modern concept of personal identity is attributed to the beginning in the Enlightenment, with Descartes (1596–1650), Locke (1632–1704), and Hume (1711–1776). The radical notion of the Enlightenment thinkers was that humans are at the center of knowledge generation, not external forces (such as God, church, state, or nature). The important consequences are that knowledge and the self can be more volitionally directed. However, there were two different views as to *how* humans are at the center of knowledge generation. Rationalists such as Descartes and Leibniz thought that knowledge was generated exclusively by reasoning, while for empiricists such as Locke and Hume, only through experience.

Descartes's Doubting Cogito

Descartes establishes the basis for personal identity with the *Cogito, ergo sum* statement that 'I think, therefore I am' (Descartes 1637, 127). Sitting by the fire in his study wondering about the shape of wax as it melts, he decides that the only thing that cannot be doubted is the fact that he himself has a mind that doubts. Every other mode of knowing is subject to possible deception or illusion, including sense perception, logical reasoning, and dreams. Thus, the central idea that 'I think, therefore I exist' is the only claim of which one can be sure. This is the only assertion that can find 'acceptance as the first principle of philosophy' (Ibid.). For Descartes, the mind is the seat of consciousness. Human sentiments, drives, and passions (i.e., identity) come from the mind. The mind is the source of human identity.

Locke's Experience-Unifying Consciousness

Locke was the first to define the concept of the 'self' as the continuity of consciousness. He says that *personal identity* consists in 'a thinking intelligent being's sense of continuity when considering itself as a self, as the same thinking thing in different times and places' (Locke 1690/1975, 335). The 'mind attains truth' through 'unprejudiced experience and observation' (Locke 1690/1975, 86). There is a two-step process in which 'the senses let in ideas,' and the 'mind abstracts them' to furnish the 'empty cabinet' (Ibid., 35). Persons begin as a blank slate or *tabula rasa*, onto

which experience is layered to create knowledge and the self. He says that 'consciousness makes personal identity' (Ibid., 319), by 'uniting actions [experiences] into the same person' (Ibid., 324). The identity of the person consists of participating in the same continued life (Ibid., 315). Successive experiences united by consciousness produces one's sense of personal identity.

Locke May Be an Unwitting Cryonicist

Locke's views on personal identity support the notion of identity malleability that surfaces in the cryonics study. He says that 'self depends on consciousness, not on substance' (Ibid., 325). The self is 'that conscious thinking thing—whatever substance made up of, (whether spiritual or material, simple or compounded, it matters not)' (Ibid.). The continuity of consciousness is the relevant factor, not the substance in which the consciousness is instantiated. Locke further underlines the point in that regarding 'being the same self, it matters not whether this present self be made up of the same or other substances' (Ibid.). Although Locke did not intend (and might dispute) the use of his formulation of personal identity in the context of cryonics, the text itself is quite clear. There is no problem running the same consciousness on another substance; the issue is preserving the continuity of consciousness (e.g., memories of experience). Some commentators worry that Locke leaves open the possibility of multiple personalities and reincarnation, but irrespective of interpretation, the important point is the continuity of consciousness.

Hume's Unconnected Bundle of Perceptions in Flux

Locke and Hume, although both empiricists (believing that knowledge comes from experience), are often discussed in the context of their opposing views on personal identity. Whereas Locke requires a notion of consciousness to unite experiences, Hume thinks that experiences cannot be unified. For Hume, experiences are 'nothing but a bundle of perceptions in constant flux,' which the imagination labels as 'personal identity' for convenience, but without any basis (Hume 1739, 133). For Hume, the notion of a self or person cannot be due to any one impression, so it is rather a meta-impression to which all of the many jumbled impressions and ideas of the mind are supposed to be related. *Personal identity* is an abstraction from the chaos of impressions. The imagination 'associates' perceptions, but they are not unified (Ibid., 137). Hume thinks that 'identity is merely a fictitious quality that we attribute to them, from an operation of the imagination' (Ibid., 136-7). He concludes that 'there is no such idea' as a self (Ibid., 132).

For Hume, the key point is that one cannot have a sense perception of the self the same way one has a clear impression of a chair. In order to count as true knowledge for an empiricist, an idea would have to have a sensible origin. Locke sidesteps this empirical requirement for an originary sense perception of a self by claiming that the experience of a thinking thing is successive and requires a sort of meta-impression, consciousness, to unify the disparate experiences. Hume thinks that this is false, that since there is no initial sense perception of the self, there is no basis for unifying experiences into a self. However, Hume acknowledges that the imagination associates experiences into a notion called the self for convenience.

Discussion of Locke and Hume

Seeing the conceptualizations of personal identity elaborated by Locke and Hume in parallel (Table 3), one point that becomes clear is that they are in agreement at a higher level than their discord. Despite their opposing conclusions that personal identity exists (Locke) or does not exist (Hume), many aspects of the argumentation are similar. For both thinkers, there is some kind of internal feature (consciousness (Locke) or imagination (Hume)) which collects experiences into a higher-level notion of personal identity, whether this process is justified (Locke) or not (Hume). The higher order principle is that there is a unification force that abstracts the collection of successive experiences into a bigger concept, such as a self.

The key point is that already in these first formulations of personal identity, the conceptualizations include aspects of malleability and flexibility. For Locke, the openness is that 'consciousness not substance' is the crucial factor for personal identity. For Hume, the porosity is that the bundle of perceptions in flux with no grounds for unification, and no initial sense perception of a self, suggests that there is not a real entity that can be called personal identity. The difference in perceptions may be cashed out by the different attitudes of the thinkers toward time. Whereas Locke attends to persistence over time, Hume sees difference over time. This signals the importance of the dynamics of time or temporal flow as a factor in personal identity, especially over longer time scales, such as in the context of cryonics.

Personal Identity Malleability: from Enlightenment Thinkers to Modernity with Parfit

The modern view of personal identity malleability is exemplified by Parfit. He finds that 'Hume's view is inadequate' on its own, but nevertheless defends a position that follows Hume 'in the relevant respects' (Parfit 1984, 126). Parfit agrees with Hume's comparison that 'persons are like nations, clubs, or political parties,' in that they can change considerably over time (Ibid., 248). However, there is an inconsistency in that nations are readily recognized as a social construct that is not 'independently real,' but persons are treated as having a real identity. Instead, Parfit argues that personal identity too should be recognized as fictional.

Parfit's central claim is that personal identity is not necessary for a person's existence or survival. Rather 'what matters is Relation R,' a relation of *relatedness*, which he defines as

Table 3 Locke and Hume: Comparison of Personal Identity Malleability factors

Philosopher	Personal identity formulation	Identity malleability claim	Effect of time
Locke	Consciousness unifies successive experiences (with justification)	Identity is consciousness not substance	Persistence over time
Hume	Imagination associates unconnected bundle of experiences (without justification)	There is no personal identity, no source perception as the basis of a self	Difference over time

'psychological connectedness or continuity with the right kind of cause,' such as a worthwhile life project (Ibid., 215). A claim of psychological connectedness across time can be made without needing to construct an entity called personal identity. The relatedness of the project not the person is the most plausible explanation that describes the link 'between all of the mental and physical events that together constitutes a person's life' (Ibid., 226). Parfit is similar to Hume in that neither denies the existence of a concept called personal identity, just that what it does is not relevant (Parfit) or justified (Hume).

Experimental Evidence for Parfit

One reason that Parfit gives for the non-cruciality of personal identity is that people do not identify with their future selves. He substantiates this by appealing to the propensity to procrastinate and to not engage in delayed gratification. Future consequences often have little effect on current behavior, for example, consider someone who decides to take up smoking. There is some experimental evidence for Parfit's claim. Brain scan (fMRI) studies have shown that people consider their future selves as strangers, as being indistinguishable from celebrities or politicians (Opar 2014). Different neural areas are activated when subjects think about their present selves and their future selves (van Gelder et al. 2013). Further, individuals think about their future selves in the third person, not the first person (Pronin 2008). These study results support Parfit's claim of a lack of necessity and persistence of personal identity over time.

Personal Identity Malleability: the View from Cryonics

Elements of the Enlightenment positions and Parfit's view can be seen in cryonics discussions of personal identity (Swan 2014). An early argument proposed by Ettinger in 1964 is that 'identity is an illusion, and therefore death is unimportant' (Ettinger 2005, 142). He thinks that there is no such thing as individuality, just 'degrees of identity' appropriate to tasks (Ibid., 142). This idea is in line with the non-self view from Buddhism, that emptiness (no self) is the default condition of being in the world, and a temporary self only resolves to respond to external stimulus and then dissolves again. Cryonicist R. Michael Perry (2000) similarly argues that death should not be seen as inevitable and irreversible, but rather as a problem that can be addressed scientifically in all aspects. Philosopher John Perry (1978) provides a detailed discussion of personal identity and immortality topics, drawing from Locke, Parfit, and others.

Transhuman and posthuman philosophers propose various formulations of the non-cruciality and non-permanence of personal identity concept. Transhumanist Max More generally agrees with Parfit, but suggests too much emphasis is placed on connectedness rather than continuity when assessing the rational apportionment of one's self as a future concern (More 1995). Instead, More considers multiple factors that might constitute one's notion of farther future self-stages. These might include one's ideal self-conception, life plans, and principles. Cryonicist Charles Tandy considers the topic of personal identity extensively in a 12-volume set (Tandy et al. 2014). Emerging technologies philosopher Hughes (2012) discusses Hume and Parfit, and the risks of personal identity essentialism at the individual and societal level.

Swan recasts questions related to the undetermined status of personal identity into the bigger category of subject-formation (Swan 2016, 59-67). The development of

capacities is the crucial element for an individual's survival along this line of reasoning, ranging from Spinoza's conatus (persevering in one's being) and Simondon's individuation, to Nussbaum and Sen's proposals for creating human capabilities (Nussbaum 2011, Sen 1989). Swan defines *liquid subjectivation* as a pure image of subject-formation that is free from the subject and can be conceived as a coming-into-existence beyond any entity, container, or embodiment.

Implications of Personal Identity Malleability for Cryonic Futures

'"I" is only a convenient term for somebody who has no real being.'—Virginia Woolf, 1929, 4

Synthesis of Philosophical Positions Regarding Personal Identity Malleability

The philosophical investigation substantiated personal identity malleability in the historical record of conceptualizations of the self and personal identity, as summarized in Table 4. Resources have therefore been obtained to explain the personal identity malleability property found in the empirical survey results, through the philosophical analysis.

Personal Identity as a Continuity Technology

The most important finding from the philosophical analysis of personal identity ranging from Enlightenment thinkers to contemporary transhumanist, posthumanist, and cryonicist philosophers is that personal identity is emergent, not fundamental. Personal identity is generated from experience, as a response, derived notion, and social construct for making sense of experience in a continuous manner. Since personal identity is not fundamental, there are no grounds for its persistence, and therefore, its shape and conceptualization could change and evolve considerably over time.

Table 4 Summary of philosophical positions regarding personal identity malleability

Orientation	Philosopher	Personal identity malleability
Rationalism	René Descartes (1637)	My own thinking mind provides my identity and sense of self
Empiricism	John Locke (1689)	Self depends on continuity of consciousness, not substance
Empiricism	David Hume (1739)	The imagination falsely labels the unconnected bundle of perceptions in constant flux as personal identity
Moral Philosophy	Derek Parfit (1984)	Personal identity is a fictional construct, psychological continuity is what matters for a person's existence
Cryonics	Robert Ettinger (1964, 2005)	Identity is a matter of degree relevant to a task
Transhumanism	Max More (1995)	The self is a future concern comprised of self-conception, life plans, and principles
Posthumanism	Melanie Swan (2016)	Liquid subjectivation: ephemeral instances as a post-subject subject-formation beyond entity, container, and embodiment

One consequence of the philosophical discussion is that *personal identity* is more of a proposed solution to a problem than a stand-alone construct. Personal identity is an effect, not a cause, and emerges for a variety of reasons, most prominently as a technique for preserving continuity. The problem is the need for a mechanism to collect successive experiences such that there can be psychological continuity over time. Locke's 'consciousness uniting actions into a self' is one explanatory attempt at this persistence. Hume's formulation of the 'imagination labeling otherwise unconnected bundles of perceptions as personal identity' is another. Parfit's Relation R (what matters is psychological continuity tied to a worthwhile project) and Ettinger's 'degrees of identity appropriate to a task at hand' are other proposed solutions.

Another consequence of the philosophical investigation is that irrespective of whether a claim to a notion called *personal identity* is justified, the need for the function it supplies is valuable and likely to persist. How the concept of personal identity is conceived, mobilized, and applied could vary widely, and continue to evolve over time, especially for project timescales on the order of cryonics. One example of a contemporary shift in the framing of the subject and personal identity is Sen and Nussbaum's focus on the development of human capabilities. This idea could supplement or supersede the traditional Enlightenment notion of the modern subject as a self-determined agent with free will.

Theory of Cryonic Life Extension Constituted by Personal Identity Malleability

For cryonics, the important implication of the philosophical investigation is that there is a mechanism for ordering temporal events into a whole that provides an apparatus for persons to make sense of their experience. The consolidated philosophical view for cryonic futures is that humans are not a consistent identity moving through time, but rather a chain of successive selves, each linked to, and yet distinct from, the previous and subsequent ones. The survey results and the philosophical findings endorse a malleable theory of personal identity, which is incorporated into the theoretical model in Fig. 5.

The view of personal identity that appears to be a necessary precondition for an individual to select cryopreservation is clarified. This is a notion of personal identity that includes some

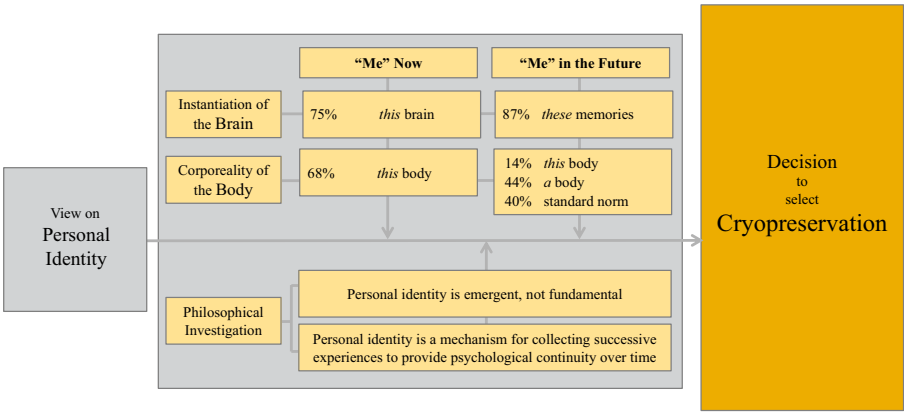

Fig. 5 Theory of cryonic life extension to explain cryopreservation decision

degree of portability and openness as to how the future self is to be instantiated, both the brain (memories) and the body (incorporeality), and how the notion of self is to be reflected conceptually, as a continuity mechanism for ordering the temporal relationality among the events that constitute a person's life. This work has defined an empirical and philosophical formulation of personal identity malleability that substantiates the proposed theory of cryonic life extension to explain an individual's decision to select cryopreservation.

Risks and Limitations

There are many critiques that could be levied against cryonics and the current work. One complaint is that the idea of cryonics is not new; it is the same quest for immortality that has shaped traditional religions and other human endeavors since the beginning of time. However, the distinction is that immortality is not a word frequently used by cryonicists, and the focus is much more on the technical feasibility and the clear goal of medicalizing what is seen as reversible death. Outsiders might label the cryonics project as nothing more than the usual goal of immortality, but this would be to misconstrue how cryonicists see themselves and the endeavor. Cryonics is also not 'scientific advance as a religion' (i.e., accepted without question), but rather based on a critical mindset and examination of the possibilities suggested by an ongoing trajectory of experimental evidence.

The other main and more serious critique of cryonics is that the science is currently unproven. This is true; the science of cryonic preservation and reanimation is undemonstrated in humans. Further, the success of cryonics also depends on the resolution of the underlying pathologies that end people's lives in the first place, which is likewise challenging and without current resolution (Shermer 2001). The risk of false hope in cryonics is noted as a concern (Lepore 2010). These points are acknowledged by cryonicists, who call for more resources to be devoted to research, and point to the cryonics wager argument that, at minimum, it cannot be proven that cryonics would not succeed.

Another class of risks pertains to the current work. The survey results may be limited by the cross-sectional design and opt-in nature of the study, and the lack of validation of authentic and independent participants. However, there were 316 respondents, data were carefully checked for apparent authenticity, and answers were found to consistently converge on a few key themes. Other risks are related to the analysis proposed in this work. The proposed theoretical model would need to be tested in more detail, and perhaps the philosophical approach is under-determined for the results it claims. However, given the contemporary moment of human adjustment to the fast pace of technological development, even an early sketch of conceptual resources to consider issues such as the future of personal identity might be helpful.

Conclusion

The aim of this paper is to discuss the results of a Worldwide Cryonics Survey conducted July–August 2017 (n = 316). A Theory of Cryonic Life Extension is proposed to explain the causal factors that may influence an individual's decision to select cryopreservation. There are two lines of decision-making. One relates to a person's attitude toward scientific advance in related fields such as cryonics and

cryobiology, longevity and health span extension, and medical pathology resolution. The other trajectory is a person's conceptualization of personal identity as instantiated in the body and the brain. Regarding the two vectors, cryonics participants in this study are likely to have a positive view of the possibilities of scientific advance, but vary more widely as to attitudes about personal identity. However, the key survey finding is that there is some degree of malleability to personal identity.

Personal identity malleability is indicated in that for survey respondents, although the 'source of me' is *this* biological brain (for memories, personality, and skills), how it might be instantiated in the future is more open. Specifically regarding the brain and personal identity, *this* physical brain must be the 'source of me' now (75%), and in the future, 87% require *these* specific memories to be the 'source of me' in a potential revival. On the topic of the body and personal identity, 68% have the sense that *this* physical body is 'part of me' now (part of my personal identity), but, in the future, only 14% require *this* physical body in order to 'feel like me.' forty-four percent would prefer *a* physical body, and 40% favor whatever is standard and feasible at the time.

Conceptual underpinnings supporting the idea of personal identity malleability are synthesized from the philosophical positions of Locke, Hume, Parfit, and others, extending previous philosophical discussion of this topic. The important result of the philosophical analysis is that personal identity is not fundamental, but rather emergent. Personal identity is generated after the fact of experience, as a response; as an effect not a cause. Personal identity is not so much an ontological thing-in-itself as it is a solution to a problem, a *continuity technology*, or mechanism for collecting successive experiences to provide psychological continuity over time.

This work clarifies the concept of personal identity that may be conducive to an individual deciding to select cryopreservation. This is a notion that includes some degree of portability and openness as to how the future self could be instantiated, both the brain (memories) and the body (incorporeality), and how the self is reflected conceptually (as a continuity mechanism for ordering the temporal relationality among the events that constitute a person's life). The central contribution of this paper is to define an empirical and philosophical formulation of personal identity malleability that substantiates the proposed theory of cryonic life extension that explains an individual's decision to select cryopreservation.

The consequences of this work are twofold. First, an examination of the current attitudes and motivations of a specific practice community, worldwide cryonics enrollees and supporters, is obtained, which provides a unique understanding of this group. Second, the survey findings and the philosophical substantiation of personal identity malleability constitute the beginnings of a comprehensive theory of posthuman-transhuman personal identity that could be elaborated in future work. This could be significant as the current era is characterized by a greater intensity of science and technology that renders the ongoing question of what it means to be human more acute (Swan 2017). Conceptualization resources emerging from forward-thinking groups such as the cryonics community might be helpful in stewarding smooth transition processes to uncertain technologized futures for all persons.

Acknowledgments The author would like to acknowledge and thank numerous cryonicists for their help in this project.

Appendix 1. Worldwide Cryonics Survey: Results Methods and Highlights

Survey Methods: Worldwide Cryonics Community Survey (n = 316)

To obtain the attitudes of cryonicists (cryonics program enrollees and supporters), a worldwide survey was conducted July-August 2017. The survey was carried out through an open call to several cryonics community social media outlets such as email lists, forums, and social networking interest groups. KrioRus translated the survey into Russian for their members. The aim of the survey was to identify key themes and composite views of worldwide community members. 'Community members' are self-designated as those being interested in and supportive of cryonics. 88% of survey respondents indicated that they are enrolled members of a cryonics provider (Table 24). The format of the survey was 37 questions with suggested multiple-choice answers plus 'other' and write-in comments available for all questions. The results are tabulated here for 316 worldwide survey respondents. Results are reported with the top answers given for all respondents to any question (not everyone responded to every question). Since multiple responses are allowed, total responses may sum to greater than 100%. Tag clouds are used as a visualization technique to represent qualitative responses, the larger the word size, the more frequently it was cited by respondents.

Survey Highlights

Cryonics motivations and conceptualizations

- The biggest motivation for cryonics is the possibility of future revival (74%) and the affirming attitude that 'life is good, more is better' (72%)
- The current physical body is thought of as being 'part of me,' temporary, a platform, a current necessity, and something adequate but fragile that is in need of repair and upgrade
- What happens when you are cryopreserved is that it is like being in a temporary off-state; degradation and decay are halted. In this state of suspended animation, deep sleep, stasis, and deanimation, it is like being on hold, paused, anesthetized, hibernating, or in a coma
- Seventy-five percent think that it is crucial to cryopreserve one's own brain as opposed to creating a virtual version of oneself from photos, correspondence, etc.
- Fifty-seven percent believe that only 'my actual brain' can be 'the real me,' while 43% say that 'my actual brain' is closest to 'the real me'
- While "the source of me" must be *this* physical brain, "my current physical body does not have to be crucially me" in the future; preferably it is but it does not have to be

Cryopreservation specifics

- Fifty-three percent chose whole-body cryopreservation and 39% neuro-cryopreservation
- Cost (48%) and perceived technical feasibility (46%) influence that decision
- Fifty-seven percent prefer whole-body cryopreservation if concerns can be allayed

- Ninety percent are most concerned about obtaining a good-quality cryopreservation in the final moments of their current physical body
- Fifty-eight percent think that whether any trauma is experienced could depend on the cryopreservation and other factors

Revival

- Forty-four percent of respondents would like to be revived in a biological flesh-based body
- Fifty percent think that the first revival might occur in 2075–2100
- Eighty-seven percent would like to revive all memories, and intellect (89%), personality (87%), skills (77%), and emotion (76%)
- The biggest motivation for revival is a desire to experience the future world (89%)
- The principle concerns regarding revival are impairment or loss during cryopreservation (61%) and the technical feasibility of revival (61%)

Ceremonial rites, spirituality and religion, family support, and attitudes toward death

- Regarding traditional ceremonial rites, most would like whatever is appropriate at the time (54%), some a celebration of life (24%), and some a funeral (12% a non-religious funeral and 9% a religious funeral)
- Concerning spirituality and religion, 68% indicate that "non-religious" is a term that describes their views, and 6% religious; 17% non-spiritual and 14% spiritual. Forty-one percent are supportive of empathy and compassion and 17% indicate having a holistic view of the world
- For those selecting neuro-cryopreservation, preferences regarding the disposition of the body are donating it to research (39%), leaving it to the discretion of the cryopreservation facility (33%), cremation (19%), and burial (11%)
- Twenty-three percent of respondents enjoy full support (10 on a scale of 1 to 10) from family members for their cryonics decision, for others it may be irrelevant or divisive
- Seventy-seven percent think that cryonics brings more choice to the current societal approaches to death: greater personal decision-making (66%) and freedom (62%), especially since death is a taboo topic (49%), that is regulated (40%), clinical, and impersonal (33%)

Cryonics provider, payment, and community

- Seventy percent of survey respondents indicated that they are enrolled members of a cryopreservation service. Enrolled respondents are with Alcor (65%), Cryonics Institute (22%), KrioRus (11%), and other (2%)

- Fifty-three percent are happy with their cryonics provider (satisfaction ratings of 8–10 out of 10) and would like them to be doing more research in all aspects of cryonics
- Seventy-six percent think that individuals selecting cryopreservation should pay for it, and would like it to be an option incorporated into health insurance plans
- The top adjectives used to describe the cryonics community are hopeful, optimistic, visionary, small, intelligent, forward-thinking, and scientific

Demographics

- Age groups include 30 and under (22%), 30–40 (26%), 40–60 (35%), and 60 and over (30%)
- The average length of interaction with the cryonics community has been 5–10 years
- Gender identification is male (81%), female (17%), and other (1%)
- The highest level of completed education is high school (18%), college (40%), master's (29%), and PhD (11%)
- The biggest career designations are business and entrepreneurship (35%), computer science (34%), and biology and medicine (21%)

Practical Considerations: Next Steps for the Cryonics Industry

Since cryonics is currently in the early phases of development and adoption, survey respondents made suggestions about how to professionalize and systematize cryonics. Diverse processes would need to be in place for cryonics to be consistently recognized and implemented as a viable alternative. One first step in institutionalizing the practice of cryonics could be integrating it with existing health services delivery. Medicalizing cryonics as a potential treatment option, with accompanying financial structures, could help to formalize the practice as an end-of-life option.

Cryonics could be absorbed more firmly and extensively into other existing medical processes, placed in the value chain that includes scientific research on one hand (research funding, studies, and results publication), and practical implementation in health care systems on the other (treatment, licensed professionals, insurance, and financing). Other medical, financial, and legal support systems would also need to be incorporated, for example having direct integration with the funeral industry (Stodolsky 2016). Rebranding cryonics as a medical treatment could help in enhancing its public perception, and creating demand. One idea would be to promote a public understanding of cryonics as a method of developing technologies for medical biostasis, and possibly reversible death.

In the regulatory domain, delineating the legal rights of cryopreserved persons is a topic that requires greater clarification. Sixteen percent of survey respondents indicate that legal considerations are an important factor in their having selected whole-body cryopreservation or neuro-cryopreservation (Table 7), as the two forms may carry different legal status in the future. Terasem's Colloquium on the Law of Futuristic Persons discusses topics such as the legal determinations of death, different state laws, and the legal rights of cryogenically revived persons (Sega 2005).

Table 5 (Q1) What are your principle motivations for considering or enrolling in cryonics?

1	Possibility of future revival	74%
2	Life is good, more is better	72%
3	There are things I want to do and need more time	49%
4	Death is inhumane, costly, wasteful, or unnecessary	47%
5	Technical feasibility (no proof that revival is not possible)	45%
6	Support research (cryobiology, organ preservation, longevity, health span)	38%
7	Support forward-thinking ideas	34%
8	Fear/uncertainty about death	32%
9	Curiosity	31%
10	Reasonable cost/value proposition	30%
11	Not in conflict with any of my religious/spiritual views	29%
12	Friends/family/people I know/respect have enrolled	12%

Appendix 2. Worldwide Cryonics Survey: Results Methods and Highlights

(July–August 2017; 316 Respondents)

The biggest motivations for cryonics, identified by nearly three-quarters of survey respondents (Table 5), are the possibility of future revival (74%), and a life-affirming view that "life is good and more is better" (72%). About half of respondents also cite wanting more time to do things (49%), that death is inhumane (47%), and the potential technical feasibility of revival (45%). Other motivations include supporting cryonics-

Table 6 (Q2) Which method of cryopreservation did or would you select?

1	Whole-body	53%
2	Neuro	39%
3	Depends	16%
4	Leave to discretion of cryopreservation provider	2%

Table 7 (Q3a) What influences your choice of neuro versus whole-body cryopreservation?

1	Cost	48%
2	Perceived technical feasibility	46%
3	Time to revival	19%
4	Legal considerations (personhood status of whole-body versus neuro)	16%
5	Ability to have cryopreservation facility determine what is best at the time	15%
6	Social acceptance	10%
7	Recommendation of others I trust	9%
8	Choice of other persons enrolled	3%

Table 8 (Q3b) Would you prefer whole-body cryopreservation if concerns were addressed?

1	Yes	57%
2	Maybe	15%
3	No	12%
4	Depends	7%
5	Undecided	6%

related research (38%), and forward-thinking ideas more generally (34%). Fear and uncertainty of death was cited as a motivation by a third of respondents (32%), and curiosity by 31%.

Of the methods of cryopreservation currently available, 53% selected whole-body and 39% selected neuro-cryopreservation, as indicated in Table 6.

Cost (48%) and perceived technical feasibility (46%) are the main variables influencing the choice of neuro-cryopreservation versus whole-body cryopreservation (Table 7).

Fifty-seven percent of respondents indicated that they would prefer whole-body cryopreservation if concerns could be addressed regarding cost, perceived technical feasibility, and other factors (Table 8).

Respondents indicated a number of different ways in which they think about their physical body right now (Chart 1). The highest response cited is that "my body is part of me," followed by being temporary, a platform, a current necessity, something that would be adequate to upgrade, a vessel, something that is aging, ailing, and in need of repair, a machine-like entity, and something that is wonderful. Some respondents expressed appreciation, gratitude, and enjoyment of their physical body. Others point to the fact that they have not known any other form of experience other than the one based in this physical body. This physical body is the only option at the moment. Others talk about the body as a machine, mechanism, shell, hardware platform, vessel, vehicle, transport, infrastructure, and life support system. A prevalent theme is awareness of the limitations and fragility of the physical body; it has a temporality given to aging, ailing, and decay. Several anticipate the possibility of being able to upgrade, replace, modify, and enhance the current physical body. Although the most frequent answer cited is "my body is part of me," there is a further distinction as to whether "my body is *crucially* part of me," now and in the future. Here

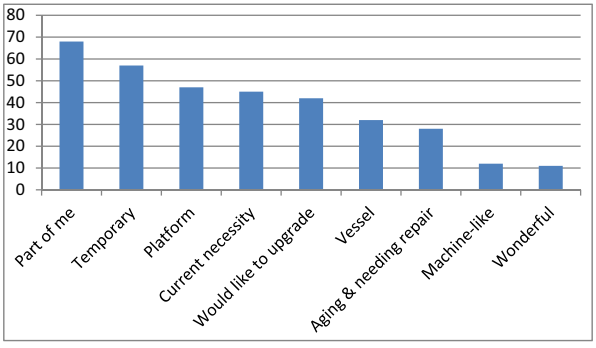

Chart 1 (Q4) How do you think about your physical body right now? My body is… (e.g., part of me, a platform, temporary, a current necessity)?

Table 9 (Q5) In what form would you like to be revived?

1	Biological (flesh-based) body	44%
2	Whatever is recommended/feasible/standard at the time	40%
3	Depends on factors such as quality of experience, maintenance cost, convertibility between forms	33%
4	Wake me up mid-process and ask (provide information about current norms)	24%
5	Digital avatar (corporeal)	13%
6	Digital upload (not necessarily corporeal)	12%
7	Whatever other persons (revived or still living) who know me recommend	8%
8	Whatever becomes available first	7%
9	Whatever is less costly	1%

more respondents (86%) indicated that "my current physical body does not have to be crucially me" in the future, while others (14%) do think that the persistence of the current physical body is necessary to be "crucially me" in the future. Others contemplate evolution and the difficulty of knowing now what the farther future might hold for corporeality.

Forty-four percent of respondents (Table 9) indicate a preference for being revived in a biological flesh-based body and 40% select whatever is recommended, feasible, or standard at the time of potential revival. A third (33%) say it might depend on a variety of factors, and a quarter (24%) would like to be woken up mid-process and consulted in the decision, if possible.

Overwhelmingly, 75% of respondents (Chart 2) indicate that they think it is crucial to cryopreserve one's own brain as opposed to creating a virtual version of oneself from photos, correspondence, etc.

Fifty-seven percent of respondents believe that only "my actual brain" can be "the real me" (Table 10); with 43% saying that "my actual brain" is closest to "the real me." Other reasons given for why it is important to cryopreserve one's actual brain are to capture the memories (44%), have more information than offered by a digital facsimile (40%), and to capture emotional content (37%).

Chart 3 indicated the main ideas respondents have of what happens when you are cryopreserved. The biggest response is that one is preserved (cryopreserved) such that

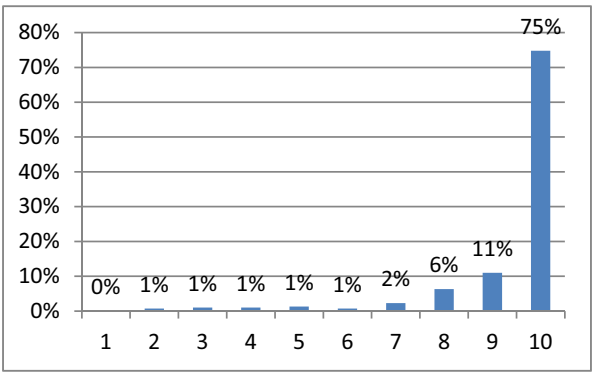

Chart 2 (Q6) How essential is it to cryopreserve your brain versus create only a "digital you" from artifacts such as photos, email, essays, papers? Inessential (1) to Essential (10)

Table 10 (Q7) What is the benefit of having your actual brain cryopreserved (versus photos, writing, etc.)?

1	Fidelity: ONLY my actual brain can be the real me	57%
2	Memories	44%
3	Fidelity: my actual brain is closest to the real me	43%
4	More information	40%
5	Emotional content	37%
6	Intellectual capabilities	27%

the ongoing biological processes of degradation and decay are halted. It is like being in a temporary off-state. Respondents indicated that they may be considered legally, clinically, and/or technically dead, in a cryopreserved manner, until they are no longer dead: it is a temporary condition. One is in suspended animation, deep sleep. It is like being anesthetized, comatose, de-animated, in stasis or hibernation, on hold, paused. Some respondents gave technical definitions about cooling the temperature of the body, perfusing cryoprotectants, and storing the body in liquid nitrogen. Respondents contemplate that revival is possibly anticipated in the future as technology advances, disease cures are discovered, and that there may be some unpreventable damage.

Considering the possibility of trauma, 58% of respondents think that whether any trauma is experienced in cryopreservation could depend on the cryopreservation process and other factors, but generally expect that trauma would be low (Table 11).

Chart 3 (Q8) How would you describe what happens to you when you are cryopreserved? (to the body, mind, etc.)

Table 11 (Q9) Do you think that any trauma is experienced in cryopreservation?

1	Depends on the cryopreservation process and other factors	58%
2	Low	21%
3	High	14%
4	Medium	7%

Table 12 (Q10) Do you think that any trauma is experienced in revival?

1	Too soon to know	48%
2	Could depend on many factors	48%
3	Low	9%
4	High	9%
5	Medium	6%

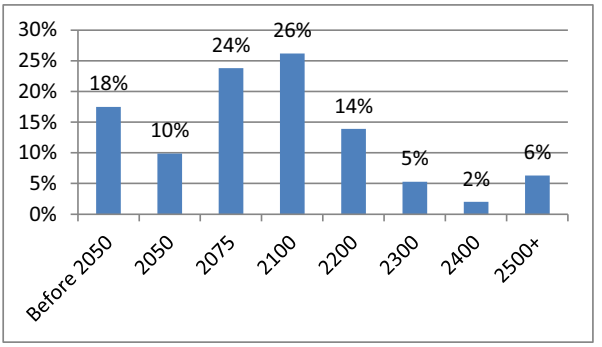

Chart 4 (Q11) When do you think the first revival might occur?

Forty-eight percent of respondents think that it is too soon to know if any trauma might be experienced in revival, and 48% also think that it might depend on many factors (Table 12).

There are diverse views as to when the first revival might occur, with 50% contemplating that it might be possible in the 2075–2100 time frame (Chart 4).

In terms of the attributes that respondents would like to revive (Table 13), intellect is number one (89%), followed by personality (87%), capabilities and skills (77%), and emotion (76%).

Table 13 (Q12a) What kind of attributes would you like to revive?

1	Intellect	89%
2	Personality	87%
3	Capabilities, skills	77%
4	Emotion	76%

Table 14 (Q12b) What kind of memories would you like to revive?

1	All memories	87%
2	Important memories	10%
3	Selected memories	9%
4	No memories	3%

Table 15 (Q13) Why would you like to be revived in the future?

1	Experience the future world	79%
2	Curiosity	58%
3	Continue enjoying life with friends/family/others	48%
4	Keep being productive	48%
5	Less pain, better quality of life (disease cures may have been developed)	47%
6	Creativity	44%
7	Contribute/help others	44%
8	Because it might be possible	42%
9	Pleasure	42%

Regarding the kinds of memories that respondents would like to revive (Table 14), an overwhelming percent (87%) said all memories, while others opted for important memories (10%), selected memories (9%), or no memories (3%).

By far the biggest motivation respondents consider for the possibility of future revival is a desire to experience the future world (89%) as indicated in Table 15. Other reasons motivating about half of respondents are curiosity (58%), continuing to enjoy life with others (48%), maintaining a state of productivity (48%), and living more comfortably because disease cures may have been developed meanwhile (47%). Also important is the ability to be creative (44%), and to contribute to the lives of others (44%).

Sixty-one percent of respondents indicated (Table 16) that their principle concerns regarding revival are impairment or loss during cryopreservation (61%) and the technical feasibility of revival (61%). 43% are troubled by the possibility that memories may be lost and "not feeling like me." About one third are concerned about the future state of the world (32%) and the cost of revival (27%).

Three-quarters of respondents (77%) appreciate that cryonics might bring more choice to the current societal approaches to death (Table 17). A majority also embrace the possibility of greater personal decision-making (66%) and the exercise of freedom (62%) regarding end of life choices.

Table 16 (Q14) My principle concerns regarding revival are…

1	Impairment/loss during cryopreservation	61%
2	Technical feasibility	61%
3	High-quality revival (memories lost), I won't "feel like me"	43%
4	State of the future world	32%
5	Cost	27%
6	Ensuring a revived mental attitude in addition to physical functionality	18%
7	Inability to habituate to the future world	11%
8	Inability to socially integrate with others in my community or others like me	9%
9	Overpopulation, resource-use concerns	7%
10	Boredom, meaning, purpose, ennui, nihilism (I won't know what to do with my time)	5%
11	Disrupts natural biological birth-death lifecycles; does not make way for the next generation	4%

Table 17 (Q15) Does cryonics bring any of these qualities to the way we approach death in society?

1	Choice	77%
2	Personal decision-making	66%
3	Freedom	62%
4	Empowerment	57%
5	Liberty	47%
6	Dignity	40%
7	Agency	34%

Table 18 (Q16) The legal treatment and general societal perception of death is…

1	Taboo/undiscussable	49%
2	Regulated	40%
3	Non-agential (out of the hands of personal decision-making)	35%
4	Clinical/impersonal	33%
5	Medicalized	29%
6	Controlled	29%
7	Non-transparent (difficult for individuals to find out information)	23%

Regarding the legal treatment and general societal perception of death, half of respondents (49%) bemoan that death is a taboo that is not discussable (Table 18). Respondents also think that death is regulated (40%), non-agential (35%), and clinical and impersonal (33%).

The overwhelming majority (90%) of respondents are most concerned about obtaining a good-quality cryopreservation in the final moments of their current physical body (Table 19). Beyond that, 37% are concerned about the availability of medical and emotional support, 35% about pain management, and 33% about the ability to identify, understand, and address decline.

Table 19 (Q17) What are you most concerned about in the final moments of your current physical body?

1	Obtaining a good-quality cryopreservation	90%
2	Availability of support (medical and emotional)	37%
3	Pain management	35%
4	Ability to identify, understand, and address moments of decline	33%
5	Quality of treatment	28%
6	Disease (onset, progression, cure)	22%
7	Cost of treatment	21%
8	Ability to exude personal agency	21%
9	Health span	21%
10	Ability to go quickly	17%
11	Dignity	14%

Table 20 (Q18) Regarding ceremonial aspects, do you (friends/family) plan any of the following?

1	Whatever is appropriate at the time	54%
2	Celebration of Life	24
3	Funeral (non-religious)	12
4	Obituary publication	12
5	Funeral (religious)	9

In terms of traditional ceremonial aspects regarding the final moments of their current physical body, over half (54%) indicated that their plan is whatever is appropriate at the time (Table 20). A quarter (24%) of respondents consider a celebration of life, 12% a non-religious funeral, 12% an obituary publication, and 9% a religious funeral.

Respondents reflect varying degrees of familial support for their cryonics decision, with a quarter (23%) enjoying full support on a scale of 1–10. For others, family support is not relevant, or they receive little support or antagonism regarding their decision (Chart 5).

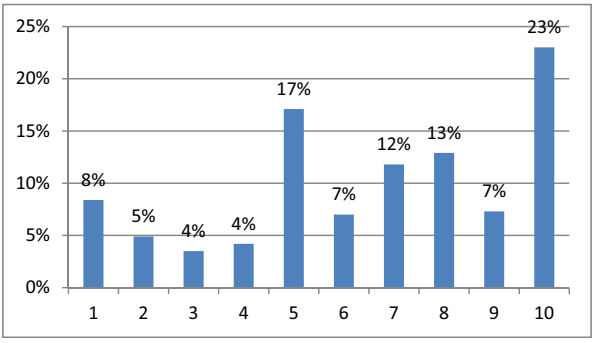

Chart 5 (Q19a) Does your family support your cryonics decision? Does not support (1) to Supports (10)

Chart 6 (Q19b) Comments regarding your family supporting your cryonics decision?

Table 21 (Q20) What disposition of your body do you prefer (if selecting neuro-cryopreservation)?

1	Donate to research	39%
2	Per discretion of cryopreservation facility	33%
3	Cremation	19%
4	Burial	11%

Respondents commenting on the supportiveness of their family regarding their cryonics decision reflected the themes of wishing that other family members would also enroll, and family member thoughts being divisive or irrelevant to member decisions (Chart 6).

Regarding the disposition of the body for those selecting neuro-cryopreservation (39% versus 53% for whole-body cryopreservation (Table 6)), 39% indicate a preference for donating it to research, 33% leaving decisions to the discretion of the cryopreservation facility, 19% cremation, and 11% burial (Table 21).

On the topic of spirituality and religion, 68% of respondents indicated that non-religious is a term that describes their views (Table 22). 41% identify with being supportive of empathy and compassion, 17% non-spiritual, 14% spiritual, and 6% religious. There is a diversity of views, and the largest identification is being non-religious, however cryonics is not incompatible with religiosity as 6% indicate. Some respondents indicate a holistic view of the world (17%), appreciation of yoga, mindfulness, etc. (17%), and a sense of being at harmony with the world (11%).

The more frequent adjectives used to describe the cryonics community (Chart 7) are hopeful, optimistic, small, intelligent, forward-thinking, and scientific. There is a strong affirmative theme of wanting to support and extend life for the self and others. There is also a realization that cryonics is currently a small community.

A point of demographic diversity is the wide range of time over which individuals have been interacting with the cryonics community (Chart 8). The biggest category is 1–5 years, 5–10 years is the general average, and the range extends from under 1 year to over 60 years.

Table 22 (Q21) Do any of the following describe your views?

1	Non-religious	68%
2	Supporting of empathy, compassion	41%
3	Non-spiritual	17%
4	A holistic view of the world/universe	17%
5	Appreciative of yoga, mindfulness, etc.	17%
6	Spiritual	14%
7	A-religious	13%
8	Observing of social and/or ceremonial rites	12%
9	At harmony with the world	11%
10	Religious	6%

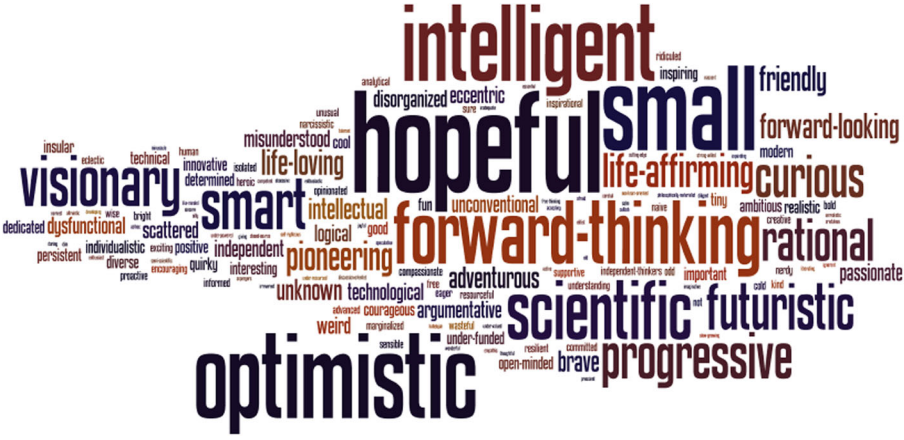

Chart 7 (Q22a) What are three adjectives you would use to describe the cryonics community?

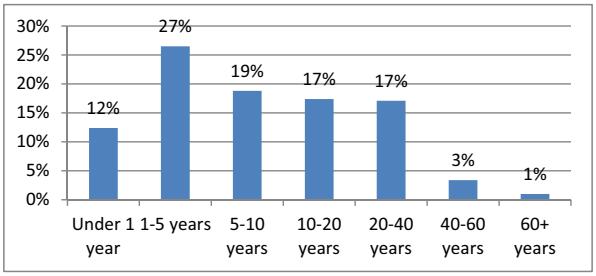

Chart 8 (Q22b) How long have you been interacting with the cryonics community?

In terms of who should pay for cryopreservation, three-quarters (76%) of respondents say that they think the individuals selecting cryopreservation should pay for it (Table 23). Half of respondents (52%) would like health insurance plans to offer more kinds of options regarding end of life choices such as cryopreservation. 19% support

Table 23 (Q23) Who should pay for cryopreservation?

1	Individuals selecting cryopreservation	76%
2	Health insurance (including with more options concerning end of life choices)	52%
3	State or federal government	19%

Table 24 (Q24c) Who is your cryonics provider?

1	Alcor Life Extension Foundation	65%
2	Cryonics Institute	22%
3	KrioRus	11%
4	Other	2%

Table 25 (26b) Gender identification (optional)

1	Male	81%
2	Female	17%
3	Other	1%

the idea of state or federal governments covering some portion of the cost of cryopreservation.

Respondents are generally happy with their cryonics provider, over half (53%) give a satisfaction rating of 8–10 (Chart 9).

Overwhelming, survey respondents would like their cryonics provider to be doing more research, regarding all facets of cryopreservation, patient support, and potential revival (Chart 10).

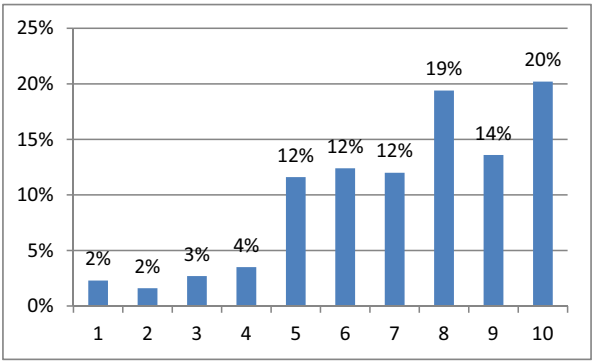

Chart 9 (Q24a) Do you think your cryonics provider is doing a good job?Dissatisfied (1) to Satisfied (10)

Chart 10 (Q24b) What would you like your cryonics provider to be doing?

Chart 11 (Q25) Any other comments?

Seventy percent of survey respondents indicated that they are enrolled members of a cryopreservation service. Enrolled respondents are with Alcor (65%), Cryonics Institute (22%), KrioRus (11%), and other (2%).

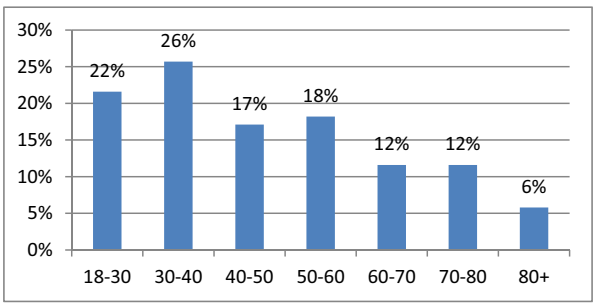

Chart 12 (Q26a) Demographic age (optional)

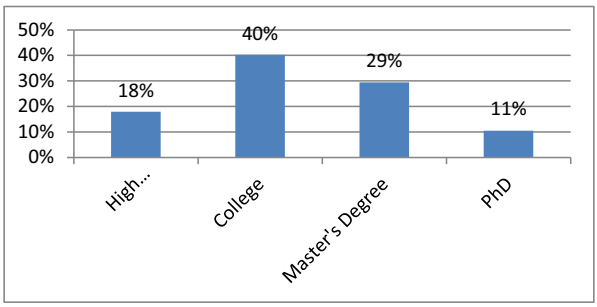

Chart 13 (Q26c) Highest-level of education completed (optional), top designations

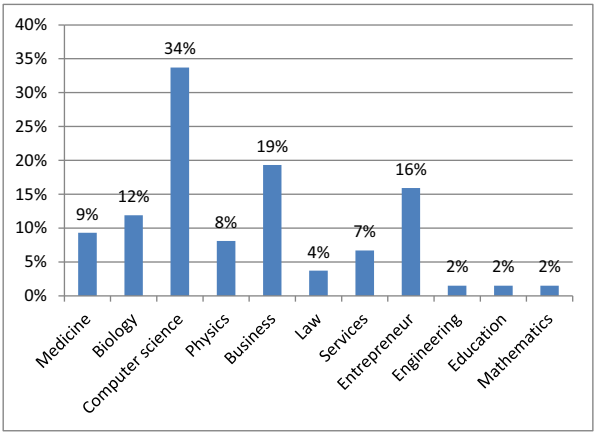

Chart 14 (Q26d) Field (optional), top designations

Final overall comments focused on respondents wanting more worldwide cryopreservation facilities to be established, wondering about the right cost for cryopreservation and affordable options for paying for it, more research to be conducted in all related areas, the community to be better-known and supported, and hope for the future (Chart 11).

The ages of respondents are diverse and well-represented across demographic groups with the heaviest weighting in the 30–40-year-old category (26%) as indicated in Chart 12. Twenty-two percent are 30 and under, 26% 30–40, 35% 40–60, and 30% 60 and over.

One area reflecting less diversity than others is gender identification. The cryonics community skews toward male, as 81% of respondents indicate (Table 25), with 17% female, and 1% other.

Regarding the highest level of completed education (Chart 13), 40% of respondents indicate having earned a college degree, 29% a master's degree, 18% a high school degree, and 11% a PhD.

Career designations cited by respondents include a third in computer science (34%), 19% in business, 16% entrepreneurs, 12% in biology, 9% in medicine, 8% in physics, 7% in services, 4% in law, 2% respectively in education, engineering, and mathematics, and many other specific fields in a range of science, liberal arts, and humanitarian areas (Chart 14). The biggest categories are computer science, business and entrepreneurship, and biology, medicine, and physics. There are many other categories identified, for example politics, literature, journalism, humanities, services, trades, and other areas that were less in aggregation than the eleven top designations listed.

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