



Should the colonisation of space be based on reproduction? Critical considerations on the choice of having a child in space

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ABSTRACT

This paper aims to argue for the thesis that it is not *a priori* morally justified that the first phase of space colonisation is based on sexual reproduction. We ground this position on the argument that, at least in the first colonisation settlements, those born in space may not have a good chance of having a good life. This problem does not depend on the fact that life on another planet would have to deal with issues such as solar radiation or with the decrease or entire absence of the force of gravity. These issues could plausibly be addressed given that the planets or settlements we will feasibly colonise could be completely transformed through geoengineering processes. Likewise, the ability of humans to live in space could be enhanced through genetic modification interventions. Even if, however, the problems concerning survival in space were solved, we think that, at least in the first period of colonisation of space or other planets, giving birth to children in space could be a morally irresponsible choice since we argue, the life we could give them might not be good enough. We contend that this is the case since when we decide to have a baby. We argue that it is not morally right to be content that our children have a minimally sufficient life worth living; before we give birth to children in space, we should make sure we can give them a reasonable chance of having a good life. This principle applies both on Earth - at least where you can choose - and for space travel.

1. Towards a Colonisation of space?

The primary challenge with any voyage or mission into space or onto other planets is indubitably survival. The moment we leave our planet, we find ourselves in hostile territory. Take, for example, Mars, the planet closest to Earth in our solar system. Not only do we find very low temperatures (between -120 and -14 °C) and a rarefied atmosphere, but also lower gravitational strength (about one-third of Earth's) and solar radiation that is about 700 times higher. From this point of view, the fact that Mars or other planets are far away is the least of the problems. With the technologies we have at our disposal, we could also consider a mission with a crew of human beings of three or more years between a round trip to Earth. This period would include the time spent on Mars waiting for Earth to approach and geo-sync, permitting a return journey. To go to Mars safely, we would need technologies capable of protecting us from an environment that is otherwise incompatible with human life. However, the survival problems could be entirely (or at least partially)

overcome through genome editing interventions, designed to adapt our biological constitution to the environmental conditions we will find on other planets or extraterrestrial settlements. The reprogramming of the biological constitution of astronauts through (targeted) interventions of genome editing seems to be the most advantageous solution amongst those being discussed.

For one thing, not only does it present itself as the more straightforward solution, but it would most likely have a much lower cost than any environmental transformation intervention (suffice it to think that Elon Musk suggested making the planet Mars habitable through the prolonged and massive bombardment of the Martian polar caps with nuclear warheads) (Walker, 2019). This approach would also be less invasive since, at least in the initial phases,¹ it would be enough to practice them on the small number of people who will go into space. Furthermore, even from a moral point of view, the balance would not be unfavourable - even if we wanted to assume that the transformation of the environment of other planets was not morally relevant - as genetic

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¹ Things could change later if the settlements grow and space travel increases in frequency.

modification interventions do not raise particular moral problems. Naturally, however, it would be irresponsible to practice such techniques before having sufficient assurances concerning their safety. We have to take into account not only their benefits but also their potential risks. Regardless, the point is that there is nothing intrinsically immoral concerning genetic modification interventions (i.e., they are not *mala in se*).

Those who argue that we would have no right to change our genetic heritage because such genetic heritage represents a fundamental good that belongs not to the individual, but rather to the whole of humanity not only maintain a nonsensical position but defend a perspective that is not morally sustainable (UNESCO, 1997).² First of all, every time we have a child, we modify the genetic heritage of humanity, given that through sexual reproduction (or assisted reproduction interventions), we bring into the world individuals who have a genealogy different from that of their parents, or, in any case, of the people who contributed to the birth via their germ cells. From this point of view, this is an immutable trait of human nature (or of our humanity). Our species can *only* continue to exist via the modification of our genetic patrimony, i.e., via reproduction which does this modification *ipso facto*. This would be true even with reproductive technologies that, at the moment, do not seem practical/efficacious, but in the future, could become so, such as cloning. More specifically, the production of an embryo using the nuclear DNA of the somatic cells of an adult. In fact, John Harris affirmed that “All forms of reproduction except cloning fail in fact to reproduce, they almost infinitely vary the genome via a random process, aptly called by some ‘genetic roulette’” (Harris, 2014, p. 57). We don’t agree with Harris given that even in the case of reproductive cloning, we could not avoid changing humanity’s genetic heritage. Why? The problem is that children born by cloning can be genetic copies of another person only if they receive the mitochondrial and nuclear DNA from the same individual (Devolder, Gyngell, 2017; Harris, 2004; Levy, Lotz, 2005). If not, they will have a unique genetic heritage like sexually conceived children given that they will receive nuclear DNA from one person and mitochondrial DNA from another. Even if, then, we were to give birth by cloning only to children who have the same genetic heritage as another person, we would no longer have to give birth to more male children since - if we resort to reproductive cloning - only girls can receive the genetic heritage (that is, both mitochondrial and nuclear DNA) from the identical person. Men can use reproductive cloning as many times as they want. Still, they will never be able to have a perfectly similar baby (at least from a genetic point of view), as they have no egg cells and consequently will never pass on mitochondrial DNA to them. However, giving birth to girls - and therefore condemning the male gender to extinction - does not seem the best way to preserve the genetic integrity of our species.³

Furthermore, even if it were possible to have children and preserve our species’ genetic integrity, modifying humanity’s genetic heritage does not seem morally irresponsible when it produces positive consequences on the quality of our life and our children (Harris, 1992, 2007; Buchanan, 2011, 2012). For example, by changing the genetic makeup of the unborn child, we can not only prevent major illness and suffering but also enable ourselves (and future generations) to have or develop better physical and cognitive dispositions to cope with life. On a moral level, the most significant concern is that these interventions can be used not only for therapeutic purposes but also for improvement or enhancement. However, those who have argued that it is not morally

justified to employ human bioenhancement interventions have failed to provide, at present, any truly convincing or, in any case, universally acceptable reasons for sustaining that position. One of the criticisms we find in the debate is that society would have difficulty (or at least more difficulty) in recognising the dignity or rights of people who are born with an enhanced gene pool (Fukuyama, 2003) or that people who come into the world with an enhanced gene pool would be doomed - due to empowerment - to live a life that others have chosen for them and that for this reason, they would no longer be the protagonists of their life, but mere spectators (Habermas, 2013; Kass, 2004). It was also stated that any genetic improvement (or enhancement) would have negative consequences on the character and moral sensitivity of the people who are born, making us lose the ability to appreciate life in any form as a gift or by encouraging deeply selfish attitudes or, even worse, by extinguishing any capacity for empathy (Sandel, 2007). However, it is not true that moral relevance and fundamental rights are rooted in our current human nature, as we can extend the content of dignity and rights to non-human animals as well (but we can go even further and recognise them for extraterrestrials with mental and physical abilities similar to those we possess). Those born with an enhanced genetic patrimony are not automatically deprived of their freedom, as they can still choose whether to cultivate those particular dispositions they have received or which dispositions to cultivate and which ones to neglect. In fact, it is unthinkable that an enhanced person can develop their physical or mental abilities automatically, without any will or degree of minimum commitment or effort (Agar, 2004, 2013; 2019; Sandel, 2007; Savulescu, 2009). Finally, a person with the opportunity to have better mental and physical abilities thanks to interventions that have changed their genome would feasibly feel even greater gratitude to their progenitors and society compared to that of unenhanced individuals. Not only this, but such enhancement may open up the possibility of being born with a greater ability to empathise with other people or, in any case, to implement behaviours that favour other people’s interests (Harris, 2016a; Persson, Savulescu 2012; Rakic, 2021a; V. 2021b). Regardless, the genetic modification interventions that would be necessary to allow astronauts to travel into space and colonise other planets would not be ameliorative, as they would only serve to enable people on missions in space to survive in an environment obviously very different from what we have on our planet. For this reason, we should consider them merely as therapeutic (interventions): to be precise, they would be ‘gene therapy’ interventions on the somatic line (Balistreri, 2020).

Gene therapy interventions can be practised both on the germline and somatic line; the genetic changes produced by interventions on the ‘somatic line’ cannot be transmitted to the offspring, as they only concern the genetic heritage of the organism’s cells (in other words, do not change the genetic heritage of oocytes and/or spermatozoa). Even if, therefore, those who travel to other planets have a modified genome (Szocik, 2020; Szocik & Braddock, 2019), they will not be able to naturally transmit the characteristics that allow for survival. Every time they have a child, they will have to undergo a genetic therapy intervention. The genetic modification intervention could be practised after the child’s birth; therefore, it would once again be a genome editing intervention on the somatic line. However, waiting for the delivery could be risky and expose the future baby to solar radiation or other environmental conditions that could compromise its normal development.⁴ For this reason, it seems much more reasonable to practice the intervention before birth. The genetic heritage of the embryos or gametes could be modified before fertilisation; the result would not change, and the modification could then be transmitted with reproduction. The gene therapy intervention could be practised in a laboratory of the new

² The reference is to UNESCO International Bioethics Committee’s resolution on the ethics of cloning demanding “the preservation of the human genome as common heritage of humanity.”

³ Of course, things would change if human males could produce egg cells/oocytes from their somatic cells, as in this case, men too could pass on their mitochondrial DNA to their offspring (Cutas, Smajdor 2017; Smajdor, Cutas 2015).

⁴ Here, it is sufficient to think that the genetic heritage of the astronauts would not be modified on another planet but on Earth and before the start of the mission.

settlement, but the embryos could first be modified on Earth and then transported to Mars. The place where the genetic modification of the embryos will be carried out has no relevance; the important thing is that the intervention has been tested, can be considered sufficiently safe and, therefore, does not expose the born child to unjustified and/or unacceptable risks. From our point of view, the fact that tomorrow the people who will be born (on Earth or any planet) will have a modified genetic heritage is not a moral problem. Unlike the genetic modification interventions that we practice on the 'somatic line', these interventions cannot be practised with the consent of the person who will then be born (since we do not yet have a self-conscious person able to understand and want). However, this does not mean the type of intervention cannot be morally justified (Harris, 2016b, 2017).

Moreover, precisely because our children cannot yet make autonomous choices, we have not only the right but also the (moral) responsibility to choose in their place (i.e., Scanlon, 2000). That is, the fact that we choose for them cannot be considered a violation of their autonomy, nor can we be accused (for this alone) of having an unjustifiably paternalistic and, in any case, morally criticisable stance. What matters is that our decision promotes the interests and well-being of those who come into the world and that it is possible to imagine that those born could have been in favour of the choice.⁵ Let's now think of genome editing interventions for space travel. It is not difficult to imagine it, as the alternative would be to be born with a genetic constitution unsuitable for the environment. However, when discussing reproduction in space it seems that the only morally relevant thing is to ensure that children have an adequate genetic constitution, capable of making them sufficiently fit to live or survive in an environment very different from that which we have here on Earth (Edwards, 2021a; M. R. 2021b; Garasic, 2021; Szocik, 2021a). We, on the other hand, intend to argue that this is not a sufficient condition to consider the choice of having a child/children in space as being *de facto* morally responsible. We will argue that we have a duty to assure people that we give birth to a child that will have *both*: (1) at minimum, a sufficiently good life and that (2) if (1) is not possible, then the most responsible choice is to postpone conception or not reproduce at all. In our opinion, these considerations allow us to hypothesise that - at least in the initial phases of colonisation - it is possible that the colonisation or exploration of other planets should not be based on reproduction since, at least at the beginning of the construction of the first settlements, it is not certain that we will be able to ensure a sufficiently good life for those who are born (to those we bring into the world). Astronauts who choose to leave for space have the right to decide to make significant sacrifices, but we shouldn't impose these same sacrifices on other people.

2. Is having a child in space moral?

We think that genetic modification interventions will allow children born on another planet to have a genetic makeup suitable for surviving in a hostile environment is not sufficient to conclude that having children in space or on another planet is thereby responsible. We can imagine that, in the near future, genome editing interventions might become increasingly safe and therefore be used not only to enhance astronauts' abilities but also to make those born much more suitable for their environment. However, even assuming that we could successfully carry out genetic modification interventions at the germinal level and change the characteristics of those we bring to the world to allow them to live in space or on another planet without running the risk (due to solar radiation or absence of gravity) to get sick or die quickly, this would still not be enough to conclude that then having a child in space would be moral.

At least in the early phase of colonisation (of any other planet or

space), children who will be born in space settlements may not have a good enough life. The biggest problem of those born in the first settlements in space (or on another planet) will probably not be the fact of always living continuously in contact with other people. It is true that, for a purely logistical issue, the first settlements will likely be made up of very narrow spaces that will not allow people to be able to easily withdraw into environments that are sufficiently protected from the presence, curiosity, and interference of others. According to Szocik et al. (2020), p. 7), to best satisfy the need for solitude in private spaces without compromising the equally important need for socialising moments, the accommodations could be built according to the modified Panopticon architectural project, along the circumference of one space, with access to a shared space in the centre:

When it comes to establishing close relationships, proximity is destiny. Such a design would ensure that everyone would be more or less equally likely to mix with everyone else in the shared space in a kind of Arthurian egalitarianism. Like the Knights of the Round Table, no person would be isolated at the ends. And because of the circular design devoid of interior private sleeping quarters, each sleeping quarter would enjoy an outward view, necessary for the orientation of time and place, and to present novel stimuli to avoid the hallucinations concomitant with isolated environments. Even symbolic territorial demarcations can lower the psychological stress of crowding (Szocik et al., 2020, p. 7).

However, one can imagine that even if we could build such a space base (according to a modified Panopticon architectural model), the early colonisers would still have to spend most of their time together, as they would have to constantly confront each other concerning their responsibilities and duties of the mission. Furthermore, it seems clear that some works (or tasks) inside the space base or outside (exploration of the planet or construction of new settlements) can only be carried out together or by coordinating their actions with the rest of the crew. Even if, therefore, we build a space base according to an architectural project that separates the work or socialisation space from the more 'personal' one (in which astronauts can not only rest but also play sports or see a film), this hardly would change the condition of astronauts in the first extraterrestrial settlements. Perhaps it would be too much to say that early settlers will never be able to choose when to be alone and when, instead, to spend time or be with other people. However, we can confidently say that most of their time will be spent near their fellow settlers, with most of their time and relationships delegated toward the goals of their mission.

Environmental conditions of this type, which, as they emerge, leave little room for the possibility of planning one's existence independently without the need to coordinate with others, can naturally affect the quality of life of people and, to a certain extent, make it (much) more difficult for people to reach a condition that allows them to live well. However, our position is that this problem is not the most significant challenge concerning being born in an extraterrestrial settlement. The problem is not even the fact of coming into the world in a (very) isolated environment. Konrad Szocik et al. (2021) rightly state that:

isolation and confinement, especially as experienced by the first sets of explorers and settlers, will be dramatic; these have not only direct psychological consequences (depression, anxiety, interpersonal conflict) but can also contribute to degradation in physiological functions such as immunity and cardiovascular functioning (Szocik et al., 2021, p. 6).

The isolation, however, could be at least partially overcome through technological devices that allow immersion in virtual reality or frequent contact and relationships with those on Earth. Furthermore, one can easily imagine that the more scientific and technological development will go on, the more immersive technologies will allow us to emulate a physical environment or world and thus extend any reality by simply exploiting digital means and interactive interfaces (Botella, Baños,

⁵ In other words, what is important is that there is a presumed consensus; that is, that if they could have done so, they would have given their consent to the type of intervention in question.

Etchemendy, García-Palacios & Alcañiz, 2016; Wu et al., 2015). This seems an adequate solution - and in step with the times and technological development - than the one proposed by Szocik et al. (2020), according to which the 'natural' need of nature could be at least partially satisfied by resorting to the interiors of the (spatial) base in colours such as the blue to simulate an immense open sky or the green of a forest or a garden, which can serve to augment the mood of travellers and settlers via the evocation of nature. Instead, we agree with Szocik et al. (2020) that 'robotic' animals (evidently more manageable than biological ones) could prove to be a vital resource in any space mission not only for the problem of isolation but also for the amelioration of stress.

The issue, however, is that people who will be born in the initial settlements may not have the possibility to choose their own lives in a way that could be considered original and unique. More specifically, they may not be permitted to select what to do, what skills or abilities to develop, what passions or interests to cultivate over time or what kind of profession and/or job to dedicate themselves to. This may result from coming into the world in a small and isolated community with a fixed goal. Therefore, they will be called to responsibility and ensure their contribution to the mission. In practice, however, Neil Levy (2016) raises concerns about what may happen to children born on a generation ship, that is, both a spaceship able to support not just those who set out on them for the original mission but also their descendants: "A generation ship can work only if most of the children born aboard can be trained to become the next generation of crew. They will have little or no choice over what kind of project they pursue." In this case, however, children born would have a much more comprehensive range of options than children born in a first settlement might have. "A generation ship would have to be a whole society in microcosm, with hospitals and schools, living quarters and perhaps entertainment districts, a security force, maybe even a judiciary," to which those born will have access (Levy, 2016). We think that in the first settlements in space, the possibilities of choice will be more limited. For this reason, those born on Mars or the Moon could have the impression that the generation ship can offer much more promising life prospects (see also Umbrello & Balistreri, 2022).

Of course, the people who will leave for space have the right - if this is their desire - to restrict their future opportunities, engaging in such an extraordinary adventure that allows them to reach and colonise other planets that have never or rarely been explored before. However, they should not impose these sacrifices (and consequently their particular conception of the good life) on others and even less on the people they choose to bring into the world. The question could arise whether - after a certain number of years (for example, when they reach the age of adulthood or have a period for conscious choices) - people born in space could if this is their desire, choose to move back to our planet. We think that people who voluntarily choose to go on a mission in space and even more so people born in space, should have the right to do so (Balistreri & Umbrello, 2022). The problem, however, is that things could be more complicated than at first glance. For example, the first settlements could be built on planets (and solar systems) very far from Earth and from which it may therefore not be possible to return in a very short time. The return journey could take many years - for example, decades - and there could be essential risks. There could be technical problems that cannot be solved or environmental situations that make it impossible to reach Earth.⁶

Today we think about the colonisation of the planet Mars because it is the planet most similar to the Earth we know. Still, it is not, however, such a hospitable planet, even if only for the temperatures, whose minimum and maximum are very similar to those recorded on Earth in

Antarctica (Wharton, McKay, Mancinelli & Simmons, 1989). Indeed, Mars is only six to nine months away from Earth; however, going to Mars and then returning to Earth takes longer because the orbit of Mars is not geosynchronous; i.e., the closer Mars gets to our planet, the less time and kilometres are necessary for the journey. However, we could find planets much further away and much more suitable for us in the near future. Even if, then, the world in which our settlement is located is not so far from Earth, the transfer back to Earth could be complex or more complicated due to the genetic editing interventions that astronauts and (the children who were born from them) were subjected to allow them to survive solar radiation or the decrease or absence of gravity. In other words, return (or relocation, because children born in space have never been to Earth) might be impossible because astronauts, early colonisers, and their descendants, even if they belong to the human species, would no longer be suitable for life on Earth.

Not only this, but it can also be imagined that people who leave for a mission to another planet should have the right, at any time they wish, to be able to return to Earth and, nevertheless, due to the genetic changes, it may be impossible to satisfy that wish. Furthermore, even if it were possible to return to Earth (for example, genetic modification interventions being reversed or other further modification interventions being performed), other problems could make returning to Earth complicated. For example, even if it were possible to return to Earth, those born in the first settlements may have difficulty separating forever (or in any case for a very long period) from their family and from the people to whom familial or similar bonds link them. Likewise, people born in space or on another planet may still have difficulty settling on Earth, in an environment completely different from the one they were born in; they may suffer from loneliness because they are used to sharing all their time with others or used to following a series of activities planned by other people in their group. They may even have difficulty dealing with the freedom to always decide on anything, such that they may have the impression that this is more of a burden than a real opportunity. Consequently, it would not be hard to imagine that such individuals may have difficulty finding their way around the world without the psychological support and affection of the people with whom they grew up and who are part of their lives. Even if they did not have these problems, they could live with the impression that they had betrayed their parents, the values that had guided them in the exploration of the galaxy and other planets or, in any case, they could feel that they had not succeeded to be at their height, nor to meet their expectations or those of others.

3. A life simply worth living is not enough

We have argued that having children in early settlements could be a morally irresponsible choice because a child born in space, at least in the first phase of colonising any planet, may ultimately not have a good enough life. Our conclusion might *prima facie* seem like an easily criticisable and unsustainable position. It does not appear that by giving birth to children with a life that is not good enough, we necessarily condemn them to a life not worth living (Magni, 2021). On the contrary, we can also admit (for the reasons we have described above) that the life of those born in the first settlements in space will undoubtedly be different from ours and that those people - and this is our conclusion - may have a more limited chance (in comparison to ours on Earth) to be able to choose the type of life they want, both professionally, but also personally. However, we can hypothesise without much difficulty that those born in these first settlements in space will not only not suffer from hunger or thirst but will be able to access a series of goods/resources; for example, medical care and both therapeutic and human enhancement interventions. Through the use of the most advanced technologies, people who will be born in these settlements in space and on other planets will probably suffer from a very isolated existence. However, they will still be able to have access to virtual knowledge and areas of experience that will allow them to bear the loneliness, confinement, and

⁶ This problem becomes even more intractable when considering generation ships, which, by their very nature entail journeys that take more than a single lifetime to complete (see Umbrello and Balistreri, 2022).

perhaps even boredom with greater ease. In other words, the life of the first people born in space could be much better than the lives of many people (it is by far the majority of people) born on Earth today.

Furthermore, it can also be admitted that for those born in space, the fact of being able to have fewer opportunities than those born on Earth (at least in the wealthiest part of the world) could be at least partially be offset by the fact of involuntarily participating in an unprecedented project, a project which represents the first step in the exploration of other worlds and other galaxies hitherto unknown. Even if, that is, it was true that their life could not be 'good enough', it would be difficult to deny that they would still have a life at least worth living. However, we think that the minimum threshold of well-being (that is, a life worth living) cannot constitute an appropriate moral criterion to refer to in order to evaluate our reproductive choices and consequently establish whether it can be moral to have a child in space.

First, a 'life worth living' is a criterion that, besides being vague, does not allow the determination of a precise limit beyond which it would be morally irresponsible to give birth to a new person. If, that is, when we choose to have a child, the only thing that matters is that the life of the person we bring into the world is at least a life still worth living (i.e., one at the very threshold), it seems that only in very sporadic cases could we be morally criticised for our reproductive choices. The principle of the minimum threshold of well-being is not morally indifferent to the choice between a child who will have a happy life and one who, on the other hand, will have a life full of torments and suffering. This is undoubtedly a critical point favouring the "minimum welfare threshold". From this perspective, giving birth to a child with a very happy life is not an obligation (although it certainly is a morally praiseworthy choice); it is always wrong to give birth to a person who will *not* have a life worth living. However, the minimum welfare threshold principle is plausible only in the most abstract cases. If we can choose through the selection of embryos or genetic modification interventions on the embryo, it is better to give birth to a happy child than an unhappy one.

Furthermore, it is better not to have children than to have a child with a life not worth living; if we cannot have a child with a life worth living, it is better to give up entirely. Suppose the problem depends exclusively on our genetic heritage and the genetic anomalies that we can transmit. It is better to resort to adoption or assisted reproduction intervention and use a donor's gametes (i.e., sperm and oocytes). For example, suppose an environmental condition is not conducive to a life worth living (i.e., the air is unbreathable, nuclear contamination caused by an accident or a war, or natural resources are increasingly scarce). In that case, it is better not to reproduce. In less straightforward cases, however, the implications of this principle are less acceptable.

The biggest problem with a principle that sets the minimum threshold of well-being in a life worth living lies in the inability to criticise the choice of giving birth to children with very difficult lives (Glover, 2006). Based on this principle, for example, there is nothing wrong with giving birth to a deaf and/or blind child, even if a healthy child could be born by waiting a certain period of time (e.g., three months). This is the case presented by Julian Savulescu: "A woman has rubella. If she conceives now, she will have a blind and deaf child. If she waits three months, she will conceive another different but healthy child. She should choose to wait until her rubella is passed" (Savulescu, 2001, p. 417).

Even though not seeing and hearing will reduce the chances of the child being born, and probably most of us would not want our children to be in this condition, we cannot conclude that his life would not be worth living. After all, even people born with severe disabilities can be happy to exist; add to this that, based on the problem of non-identity, if the mother waited three months before having a child, the same child would not be born anyway, but a different child entirely. However, we can make the child's condition who comes into the world even worse, and it would still be difficult for that child to determine when their life will no longer be worth living. If, in addition to being blind and deaf, the child born also had other problems, we would approach that threshold

under which their life is not worthy, and the mother is wrong to bring them into the world. However, it is difficult to think that we will certainly exceed this threshold if we add motor difficulties or other physical problems (for example, terrible back pain) to their life, cognitive deficits that prevent or make it more challenging to have a social life, a limited life expectancy and - to make the case even more dramatic - surgical operations preceded by debilitating therapies. Again, the child may still have a life worth living. They will probably need medical and psychological assistance throughout their life. In addition to suffering, they will never be utterly self-sufficient because they will always depend on the care of other people. Still, this does not mean that their life is no longer worth living, even with such a deterioration of health conditions.

Notwithstanding, this is not the worst situation we can imagine in a person's life. The problem, however, is that if we look at things from the point of view of the child that we can bring into the world (the situations in which we can harm them are scarce, as), it isn't easy to set a limit, beyond which life cannot be more worth living. Steinbock and McClamrock (1994, p. 16) explain the most morally problematic aspect well. We can try to focus on the circumstances that offer fewer opportunities and advantages to the child who is born: "let's think, for example, of slavery, of a very high probability of going through an agonising death from hunger in the first years of life, of a severe mental retardation plus complete quadriplegia, etc.," a person's life may still be worth living. We agree with Jonathan Glover (2006, p. 52) that life must be terrible to push a person to suicide or think it would have been better for that person not to be born. "A child's life has to be very terrible before people think that euthanasia might be an issue, or, at least, think that it would have been a mercy if the child had not been born" (Glover, 2006, p. 52).

So far, we have reasoned thinking about cases and situations that may arise on Earth. Still, we can extend the previous discourse to space travel and try to imagine in which particular conditions the life of those born may no longer be worthy. Also, in this case, it is not essential which exemplary case we start from; what we can observe is the ease with which we can quickly slide down a slippery slope. For example, we can imagine that babies are born in settlements on other planets made up of a limited but not a very small number of people (crews of 500 to 1000 people). We hypothesise that people, for the reasons we have previously tried to imagine, can have relations with the Earth but cannot go and live on another planet. Those born in these settlements will contribute to the formation of a new world (in space) - they will probably work to make the planet more habitable and to design and build ever larger settlements that can gradually accommodate an ever-larger population - but they will probably not have the time to derive significant direct benefits from this work. Their lives will not be marked by extreme suffering: you can also consider more or less long moments of depression, problems falling asleep, boredom, loss of motivation and other psychological issues related to confinement. However, these psychological problems can be treated with particular medications or by resorting to distraction tools and games. Even if it is an existence that the people born have not chosen, and that will be sacrificed towards the realisation of a project of their parents' or previous generations' choosing, this does not mean that their life will not be sufficiently worth living. However, the judgement on the quality of life of the people who live in the new settlement in space does not change automatically even if we progressively modify the starting example and imagine an increasingly worse (or, in any case, increasingly complex and demanding) condition.

For example, we can imagine that - at least in an early phase of colonisation - the space crew is composed of a minimal number of people (we must not think that there are only a dozen, we can assume that they are less than 100) and that the base has discontinuous relations with mother Earth. We can add, then, a worsening of the psychological conditions of astronauts - due in part to greater confinement and more significant difficulties in having normal relations with the motherland and the difficulty of receiving promptly the resources necessary for their survival, as well as environmental conditions that make a life of survival

on the base a little more complicated. Even in this case, we do not have reason to think that life would not be worth living and that, therefore, the people involved would prefer to die than to continue living as they are. Continuing at this rate, we could, with our examples, continue to make the life of astronauts (and their children) more and more difficult without being able to make it no longer worth living. The problem is that we do not fall into any (logical) contradiction if, in the end, we affirm that a person can be born and then spend the rest of their life on a space base not much larger than the international space station without peers and amongst only a few people and still have a life worth living.⁷ According to the minimum threshold of well-being principle, there is no problem here in any case. Instead, we contend that something is alarming in a principle that states that we do nothing wrong in having a child with a life that is barely worth living (Glover, 2006, p. 52).

There is, still, another problem with a conception that sets the threshold of moral responsibility in reproductive choices to a life worth living: not only can it be challenging to consider things objectively and precisely establish the threshold beyond which life becomes unworthy of being lived, but we can overestimate the condition of well-being possible in a given situation and ignore or otherwise underestimate the difficulties and problems that instead characterise it. As long as this psychological mechanism concerns our life, it can be an acceptable survival strategy; when it involves a child's life, it can be a problem, as it could condemn them to live a life that is less worthy than it may seem to us. When we think about the morality of our reproductive choices, we should consider that we might tend to evaluate existence more favourably than we should (Benatar, 2008). The fact that despite the difficulties which we have described and which we can easily imagine, the life of these children may seem to us, however, still worth living is not enough to conclude that then our choice is undoubtedly morally acceptable (i.e., that we do nothing wrong - we do not harm them - if we bring these children into the world). With the best of intentions, we could condemn them to a life not worth living. In any case, even if we do not err, it is never a good thing to be born/come into the world with a life barely worth living. That is, those who defend the principle of the minimum threshold of well-being affirm that we cannot morally criticise parents who bring into the world a child with a life that is not so happy but with a life still worth living as they have not, in any case, harmed that child. In other words, it is not true that for those who come into the world, it would have been better not to be born at all. However, bringing into the world someone with a life *just* worth living may not be a harm. However, it is still a morally irresponsible action, as it means putting the person born in a situation where any slight change could transform their life forever into hell and (suddenly) make their life no longer worth living.

4. Do we have a duty to deliver the best baby (in space)?

Within our reflection, Julian Savulescu and Guy Kahane's perspective, relating to the duty, at least *prima facie*, to bring the best child into the world does not add morally essential elements and is not an original solution to the question of reproduction in space. This is because it does not represent a real alternative to the 'principle of the minimum threshold of well-being'. It is also true, as Savulescu and Kahane affirm, that whoever wants a child should give birth to the best child:

If reproducers have decided to have a child, and selection is possible, they have a relevant moral reason to [should] select the child, of the

possible children they could have, whose life can be expected, in light of the relevant available information, to go best or at least not worse than any of the others (Savulescu & Kahane, 2009, p. 274).

However, they argue that:

- 1) that the principle of procreative charity is not an absolute obligation but only a significant reason to choose, amongst the different children that one can have, the best one;
- 2) the search for the best child is limited to the purely genetic level (when that is, it is possible to select/choose the embryo to be transferred amongst those produced through reproductive interventions) and;
- 3) when we talk about the best child, the best adjective is always a term that is not absolute but comparative because it must be measured concerning the real possibilities available.

In other words, we can also imagine that in the first settlements, the genetically best child can be born: for example, the one amongst the embryos that can be genetically modified (and possibly enhanced), which will make it possible to give those who are born greater resistance to solar radiation and health problems related to the absence or decrease of gravity. Even if, that is, the children born in the first settlements do not have the absolute best genetic heritage, this would not be a (moral) problem for Savulescu and Kahane, given that what matters is that the child born is the best amongst those whom they can come into the world as. The problem, however, is that even if we give birth to the genetically best child, we can still have reasons to criticise this choice because it puts the child in a condition that will not allow them to have a good chance of having a good life. Our children deserve "certain better living conditions," and a good parent should not deliver them if they cannot count on a "good chance of having a happy life" (Glover, 2006, p. 56). We agree with Bonnie Steinbock and Ron McClamrock (1994) that a parent should ask: 'What kind of life will my child have?' The responsible parent will not be satisfied but will want a life worthy of living and endeavour to ensure it. This principle of parental responsibility offers a person or a couple who wishes to have a child a more reliable criterion of choice than other principles of reproductive choice.

5. Conclusions

The debate on reproduction in space has turned its attention exclusively to issues concerning the health and well-being of the mothers and that of the children who eventually come into the world. We think that an appropriate reflection on the morality of reproduction in space should also consider the kind of quality of life that we can give to those born. For the choice to reproduce in space to be considered moral (i.e., responsible), it is not enough that the child born has at least a life worth living; the child who comes into the world should have at least a good chance of having a good life. This paper has aimed to show this by imagining the possible scenarios we can have with the first colonisation expeditions of space. Early settlements on other planets are likely to be challenging places for astronauts. Perhaps the genome editing interventions will allow them to survive without issues in otherwise hostile environments (e.g., with solar radiation and different gravitational contexts than that of Earth). However, once they arrive at these settlements, they will no longer have many choices and must conform to the mission's objectives. We think people should be free to choose such a life, but they should not force it on others, for example, by having them born on a space base.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

⁷ Edwards (2021a; 2021b), for example, imagines that to save the human species from extinction a spaceship could take a certain number of human embryos to another planet. These embryos would be grown by ectogenesis in artificial machines and then reared and raised by intelligent machines programmed to take care of those who are born. According to Edwards, such a life would have limitations but would still be worth living.

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