**Avoiding the potentiality trap:**

**thinking about the moral status of synthetic embryos**

**Abstract:**

Research ethics committees must sometimes deliberate about objects that do not fit nicely into any existing category. This is currently the case with the “gastruloid,” which is a self-assembling blob of cells that resembles a human embryo. The resemblance makes it tempting to group it with other members of that kind, and thus to ask whether gastruloids really are embryos. But fitting an ambiguous object into an existing category with well-worn pathways in research ethics, like the embryo, is only a temporary fix. The bigger problem is that we no longer know what an embryo is. We haven’t had a non-absurd definition of ‘embryo’ for several decades and without a well-defined comparison class, asking whether gastruloids belong to the morally relevant class of things we call embryos is to ask a question without an answer. What’s the alternative? A better approach needs to avoid what I’ll refer to as “the potentiality trap” and, instead, rely on the emergence of morally salient facts about gastruloids and other synthetic embryos.

**Keywords:** embryo;biotechnology; potentiality; research ethics; stem cell research; synthetic embryo

“All great scientific advances have a way of exposing the imprecision of common concepts and forcing people to rethink them.”

-John Aach

**Introduction**

Objects of biomedical research are often organized into “natural kinds”—e.g., human being, nonhuman animal, human embryo, etc.—that are assumed to track morally relevant properties. Grouping things together this way makes it easier for ethics committees to recycle moral considerations: once the committee knows which category an object belongs to, it may apply to that object the considerations of others in that category to arrive at morally appropriate judgments. But every once in a while, an ethics committee is faced with an object that doesn’t fit nicely into an existing category and must therefore re-think its moral status. This is currently occurring with the “gastruloid,”[[1]](#footnote-1) which is a self-assembling blob of cells that resembles a gastrulating human embryo.[[2]](#footnote-2) If gastruloids sufficiently resemble their embryonic counterparts and thereby belong to the category of embryos, ethics committees can use the latter’s guidelines to determine how the former should be treated. There is significant uncertainty, however, about whether gastruloids do in fact sufficiently resemble embryos, with a number of bioethicists and scientists recommending that we pause to determine whether gastruloids really should be grouped with embryos and thereby inherit their moral status. (See, for example, Denker 2014; Hurlbut et al. 2017; Hyun et al. 2016; Pera et al. 2015; Rivron et al. 2018).[[3]](#footnote-3)

While I agree that gastruloids (and synthetic embryos more broadly) present significant moral quandaries that need to be considered anew, I will argue that approaching such questions by attempting to determine whether gastruloids belong to the same moral category as embryos is a mistake. There is no non-absurd definition of ‘embryo’[[4]](#footnote-4) and without a well-defined comparison class, asking whether gastruloids belong to the morally relevant class of things we call embryos is to ask a question without an answer. What’s the alternative? A better approach needs to avoid what I’ll refer to as “the potentiality trap” and, instead, rely on the emergence of morally salient facts about synthetic embryos. By considering the emergence of such facts, we’ll be in a better position to think about how gastruloids and other synthetic embryos should be treated, since observations about morally salient facts will be our deliberative guide rather than a poorly defined comparison class.

Here’s how the paper will unfold. In Sections 2 and 3, I explain the source of our problem, which is using the notion of potentiality to define the concept of an ‘embryo’. I review arguments used to support this definition and consider both old and new critiques of them. As I see it, the main problem with relying on potentiality to define the concept of an embryo is that it’s nearly impossible to avoid the threat of *reductio ad absurdum*. I call this the potentiality trap and, in Section 4, argue that it should be avoided when formulating guidelines for the ethical treatment of synthetic embryos. To illustrate, I provide an example that shows how to spot and avoid the trap that is my concern. I conclude with a summary of my argument.

**Categorizing by resemblance**

Whether a clump of cells is an embryo determines what can be done to it for the sake of research. While most countries allow for research on surplus embryos, many countries categorically prohibit their creation for the exclusive purpose of research. Similarly, determining whether something is an embryo has implications for funding. In the U.S., for example, The National Institutes of Health are currently prohibited from supporting research involving entities that fall within the “statutory definition of a human embryo” (Regaldo 2017). The problem in both cases, however, is delimiting the range of objects that fall (or ought to fall) within the statutory definition.[[5]](#footnote-5)

This wasn’t always a problem. We used to define embryos using a backward-looking approach that appealed to the act of fertilization. This approach worked fairly well until the 1990s, when scientists discovered somatic cell nuclear transfer (SCNT), or cloning, which made possible the creation of sexually reproducing organisms without the act of fertilization (Campbell et al. 1996). As a result, the act of fertilization had to be dropped as a necessary component of the definition of an embryo. A similar shift happened when James Thomson and colleagues (1998) learned that human embryonic stem cells (hESCs) that have been isolated from a very young embryo also have the ability to develop into an organism. And a decade later, when Kazutoshi Takahashi and colleagues (2007) derived human induced pluripotent stem cells (iPSCs)—which are ordinary somatic cells reprogrammed to behave like embryonic stem cells—the hope of finding any peculiar feature of embryonic cells by looking to their origins seemed to have vanished.

In light of these facts, various attempts have been made to define embryos by shifting to a forward-looking approach. Instead of looking backwards, to where cells come from, the idea has been to look to their future trajectories as the essential property of all embryos. Hence, the new approach is to ignore the varied origins of cellular material and focus instead on the potential trajectory of some cells to grow into human beings. Those that can are embryos; those that can’t are not. A number of countries have adopted this forward-looking definition. For example, the German Stem Cell Act (Baylis & Krahn 2009, 45) defines embryos as “any human totipotent cell which has the potential to divide and to develop into a human being if the necessary conditions prevail.” The Dutch and Belgian Embryo Acts (see Pera et al. 2015, 919) characterize the embryo as a cell or cells “with the capacity to develop into a human being,” and the Australian legislation includes in the definition of an embryo “any other process that initiates organized development of a biological entity with a human nuclear genome or altered human nuclear genome that has the potential to develop up to, or beyond, the stage at which the primitive streak appears” (again, see Pera et al. 2015, 919).

But given recent advances in biotechnology, these definitions are increasingly becoming obviously problematic. In what way are some cells potentially human beings while others are not? In the next section, I’m going to take up this question by reviewing some fairly standard arguments used to support the idea that some cells (viz., embryos) have a special kind of potential. I will then provide some old and add some new reasons as to why these arguments cannot escape the threat of *reductio ad absurdum*. The result will be that defining embryos by appealing to their cellular potential is entirely unsatisfactory. We need a different way to think about things.

**A ‘potential’ explosion**

Human embryos are generally believed to deserve some moral reverence even if they are not afforded all the rights and protections of human beings as persons.[[6]](#footnote-6) The *argument from potentiality* justifies this special treatment of embryos by reference to their “potential to *develop into* bearers of rights” (Stier and Schoene-Seifert 2013). But in order for such an argument to work, it must be the case that embryos have that potential uniquely. Indeed, if any human cell has the potential to develop into a human being, it would be absurd to afford only some of them special protection on that basis.[[7]](#footnote-7) John Harris made a similar point when he wrote, “It is not only the fertilised egg that is potentially a human being. The unfertilised egg and the sperm are equally potentially new human beings” (1985, 11). Here, Harris notes the most immediate problem that arises from definitions that rely on the notion of potential. If sperm and egg cells also have the potential to develop into bearers of rights, the argument that only embryos deserve special treatment because of their unique potential is headed for trouble.

 Michael Tooley (1974) has pointed out that the problems inherent in the language of potentiality are even deeper. Indeed, there is the threat of what I’m going to call a moral status explosion problem (or ‘explosion problem’ for short). He asks us to imagine a serum that, when injected into kittens, causes them to develop into cats that are as mentally sophisticated as normal adult persons. Given this thought experiment, couldn’t we say that, just like sperm and egg cells, these kittens have the *potential* to become persons? If so, would we be obligated to assign special moral status to all kittens? Or suppose (and now I’m moving away from Tooley) that I have a particle replacement device that can take any household object and, particle by particle, turn it into any other object. Should I treat my vacuum cleaner as a potential person? The proposal is absurd, since doing so would lead to an explosion of moral status for all objects. Without a response to this problem, arguments that rely on the potential of embryos to become persons should be rejected.

Elizabeth Harman (2003) has offered a reasonable way of avoiding the explosion problem. According to her, the right way to think about a thing’s potential is to determine whether the potential is part of that thing. So, for example, a vacuum doesn’t have the potential to become a person because there is no part of any vacuum itself that could serve to develop the characteristics of persons. Similarly, all kittens would not need to be treated with special moral concern because it would only be kittens that had been injected and only “once the serum has sufficiently interacted with the cat’s own cells and tissues” (Harman 2003, 189) that the kitten would have the potential to become a person. As Harman explains:

The important point is that the cat, as an entity, can be seen to exist wholly distinctly from the serum; the serum is within the space in which the cat is located, but it is not intrinsically part of the cat. Babies are not similarly separable from their DNA. Babies have the plans to become a person *intrinsically within them*; cats recently injected with the serum do not. (2003, 189, emphasis in original)

The same point applies to vacuum cleaners. Since my particle replacement device is not part of the vacuum, it’s reasonable to insist that my vacuum doesn’t have the potential to become a person. It’s only when the potential is *intrinsic* to the object, like the DNA that grounds a baby’s potential to become an adult human being, that the object can be said to have the potential to become something other than what it is. The same reasoning applies to sperm and egg cells, since each has only half the DNA required to make a human being, each is like a cat without serum or a vacuum without an intrinsic particle replacement device, not worthy of any special moral consideration. Only when they (sperm and egg) are joined do they form a zygote, which is an object with the potential *within it* to develop into a human being or a person. Thus, it is the *intrinsic* potential of embryos that grounds their special moral status and avoids the moral status explosion problem (or so Harman argues).

 Unfortunately, the explosion problem can’t be avoided so easily. Even if we accept Harman’s argument and constrain the notion of potential such that A is potentially B only if A has within it the plans for developing into B, we’ll still be forced to extend moral protections to all sorts of objects that don’t obviously warrant them. Since nearly all of a human being’s cells are diploid—meaning they have the entire DNA sequence embedded within them (in contrast to haploid sperm and egg cells)—and since there are a variety of methods for turning ordinary somatic cells into cells with the potential to develop into human beings, it would seem that nearly all of our cells warrant moral protections. After all, nearly every cell in our body has *within it* the plans required for developing into a human being.

 One might resist this conclusion, and thereby avoid the problem I’m pressing, by insisting that somatic cells do not have the same potential as embryos (even if their DNA is the same). The idea is supported by noticing that an awful lot of manipulation is required to turn somatic cells into cells with the potential to develop into human beings. As Andre McGee argues, “intrinsic power refers to that which would actualize itself in the appropriate circumstances without any artificial or technological intervention” (2014, 703-4). Somatic cells seem to lack this “intrinsic power” because they require artificial or technological intervention to develop into a human being. The same is not true of embryos, however. All they need is the nurturing environment of the womb to develop into a human being. Consequently, they must have a unique (intrinsic) potential not possessed by somatic cells.

An analogy will help to make the point and locate the intuition that justifies treating somatic cells differently from their embryonic counterparts. Acorns seem to possess the unique potential to become oak trees. Sure, they need decent soil and water to grow into oak trees, but that dependence, like an embryo’s dependence on a womb, does not undermine an acorn’s oak-tree potential. Sunflower seeds, on the other hand, don’t have the potential to become oak trees and that difference in potential isn’t undermined if we could turn a sunflower seed into an oak tree by poking, prodding, and manipulating its DNA. Similarly, embryos have a potential different from that of somatic cells because the latter (but not the former) require a lot of poking, prodding, and manipulation in order to possibly grow into a human being. As John Fisher explains, “[P]otentialism is teleological in the sense that it views the goal as *built into* the process, as present from the beginning” (1994, 265).[[8]](#footnote-8) Since the manipulation required to turn somatic cells into cells with the potential to develop into human beings indicates rather obviously that they don’t have what it takes to develop into a human being “from the beginning,” somatic cells do not have the same potential as embryos.

 This is an important objection. If the intuition motivating the objection is correct, if it is true that somatic cells lack the unique potential of embryos because they need to be manipulated to develop into human beings, then the argument I’ve been making is significantly weakened. But is it true? Can the idea that some cells are unique because they needn’t be manipulated bear the weight necessary to distinguish embryonic cells from their somatic counterparts? Maureen Condic and her colleagues (2009) believe so. Indeed, they argue that embryonic cells are uniquely totipotent and it is for this reason that they needn’t be manipulated in order to develop into human beings. As with earlier attempts to locate the unique potential of embryonic cells, however, I believe Condic’s view is mistaken.

***The Illusion Of Autonomy***

According to Condic et al. (2009), an embryo’s potential to give rise to any cell type—its totipotency[[9]](#footnote-9)—gives it a kind of autonomy not found in any other cell. But what explains embryonic totipotency? Well, it won’t be DNA, since embryos and every other cell in our bodies have it. As a result, Condic et al. suggests that the proteins, mRNA and other regulatory molecules in the oocyte cytoplasm, as well as “the three-dimensional arrangement of these factors” are the basis of an embryo’s totipotency. Indeed, the proteins, regulatory molecules, and their three-dimensional arrangement “are absolutely required elements of totipotency” (Condic et al. 2009, 39). As Condic explains, “Producing a mature organism [like a human being] requires the ability to both generate all the cells of the body and to organize them in a specific temporal and spatial sequence, that is, to undergo a coordinated process of development” (2014, 796). Very few cells have this ability. Indeed, only embryos are capable of making all of the cells of a human being and organizing them into a coherent whole.[[10]](#footnote-10) Cells produced after that early stage (up to the early blastocyst) are able to produce all or most human cells, but they lack the ability to self-organize into a coherent body plan and cells at the expanded blastocyst stage are even more limited.

What all this seems to show is that there is something special about embryos. The reason they needn’t be manipulated while somatic cells do is because the latter lack totipotency. Consequently, embryos seem unique in their potential and since most human embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) lack the ability to self-organize into an integrated body plan (presumably because they lack the elements required for totipotency), they too are not equivalent to embryos and are *not* potential human beings. If Condic is right about all this, she has substantiated the distinction between embryos and other kinds of cells and provided a basis for avoiding the moral status explosion problem I’m trying to press. There is no moral status explosion if cells that must be manipulated in order to develop into a human being don’t obviously warrant moral protection.

 However, as I’ve mentioned, I don’t believe Condic’s argument is correct. First, technological and scientific developments perpetually undermine the purportedly peculiar properties of embryos, thereby eroding their warrant for special moral protection. It’s as if scientists were perpetually showing that vacuums (or ordinary human cells) actually have built-in particle replacement devices (DNA, mRNA, cytoplasm, autonomy, or…whatever) that, when appropriately triggered, can turn them into things warranting moral status.

This is already happening to Condic’s claim that embryos are peculiar in their capacity for self-organization. Gastruloids are models of embryonic development constructed out of human pluripotent stem cells (hPSCs). The latter have been successfully used to form complex organoids—i.e., clusters of cells that self-organize in ways that mimic tissue and organ function. More recently, scientists discovered how to exploit these self-organizing capabilities to model a gastrulating embryo. In fact, recent experiments (see, Warmflash et al. 2014; Peng-Fei Xu et al. 2014) have shown that the self-organizing patterns of embryos can be induced without any supporting maternal tissues by simple confinement. As Marta Shahbazi and Magdalena Zernicka-Goetz explain, “A geometrical controlled culture and a chemical cue (bone morphogenic protein 4, BMP4) are sufficient to generate ring-like arrangements of different cellular fates, similar to those observed at gastrulation” (2018, 884). And Warmflash et al. write, “Our results show that simple confinement of hESCs to a disk-shaped region is sufficient to recapitulate much of germ layer patterning” (2014, 852). What this shows is that the purportedly intrinsic self-organizing peculiarity of embryos can be replicated in hESCs by simply placing them in the right environment. An extrinsic environmental trigger is able to set off what was thought to be intrinsic and peculiar to embryos. Of course, scientists have known for some time that the activation of the typical gene cascades, which begin the early embryonic pattern formation leading up to the emergence of a basic body plan, were strongly dependent on environmental conditions.[[11]](#footnote-11) What’s new in the Warmflash et al. experiments is that it now looks like hESCs acquire the self-organizing capacity just by being confined to circular geometries (and incubated with a bone growth factor). As the environmental assistance required is reduced, it looks like the cells *themselves* are more autonomous. Hence, what Condic thought was unique to embryos actually seems to be a function of the environment typical of embryonic development. And in the right environment, hESCs seem to have the same potential as embryos.

 Still, Condic et al. are skeptical. They respond to this sort of objection by insisting that embryos still have something that other cells don’t. They are special in that they have full autonomy: they can produce an entire organism *on their own* (without the help of geometric confinement and bone growth factors), including building their own extra-embryonic organs, e.g., a placenta. Other cells don’t have this sort of autonomy and can only undergo a process of development with help from factors extrinsic to the cell. We can put this response in terms of the earlier analogy: embryos (like acorns) have the autonomy to grow into something without external manipulation. Sure, they need a nurturing environment to do so, but the power to do so comes from within. In contrast, since hESCs (like sunflower seeds) need to be poked, prodded, and manipulated to develop in the appropriate way, they do *not* have the potential intrinsically. They lack autonomy. And because only cells that have the full autonomy necessary to grow into a human being warrant special moral status, only embryos warrant special protection.

But this response is misleading, which leads to my second objection to Condic’s view. Several authors have recently argued that there is no such thing as a fully autonomous cell (cf. Denker 2014, Devolder and Harris 2007, Magill and Neaves 2009, De Miguel-Beriain 2015, Testa et al. 2007, Sagan and Singer 2007, Stier and Schoene-Seifert 2013), because *all* cells, including those of an embryo, need help from the environment to grow into an organism. Consequently, it’s misleading to insist that hESCs are not fully autonomous because they need help from the environment in order to activate their developmental potential. All cells need help from their environment, which is to say that no cells are fully autonomous.

To be fair to Condic, however, perhaps she means her claims about the autonomy of embryos to be understood only in the context of a neutral environment. That is, embryos are uniquely fully autonomous because, when placed in a neutral environment, they have the capacity to self-organize and develop into a human being. But even on this more charitable interpretation, her claims are mistaken. As Hans-Werner Denker points out, “it is difficult or even impossible to construct a completely neutral environment” (2014, 226). Any environment is going to be either “destructive” or “instructive” which will either help or hinder a cell’s development.[[12]](#footnote-12) Consider, for example, that when human stem cells are injected into the destructive environment of a strain of inbred, immunodeficient mice, the cells give rise to tumors characterized by all three germ layers and eventually develop misplaced fat, muscle, skin, nerves and even teeth. This shows that when placed in a destructive environment, stem cells continue to recapitulate early embryonic development but in a “disordered” manner. According to Melinda Fagan, there are three aspects to this disorder:

First, the set of specialized cells and tissues that appear varies across tumors; pathological development is not robust, on a cellular level. Second, the specialized cells and tissues that appear are not arranged into functional organs; this mode of development is not robust at the organ level either. Finally, the specialized cells and tissues of a teratoma are not arranged so as to constitute an autonomous organism; robustness is lacking at the organism level. (2017, 18)

The opposite effects occur when we place stem cells in an instructive environment. In the Warmflash et al. experiments, the stem cells were able to differentiate into the three germ layers and they spatially organized into a basic body plan (with an anterior/posterior axis), mimicking gastrulation. While these “quasi-embryos” (Fagan 2017, 15) do not resemble embryos anatomically, according to Fagan they exhibit several aspects of embryonic organization: “robust timing and order of appearance of cell types, a reproducible spatial arrangement of germ layers, and polarity along the radial axis” (2017, 15). Moreover, when Condic et al. claim that stem cells do not have the autonomy of embryos because “the innate potency of stem cells is to produce tumors, not fetuses” (2009, 36), they seem to be forgetting that embryos, too, will develop into tumors if they are not provided the instructive environment of a uterus. When embryos are transferred to the destructive environment of an extrauterine site (e.g., under the kidney capsule) they don’t receive the external biochemical triggers required to develop into a fetus. Instead, they develop into tumors (Damjanov and Solter 1974; Sherman and Solter 1975).

 The point is that if embryos are ‘fully autonomous’ in the sense that they will develop *of their own power* into what they are supposed to be*,* then they lack the autonomy they are purported to possess. Whether a cell develops at all, whether its descendants are differentiated but jumbled, or spatially organized and able to form a single, multicellular organism, depends on features of the environment. As Fagan explains, the identity of embryogenerative cells is “context-dependent,” their fates depend on the “geometry, biochemical composition, or cellular makeup of their environment” (2017, 19). It seems then that all cells, including embryos, need an instructive environment to develop into a human being. Sometimes the environmental trigger is nutrition, sometimes it’s a cocktail of transcription factors, sometimes it’s a uterus, and sometimes it’s geometrical confinement. But given the importance of environment in realizing cellular potential, it doesn’t make sense to insist that some cells have a certain potential that others lack given a unique environment. Every cell has a different potential according to the environment in which it is found and there is no uniquely neutral environment by which we can determine the actual potential of cells.

 This conclusion may strike some as counterintuitive. It violates the widely held intuition that—to return to our analogy—there is a natural order dictating that certain things (acorns, embryos, whatever) unfold according to their intrinsic potential. But this intuition is an artifact of our pre-biotechnological past and cannot stand in the face of scientific and technological innovation. As Fisher points out, “Many developmental paths are possible (causally and even biologically conceivable), and this ‘open’ or unformed character of the embryo is as much a part of its nature as that it will as a matter of fact develop along a particular path” (1994, 267). Fisher’s point is consistent with recent empirical findings. Most embryos do not develop into babies; more than half perish between fertilization and birth (Jarvis 2016). Thus, while it might be intuitive for us to believe that it’s in an embryo’s nature to develop into a human being, the more accurate picture is the one for which I’ve argued. The fact is that our concern for the moral status of innovatively produced cells arises from our capacity to interact with them, to alter their environment, to poke, prod, and manipulate them, to stimulate in some ways and inhibit in others. Insisting in the face of this interaction that certain clumps of cells have some nebulous, impossible-to-pin-down intrinsic property that warrants affording them special protection misses the motivation for thinking about these issues. Either everything that falls within the category of things with the potential to develop into a human being needs special moral protection or we need to rethink the basis of extending moral protections to biological entities. Since a variety of human cells have the potential to become adult human beings given the right instructive environment, there is no sense to be made of the idea that embryos have some unique potential that warrants affording them special moral status.[[13]](#footnote-13) More plainly, the potentiality question cannot be resolved without ignoring the innovations driving the question. Consequently, we need to begin the task of rethinking the basis of extending moral status to the biological entities used in such innovations.

**Avoiding the potentiality trap**

I’ve argued that there is no reasonable way to distinguish the unique potential of embryos. Without that distinction, we lose the conceptual tools required for differentiating embryos from non-embryos and it follows that asking whether an object like a gastruloid is or isn’t similar enough to embryos to warrant the moral status of embryos is to ask a question without an answer. We can’t make a comparison without knowing how to demarcate the comparison class.

In light of these observations, we need to consider anew what should ground ethical research on gastruloids and other synthetic embryos. One suggestion, which doesn’t rely on the similarity of gastruloids to embryos, recommends that the intention of researchers be the most salient consideration when determining how embryonic models should be treated. For example, Nicolas Rivron and colleagues write:

[W]e think the intention of the research should be considered the key ethical criterion by regulators, rather than surrogate measures of the equivalence between the human embryo and a model. This was the approach taken with cloning. In the late 1990s and early 2000s, many nations prohibited human reproductive cloning, but did not ban the transfer of nuclear material from a somatic cell to an egg to produce a blastocyst and generate lines of stem cells. Here, the key consideration was the intention of the study rather than whether the clone was equivalent to a natural embryo. (2018, 185)

The idea is to determine how an embryonic model should be treated by thinking about what it will be used for, rather than about whether it is an embryo. The intention of the research ought to be the key ethical consideration.

Although this suggestion seems to avoid pinning the moral status of biological entities on their potential to become human beings, it may still fall prey to a version of the potentiality trap I’ve been pressing. Let me explain. It is plausible that the intention of researchers makes a moral difference to the status of an embryo (or embryonic model) only because the aims of the research directly influences the type of environment the model may find itself in. Some research environments will be more (and some less) suited to the model’s biological development. Elselijn Kingma makes the point explicit when she writes, “the location of an embryo—whether it is in a pregnant woman or in a petri-dish—may affect its moral status and/or value” (Nuffield Council on Bioethics 2017, 73). In other words, depending on the intentions of researchers, the context in which the embryo is situated may be better (or worse) at helping it reach its full potential. As Bernard Baertschi and Alexandre Mauron write:

Embryos created for the express purpose of being used in research will have a lesser status than embryos created in the context of infertility treatment. The two may have the same intrinsic properties, yet only the latter embryos can look forward, as it were, to a personal future: the relational properties are clearly different. (2010, 102)

But such arguments suggest that an embryo’s potential is what actually matters and that, to the extent that a research project’s intention influences that potential, it may also matter morally. Indeed, if I’m reading these arguments correctly, the intentions of researchers and the aims of their research projects are not what are morally salient—that is, the intentions of the researchers are not foundational for determining the moral status of the biological entities they are using in their research. Rather, intention is subsidiary to something more fundamental, which in these cases seems to be embryonic potential. Not surprisingly, I find this problematic. As I’ve argued, an embryo’s potential can’t be what grounds its moral status because almost all the cells in a human body have that same potential, leading us to an absurd conclusion in which almost all cells warrant special protection.

There is a better way to think about the influence of intentions when determining the moral status of embryonic models (or embryos). On this alternative, the intentions of researchers are not (contrary to Rivron et. al.) morally salient per se (and they are certainly not the key ethical consideration). Instead, the intentions of researchers should only be considered if they influence the likelihood of a biological entity developing properties that are morally relevant. These properties could include any number of things—e.g., public safety, the rights of donors, respect for progenitors, privacy concerns, and so on. In any case, the key focus of regulators should be on whether an object of research exhibits actual, rather than potential, morally relevant properties.

What properties do I have in mind? One possible candidate, proposed by Aach et al. (2017), is the appearance of neural substrates and the functionality required for the experience of pain. The development of what’s required for the experience of pain would, on this proposal, be sufficient for triggering regulations that restrict further research. Alternatively, we might want to opt for less stringent regulatory guidelines. Perhaps the appearance of neural substrates tied to pain experiences is too strict and, instead, we should only impose regulations on biological entities that exhibit pain responses. Or perhaps that’s too broad and we need something narrower. I don’t know. There is much to be discussed here, all of which is beyond the scope of this paper. My point is simply that only after we determine what properties are morally salient—whether it’s the capacity for pain or something else—should we turn our focus to the researchers’ intentions. The researchers’ intentions are relevant only insofar as they can help us determine the likelihood that their embryonic models will develop morally salient properties. And it is the appearance of those properties, rather than their potential appearance, that should be the basis of extending moral status to the biological entities used in research.

**Conclusion**

Ethics committees must sometimes decide how entities that don’t fit nicely into existing categories of research should be treated. The typical solution to this problem is to look for similarities between the new entity and entities that already have established research guidelines. When it comes to gastruloids, the obvious comparison class is the human embryo. However, I’ve argued that since we don’t have a non-absurd definition of ‘embryo’ (and we haven’t had one for decades), comparing gastruloids with embryos in order to determine how they should be treated is unhelpful. Instead, we should focus on the actual properties possessed by gastruloids and other synthetic embryos when making decisions about how they should be treated.

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1. Gastruloids belong to a growing category of SHEEFs (Synthetic Human Entity with Embryo-like Features), an acronym coined by Aach et al. (2017). [↑](#footnote-ref-1)
2. Throughout the paper, I’ll be using ‘embryo’ instead of ‘human embryo’ for the sake of brevity. [↑](#footnote-ref-2)
3. Part of the interest in the question surely arises because the answer influences how these entities will be regulated. If gastruloids were considered embryos, they would be subject to the 14-day rule. In more than a dozen countries—including the U.S.—*in vitro* research on human embryos is restricted to the first 14 days of development, or the period before the appearance of the primitive streak. Recently, scientists managed to sustain human embryos *in vitro* for 12-13 days (Deglincerti et al. 2016, Shahbazi et al. 2016)—almost double the duration of what’s been possible prior to 2016—and this success has prompted requests to extend or at least revisit the 14-day rule. But whatever the limit ends up being, the relevant point for our purposes is that it will also apply to the gastruloid. That is, *if* gastruloids are functionally akin to human embryos, on the basis of that resemblance they’re likely to be subject to whatever research restrictions apply to human embryos. [↑](#footnote-ref-3)
4. The claim I’m here making has implications for the moral status of “regular” embryos. I’ll not be engaging those implications here. Instead, I aim to focus exclusively on the moral status of synthetic embryos. [↑](#footnote-ref-4)
5. For the legal and regulatory struggles of trying to define ‘embryo’ in the last twenty years, see Baylis and Krahn 2009, Cameron and Williamson 2005, de Miguel-Beriain 2014, 2015, Maienschein 2002, Pera et al. 2015, Peters 2006, Piciocchi and Martinelli 2016, Stanton and Harris 2005. [↑](#footnote-ref-5)
6. Typically, it is ‘persons’ who are afforded special moral status. As a rule of thumb, all human beings are assumed to be persons and only with considerable argumentation will that status be revoked. At death, for example, an individual may stop being a person, even if he is still a human being. It’s on this basis, presumably, that post-mortem autopsies are ethical. Some non-humans may be persons (God, the angels, and corporations, perhaps) but generally, non-human members of the animal kingdom are assumed not to be persons. It’s for this reason (again presumably) that experimentation on mice, monkeys, and a host of other animals is permitted. [↑](#footnote-ref-6)
7. Another problem with the argument from potentiality that I will *not* focus on is the obvious non-sequitur. It does not follow from A’s being a potential B that A should be treated as B (see, Testa et al. 2007, 154-55). For example, the popsicle I’m eating has the potential to be a puddle on the floor, but I shouldn’t start licking the floor because of that fact. [↑](#footnote-ref-7)
8. Another way to argue that potential is inherently teleological is to tie it to natural selection. McGee, for example, characterizes an entity’s potential as “what the entity has been designed by natural selection to do, what it does, or is for, once it reaches maturity” (2014, 697). [↑](#footnote-ref-8)
9. “Totipotency” is typically defined as a cell’s potential to produce a whole organism and, in mammals, its associated membranes, e.g., a placenta. [↑](#footnote-ref-9)
10. Condic argues that totipotency is a property of the single-celled embryo up to the four-cell stage of embryonic development. So ‘embryo,’ as I’m using it in the context of Condic’s view, refers to any cell up to the four-cell stage. [↑](#footnote-ref-10)
11. That is, scientists have been inducing potency in cells with a more complicated environment—that of a tetraploid embryo—for some time. The procedure is known as tetraploid complementation (or tetraploid sandwich) and involves fusing two cells from the first cell division after fertilization into one cell (with four complete sets of chromosomes, hence the name “tetraploid”). The big, fused cell then grows into a blastocyst. If cells that have the potency equivalent of hESCs are injected into this teraploid blastocyst, and the “blastocyst sandwich” is implanted in a uterus, the embryo proper will form entirely from the injected hESCs. The teraploid cells contribute only to the extraembryonic membranes and placenta. Hence, since the invention of the tetraploid complementation procedure in 1990, scientists have known that cells can gain the potency of being able to create all cells of the body and to self-organize if added to other cells, i.e., to the tetraploid blastocyst. [↑](#footnote-ref-11)
12. McGee (2014) uses “enabling” and “disabling” conditions in lieu of Denker’s “instructive” and “destructive” environments. In contrast to Denker, however, he also argues that the embryo has a true intrinsic potential that can be helped or hindered by these conditions. I disagree with McGee. The fact that en embryo’s potential is context-dependent means that there is no such thing as a neutral environment in which we can judge the embryo’s true intrinsic potential. [↑](#footnote-ref-12)
13. Whether hESCs or hiPSCs could actually grow into human beings has never been tested. Indeed, as Fagan has argued, the evidential constraints of these tests entail that “hypotheses about stem cell capacities (self-renewal and differentiation potential) can never be fully and decisively established by experiments” (2013, 956). My claim, then, that hESCs or hiPSCs could develop in this way rests on the idea that they exhibit properties scientists believe are indicative of having such potential. And, in anyway, all I need to show is that embryos don’t have the potential uniquely, which I’ve done. [↑](#footnote-ref-13)