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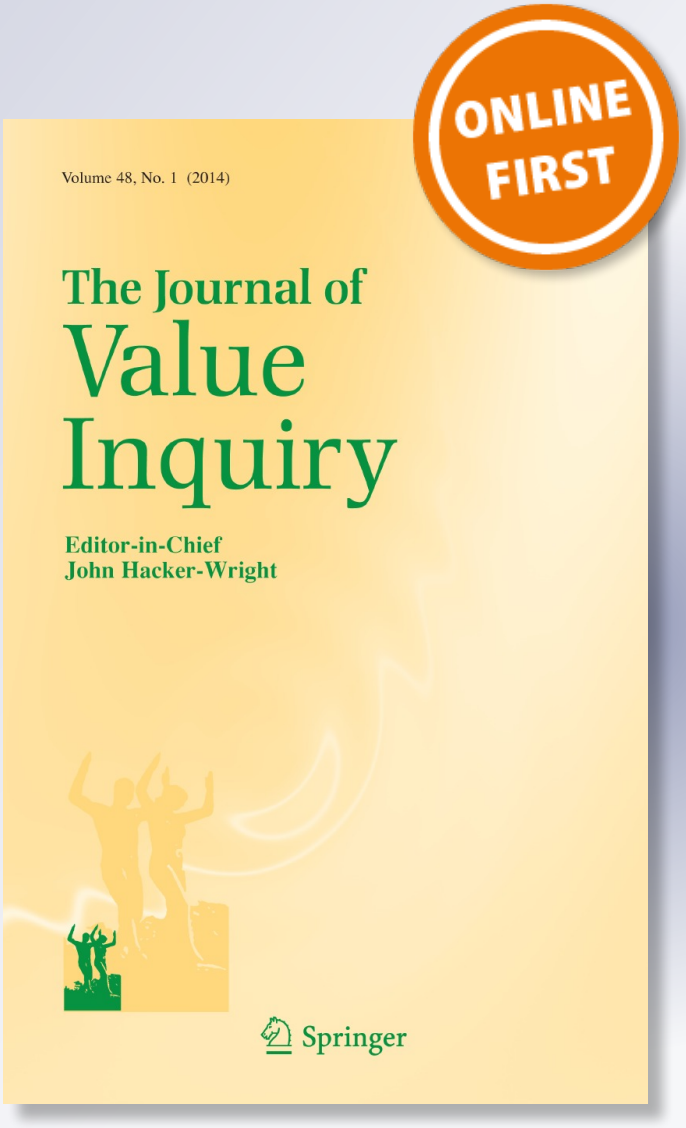
The Journal of Value Inquiry

ISSN 0022-5363

J Value Inquiry
DOI 10.1007/s10790-014-9432-2



Springer

J Value Inquiry
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BOOK REVIEW

Gregory E. Kaebnick and Thomas H. Murray, eds., Synthetic Biology and Morality: Artificial Life and the Bounds of Nature

The MIT Press, Cambridge, Mass., 2013, 214 pp.
ISBN: 978-0-262-01939-2, $21.00 (Pb)

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One way of acknowledging the putative progress of science is to trace its successes with respect to description, manipulation, and genuine innovation. In this regard, the history of genetics can be viewed as an exemplary case study. Indeed, the ground breaking work of Watson and Crick, the remarkable results associated with both describing and manipulating regulatory genes (e.g., early and recent work on Drosophila), and the cutting edge efforts related to nuclear transfer (i.e., cloning) are stunning progress-worthy accomplishments. Yet, there are moral, religious, and social implications of scientific triumphs that may give us pause with respect to ascriptions of progress. For instance, genetic modification, stem cell procurement, reproductive enhancement, and cloning have received a great deal of negative attention from moral, religious, and political factions. These groups have cried foul for a mix of metaphysical, moral, and public policy reasons. There appears, then, to be a somewhat mixed reception with respect to some scientific endeavors and feats—especially those coups commandeered by biotechnology mavens.

It is within this mixed reception that the burgeoning field of *synthetic biology* [SB hereafter] finds itself. Broadly, this discipline's innovative uniqueness is captured not so much by its goals of (1) modifying organism behavior by modifying existing sets of DNA and (2) producing new sets of DNA to assist in the production of novel tasks, but more so by its focus on *creating new organisms from (i) genetic raw material and (ii) from extant parts of living organisms*. For example, Ro et al. (2006, *Nature*) have engineered an *E. coli* bacterial organism that can produce 10,000 times more artemisinic acid (needed for a certain anti-malarial drug) than the natural bacteria that produces this same chemical. They accomplished this by transplanting into the bacteria particular genes from the wormwood plant and yeast fungus. In a

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Published online: 03 May 2014

biological flash, a new organism was created and SB was quickly gaining public attention!

Recently, in addition to clarifying the science of SB, the authors of the nine commissioned essays collected in Kaebnick and Murray's *Synthetic Biology and Morality: Artificial Life and the Bounds of Nature* grapple, to varying degrees, with some of the metaphysical, moral, and social-political issues germane to this rapidly developing sub-discipline of biology. More specifically, the essays focus primarily on the following four topics related to SB: (I) Playing God, (II) Nature, Intrinsic Value, and Moral Value, (III) Moral Issues, and (IV) Public Policy. Andrew Lustig, Joachim Boldt, and John H. Evans pay special attention to (I); Andrew Lustig, Mark A. Bedau and Ben T. Larson, John Basl and Ronald Sandler, Christopher J. Preston, and Bruce Jennings focus on (II); Joachim Boldt, Gregory E. Kaebnick, John Basl and Ronald Sandler, Bruce Jennings and John H. Evans critically engage (III); and Andrew Lustig, Joachim Boldt, Jon Mandle, Andrew Jennings, and John H. Evans tackle (IV). Unfortunately, justice cannot be done to all the intricacies of these essays. Rather, in what follows, a mere critical extraction of the four primary topics (noted in the table above) will be offered with the hope of igniting a modicum of philosophical interest in this fascinating area of inquiry within the life sciences.

1 Playing God

The topic of "playing God" is not a new response to budding advances in biotechnology. Reproductive assistance technologies and stem cell research are clear examples toward which the "playing God" outcry has been directed. In general with respect to SB, Lustig ("Appeals to Nature and the Natural in Debates about Synthetic Biology") reminds us that there are three senses of "playing God": (i) human activity that trespasses into God's domain; (ii) maintenance of proper attitudes (reverence, humility, gratitude, and awe) with respect to God's creations; and (iii) the belief that the world is ordered in a particular fashion (e.g., fixed species and natural kinds) based on God's creations (pp. 24–25). Lustig argues that he finds the force of these objections wanting because they actually mask a diverse set of views within various religious denominations that include humans as co-creators with God leading the way (pp. 28–29). In addition to Lustig's points, Kaebnick ("Engineered Microbes in Industry and Science: A New Human Relationship to Nature?") adds that encroaching upon God's creation of life reflects, in particular, a lack of acknowledgement of the "specialness" of life imparted by God onto matter. Kaebnick replies that this worry is misguided because the creation or destruction of X does not, by itself, reveal how we ought to understand X. Rather, argues Kaebnick, it is quite possible that the set of values of life we hold for naturally occurring organisms could be the very same set we hold for SB-created life forms (pp. 55–56). Finally, along with Kaebnick, Evans explains that the real "playing God" worry is that of humans thinking of themselves as creators like God. Evans ("'Teaching Humanness' Claims in Synthetic Biology and Public Policy Bioethics") goes on to quell this objection by pointing out that empirical evidence already reveals that people *do* understand themselves as creators so their self-image will not

likely change in the light of the creations put forth by SB. In fact, Evans questioned 180 religious congregations throughout the United States about the new "biotechnology Frankensteins." He concludes from his findings that so long as the goal is to contend with disease, as opposed to the goal of producing new human enhancements, religious groups acknowledge and endorse biotechnology advances. With respect to SB, Evans points out that "the ability of synthetic biology to create life itself for ends that we have already assigned to ourselves as humans…will not be seen as a new ability of the human" (p. 195).

These authors have done a fine job of tackling the "playing God" objections to SB. Not only have they shown that most of these renditions do not withstand philosophical scrutiny, they have also revealed that some of these objections are really caricatures of views that are not endorsed by many religious camps. It is worth noting, however, that the authors could have done a better job of injecting the Darwinian perspective into this discussion. Lustig and Evans hint at the evolutionary counter-point, but offer no sustained argument. For instance, some of the natural kind or unchanging essences assumptions that motivate some of the playing God objections are rendered moribund in the light of humans sharing an evolutionary history with the rest of life on Earth. Specifically, the truth of Darwinism includes the idea that variation is present with respect to *all* organism traits. If natural selection is crucial to species evolution, which it is, then variation within species must be present so that selection can do its work. Yet, it is just this core presence of trait variation that tells against immutable essences. The upshot is that those "playing God" criticisms against the practices of SB that rely on immutable essences must be jettisoned.

2 Nature, Intrinsic Value, and Moral Value

Five of the authors in this collection address the topic of intrinsic value and how it pertains to the concepts of nature, morality, and SB-produced entities. This section will focus on the efforts of Bedau and Larson ("Lessons from Environmental Ethics about the Intrinsic Value of Synthetic Life") and Basl and Sandler ("Three Puzzles Regarding the Moral Status of Synthetic Organisms"). Bedau and Larson wish to determine, upon granting inherent intrinsic value to evolutionary entities, whether or not SB-produced entities have any sort of intrinsic value that is worthy of moral consideration (p. 70). After distinguishing three senses of intrinsic value, (i) intrinsic subjective value (value imposed by cognizing agents), (ii) intrinsic objective value (value possessed by X in and of itself), and (iii) inherent worth (a good possessed by X that should be recognized as a good by those beings capable of such recognition), Bedau and Larson conclude that SB-produced entities can possess each of them. The first sort of intrinsic value seems trivially true; that is, cognizing agents could offer all sorts of value judgments about SB-produced entities in terms of their beauty, utility, complexity, etc. Additionally, Bedau and Larson claim that so long as X (e.g., Grand Canyon) has some set of systemic or structural properties (e.g., complexity, diversity, self-regulation, spontaneity, etc.), then X will be said to have intrinsic objective value (p. 78). Finally, if inherent worth is understood in terms of

entities being able to secure various sorts of physical needs and interests (related to reproduction, self-protection, group-level roles, play, etc.), then so long as SB-entities engage in these interest-satisfying behaviors, then they will be thought to possess inherent worth.

Notice that both inherent worth and intrinsic objective value are kinds of intrinsic value that are intimately tied to the biology/physicality of the entity under consideration. Unfortunately, Bedau and Larson do not explain or defend how the various sorts of biology and physicality can produce a kind of intrinsic value that is independent of cognizing agents. They explicitly assume that this is true (p. 72), relying upon the work of those in the environmental ethics and evolutionary biology camps. For example, even if it is granted that the Grand Canyon is complex, self-regulating, and diverse, it is not all clear how an additional value-laden property is made manifest by such complexity, self-regulation, and diversity. The same can be said for the E. coli organism created by Ro, et al. The authors assume that such value comes into existence, but offer no defense of why one should think that such a value is part of nature's ontology. Moreover, even if it is granted that inherent worth and intrinsic objective values have ontological clout, it is still a separate matter as to whether or not such values include a moral dimension. Again, the authors do not address this issue in their article. Finally, the reader will need to work hard to determine whether or not there is a genuine difference between inherent-worth-value and intrinsic-objective-value. It appears that the latter gives scope for non-sentient beings to possess intrinsic value, while the former is restricted to sentient beings. Bedau and Larson could have done more to make this distinction clear.

Interestingly, in what can be viewed as an attempt to address some of the worries noted above, Basl and Sandler draw upon teleological considerations in order to ground inherent worth/intrinsic value of both sentient and non-sentient organisms in a "nonarbitrary and nonderivative" way. Their solution is to endorse the etiological concept of function. Their reasoning is that organisms can be understood to have inherent worth based on goods that promote their life-sustaining ends. Since nonsentient beings cannot rely on the presence of a psychology to help determine the intrinsic normative content of their goal-promoting ends, they claim that an etiological (i.e., causal history) account is the best (p. 96) and only reasonable alternative (p. 102). Their defense of the etiological account is that it best accounts for the presence of a feature by revealing the selected effects produced by that feature. It is the retention of the feature in the light of its beneficial effects that accounts for the features continued presence. As Basl and Sanders illustrate, "one of the ends of the leaves of plants is to gather energy from sunlight; therefore, it is good for a plant that it have access to sunlight" (p. 93).

Although the infusion of the etiological account is to be commended, it is not without its difficulties. It is true that the etiological account allows for distinguishing genuine functions (e.g., the heart's pumping of blood) from accidental side-effects (e.g., the thumping sound of the heart) because a genuine function is a trait whose presence can be adequately justified by way of an evolutionary selection account. Its reliance on history, however, to defend this allowance is costly. Primarily, the etiological account is forced to attribute function to those entities that no longer possess a function by virtue of a selective history that produced the function. For

example, the human appendix no longer has a function. Yet, since the etiological account relies exclusively on selective causal history, it is forced to attribute a set of functions to vestigial organs like the appendix. As Nissan puts the worry, "Since history is forever, if functions are determined by their history, functions are forever. New functions can be added, but old ones never die" (1997, p. 185). Additionally, the etiological account is forced to accept the highly counterintuitive view that beneficial acclimations that can assist in keeping an organism alive cannot be considered genuine functions. So, if a swamp man creature suddenly emerges out of its slimy pond and successfully maneuvers like its historically created human counterparts, it cannot be said to have a set of genuine functions because of its lack of a selective causal history. These two objections—and other ones—have pushed other scholars to endorse alternative selection accounts (e.g., propensity theory, system effects theory, or openly mixed accounts). At the very least, the authors should have considered these objections and alternatives toward a rigorous defense of their normative-driven etiological account. Finally, even if it is granted that the etiological account is correct and allows for the attribution of inherent worth, it still remains to be explained why such inherent worth takes on a moral dimension. So, even granting that sunlight is a good needed for a plant, it does not follow that a moral obligation is present and/or mandated by such a good. Indeed, Preston ("Synthetic Bacteria, Natural Processes, and Intrinsic Value") complicates matters by arguing that the dual teleological nature (i.e., both natural and artifactual) of SB-entities weakens their overall inherent worth relative to naturally occurring non-manufactured organisms (pp. 119–123).The upshot is that the moral status of SB-produced organisms remains to be determined even after allowing for a teleologically-driven normative aspect to their nature.

3 Moral Issues

There are a diverse set of issues pertaining to the morality of SB beyond the teleology and intrinsic value discussions in the previous section. For example, Boldt ("Creating Life: Synthetic Biology and Ethics") stresses that determining the moral status of an organism is tied to the ability of the organism to act for the sake of reasons in the sense that it is "capable of sharing a perspective on what may count as enjoyable and good" (p. 42). He goes on to suggest that this shared perspective or mutual understanding is properly understood in terms of suffering pain. As he expresses it, "The ontological assumption that someone suffers pain thus is rooted in the perspective of shared subjective and normatively relevant experiences" (p. 43). Yet, granting a shared evolutionary history, it is clear that a common perspective regarding suffering will turn out to be a difference of degree as opposed to a difference in kind. Thus, we may very well bequeath moral status to primates, but hesitate to do so to paramecia. Still, Boldt concludes that "the challenge amounts to deciding at what step on the ladder of life one is going to insist on the inherent normative value of the entity under scrutiny" (p. 44).

Although he offers little by way of a resolution to this normative ladder-of-life problem, Boldt is correct to point it out. It is a similar kind of problem that plagues

the teleology approach noted above. At present, however, since SB-entities are non-sentient micro-organisms, their moral status is not really a concern. Still, if SB is able to produce complex biologically developed entities, then how much closer these entities are to complex mammals than micro-organisms will be of great concern. Of course, all of this further assumes that sentience is the kind of moral difference maker that Boldt claims it is. As we know, debates surrounding animal welfare and environmental ethics more generally reveal that reliance on sentience as a moral divider of the natural world is not accepted as trivially true.

Leaving to one side this dual metaphysical and moral quandary, both Boldt and Kaebnick stress that great care must be taken with respect to the release of SB-entities into the natural environment. Boldt's emphasis that our over-confidence in the environment's ability to assimilate SB-organisms (p. 45) and Kaebnick's cautionary stance regarding our potential arrogance as "creators of life" may erroneously move us in the direction of eschewing the unpredictable bad effects of novel SB-entities interacting within local environments (pp. 58–59).

This worry by Boldt and Kaebnick is on the mark. Similar arguments have been offered by many in the environmental ethics camp with respect to various species preservation/control strategies involving the introduction of natural (i.e., non-SB organisms) organisms in new environments. Part of the concern is tied to potential gross disruption of local food chains and possible unforeseen escalation in spread of diseases. Thus, even granting the potential benefits of SB-produced organisms to human and non-human lives, small scale environmental SB-organism introductions and on-going lab experiments must be closely monitored.

4 Public Policy and the Practice of SB

The final third of this collection focuses on practical policy decisions related to SB. Although Lustig, Boldt, and Evans offer insightful glimpses into the public policy aspect of SB, this section will focus on the efforts of Mandle ("Synthetic Biology and Public Reason") and Jennings ("Biotechnology as Cultural Meaning: Reflections on the Moral Reception of Synthetic Biology"). Mandle begins his essay by claiming that the sundry answers given to the religious, metaphysical, and ethical concerns surrounding SB are independent of the direct policy-driven resolutions and implications surrounding SB. Drawing upon John Rawls' concept of *public reason*, Mandle tenders that societal decisions brought to fruition via political institutions ought to be submitted by way of reasons that can be shared by reasonable citizens—citizens that may very well disagree on fundamental issues (pp. 136–139). So long as people treat one another as free and equal persons and they do so in an environment that fosters a fair system of cooperation, robust political values and public goals can be endorsed—even in the presence of reasonable disagreement—by correspondingly good public reasons. In terms of SB, public reason would require eschewing concerns about playing God, moral repugnance, or intrinsic value in determining public policy issues. Rather, argues Mandle, concerns related to, for example, (i) the physical and mental well-being of children, (ii) environmental risk, and (iii) the idea of equal opportunity constitute the kinds of topics that can be

debated about SB-products within public institutions without injecting heavy-handed metaphysical, moral, or religious ideals (pp. 142–144).

In contrast to the foundational neutrality defended by Mandle, Jennings argues that SB technology sends the wrong message about the nature of humanity. Specifically, Jennings claims that humans are fundamentally "embodied, embedded, and 'natured' creatures" (p. 167). For humans to wield the kind of power to create virtually new life forms, argues Jennings, is to ignore the potential cultural and social transformative force of wantonly actualizing such power. What Jennings means by all this is that humans are inextricably tied to "a larger network of life" as part of a shared evolutionary history. The SB project of introducing new species or radically modified organisms into the complex web of life, argues Jennings, could not only wreak havoc with existing biological constraints and complexity, but also debilitate human societies at both the local and global levels. With these worries in mind, Jennings offers the following four recommendations related to SB's potential and actual gerrymandering of life: (i) provide an appropriate label that honestly captures the risks related to SB; (ii) embrace a critical, progressive, and social democratic perspective with respect to biotechnology and SB; (iii) the ethical reflection on SB should resemble the kind of ethical reasoning that currently dominates ecology, conservation biology, and environmental policy; and (iv) regulatory practices regarding biotechnology should be framed as a global governance concern (pp. 169–172).

Putting to one side the differences between Mandle and Jennings, both scholars appear to assume a rule-utilitarian moral framework with respect to public policy. Broadly, so long as adequate attention has been given to (i) the physical and mental well-being of children, (ii) the balance of ecosystems, (iii) ecologically based moral assumptions, and (iv) the allowance of rigorous democratic debate as a response to mass-implementation of biotechnology, SB activities should be endorsed cautiously with all appropriate safeguards. This will take on a more public appeal as the kinds of SB-organisms created become more and more creative. As Evans points out, people may not mind viewing humans as socially-minded creators, but they may very well mind if that creativity moves in the direction of abusive enhancements or unchecked curiosity tinkering (pp. 192–197). These suggestions are eminently reasonable. Indeed, for example, implementation and adjustments of various kinds of public policy safeguards have already been put into practice for a number of years in the cases of voluntary active euthanasia, in vitro fertilization, animal experimentation, embryonic stem cell research, human experimentation and clinical trials, organ donation, cloning, and management and access to medical data. No doubt, regulations within all of these areas will continue to be modified in the light of further advancements and abuses. SB will have a similar trajectory within its unique practices.

The comic book expression, "With great power comes great responsibility," is an apothegm that is not without some merit. What was once a set of imaginative science fiction fantasies with respect to modifying and creating life may very well prove to be realities as SB and other biotechnologies continue to make groundbreaking advancements. The result is that many traditional boundary lines (e.g., natural/artifactual, creator/manipulator, facts/values, etc.) may need to be

redrawn or erased altogether. Still, oversight of the power of these new technologies will require a kind of globally-shared moral, social, and political shrewdness suggested by most of these authors. Given the production of novel organisms as a linchpin to these SB discussions, Boldt correctly reminds us that "generating reliable rules and methods for risk assessment will be one of the most pressing endeavors in order to promote the responsible utilization of synthetic organisms" (p. 47). Undoubtedly, the issues broached by these authors will very likely be some of the core concerns as the genuine innovations of SB continue to advance and gain greater public awareness and scrutiny. With this in mind, Kaebnick and Murray's *Synthetic Biology and Morality* provides a very good starting point for the uninitiated and an excellent teaching tool for those well-schooled on the issues.