Adaptive Design, Contingency, and Ontological Principles for Limited Beings

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Transcendental arguments are not popular in contemporary philosophy of science. They are typically seen as antinaturalistic and incapable of providing explanatory force in accounting for natural phenomena. However, when viewed as providing (certain types of) intelligibility to complicated concepts used in scientific reasoning, a concrete and productive role is recoverable for transcendental reasoning in philosophy of science. In this article I argue that the resources, and possibly the need, for such a role are available within a thoroughly naturalistic framework garnered from the work of Hasok Chang and William Wimsatt.

> I strongly doubt that Kant will ever be naturalized. (Callebaut 2005, 114)

1. Introduction. Transcendental arguments, most often associated with Immanuel Kant, are widely unpopular in contemporary philosophy of science. In philosophy of biology, they are actively dismissed. At a first glance, this dismissal squares nicely with the naturalist spirit in which philosophical analysis of science often proceeds: ideas like 'necessary', 'a priori', and the like are uncomfortable tools in a naturalized toolbox. However, the promise of deriving some kind of *intelligibility* or *coherency* for research activities linked to complicated scientific concepts that are difficult to empirically test might be one concrete and productive role that transcendental reasoning could provide for scientific purposes.

In this article, I wish to revisit the prospects of a Kant-inspired naturalist framework for constructing "contingent transcendental arguments" (Chang 2008) in the context of contemporary biology. I will not offer an exegesis or apology

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for Kant's work but rather extend several revised elements of transcendental argument structures, already pioneered by Hasok Chang (2008, 2009), to adapt such arguments to the circumstances of biology. The key elements of my extension are twofold and concern Chang's idea of "ontological principles." First, the role of 'necessity' in transcendental reasoning must be reconciled with the overarching predominance of *contingency* in the evolutionary history and development of living systems.[1] Second, the revisability of our postulated principles offers cautionary tales for any aim to understand why our epistemic activities are performed successfully. Any candidate ontological principles invoked to ensure necessity in a transcendental argument must reflect these two conditions.

The structure of this article is as follows. First, I will review the most common arguments in philosophy of biology speaking against transcendental arguments (sec. 2). I turn then to articulating some revisions required to naturally invoke transcendental arguments, particularly in biology, in light of work already provided by Chang (sec. 3) and, following this, recovering some notion of necessity in the face of contingency and revisability (sec. 4). Here I draw especially on Wimsatt's apparatus of adaptive design and specifically his notion of generative entrenchment. I conclude with some upshots about the usefulness of transcendental reasoning in naturalist settings (sec. 5).

2. The Case against Transcendental Arguments in Philosophy of Biology. Callebaut (2007b) once declared that "the Kantian stance, if mentioned at all, is typically pictured as the antiposition . . . from which contemporary philosophies then part in different ways and directions. *In the [philosophy of biology], transcendental philosophy plays no role whatsoever*" (76; emphasis added). Why this distaste for Kant and for transcendental reasoning more specifically? The reasons offered for this trend tend to converge on the diagnosis that transcendental reasoning is inherently *antinaturalistic*. That is, the role of transcendental arguments within intellectual inquiry, and Kantian philosophy generally, seem at odds with *naturalism*, a wide-ranging stance in philosophy affirming that nature, as described by the sciences, is 'all the there is' and that philosophical inquiry should be closely aligned with the products and practices of the sciences (see esp. Quine 1969; Kitcher 1992; Maddy 2001, for instructive views).

Consider three critical observations motivating this anti-Kantian stance. Two of these are succinctly expressed by Brandon (2005). "First," Brandon writes, "such arguments are *not explanatory*. That is, they do not explain the existence

1. Chang refers to "contingency" in a way distinct from how I refer to empirical contingency below. In Chang's framework, transcendental arguments are contingent in the sense that they are *conditionalized* to the aims of performing "epistemic activities" in science.

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of [anything scientifically significant] any more than the following explains the existence of the sun: Sunlight is a necessary condition for the existence of green plants on Earth. Green plants exist on Earth. Therefore the sun exists" (52; emphasis added).[2] Although "perfectly valid" when viewed as an argument, the inference lacks all explanatory force for positing something of scientific interest. There is something to be said about the charitableness of Brandon's plant-sun example in reconstructing transcendental reasoning, but the overall message is clear: transcendental arguments are deemed explanatorily vacuous and, thus, scientifically worthless.

A second and "perhaps more important" observation given by Brandon advises caution in the use of transcendental arguments, saying: "The argument is supposed to reflect necessary relations in the world, *but may unwittingly reflect limitations on our understanding of the world*" (2005, 52; emphasis added).[3] This observation essentially calls into question the abilities of human cognition and reasoning that operate in transcendental arguments in securing such a strong conclusion (i.e., the *necessary* existence of something). Instead, actual human reasoning appears *bounded* by limitations imposed by natural conditions in, for example, our ability to process or recall information, or constraints of time or resources needed to complete real-world problem-solving tasks, especially in scientific contexts (see, for this instance, Callebaut 2007a). Boundedness, however, also pertains to the state of knowledge at a given point in history, which may be revised as time goes on.

A third and related reason captures another important reason for philosophy of biology's distaste for the Kantian tradition. Specifically, transcendental reasoning deals in types of generalizations (i.e., "necessary relations in the world") that appear to be nonexistent in the living world. This, minimally, is taken to mean that what is posited by a transcendental argument 'could not have been otherwise'. Call this *metaphysical* necessity. However, few if any generalizations in biology appear to rise to this degree of ontological strength. Necessity, as envisioned by transcendental reasoning, is at odds with the role of *contingency* in explaining living systems (e.g., Beatty 1995, 2006, in turn based on S. J. Gould's work). That is, the products of natural processes like evolution and development (like traits or organisms) are by no means immutable or

2. Brandon's observations are directed toward the existence of evolutionary modules in complex adaptive systems, drawing on arguments made independently by Richard Lewontin and John Tyler Bonner. Both instances, Brandon argues, qualify as "transcendental" arguments in that evolutionary modules must exist because complex adaptations require them (2005, 52). This example is interesting in that both the individuals Brandon cites can hardly be accused of antinaturalism and, thus, exemplifies nicely the distaste for transcendental arguments in contemporary philosophy of biology.

3. A similar observation is endorsed by Callebaut (2005, 112; 2007b, 76).

otherwise mandatory for some transcendent reason. In other words, things could have been different. Thus, as Callebaut notes, metaphysical necessity "will not much impress anyone who is convinced of the *contingency* of human social interactions (Niklas Luhmann) or, at a different level (and in a somewhat different sense), of biological evolution itself (Stephen Jay Gould's 'replaying the tape')" (2007b, 76; emphasis added).

These three observations give ample reason to be skeptical of the usefulness of transcendental arguments. Overcoming them will be the goal of the next two sections.

3. Recouping Transcendental Reasoning in Science: Chang's Contingent Transcendental Arguments. Transcendental arguments are necessitation arguments, meaning that an inference is drawn for the (necessary) existence of something (e.g., an "ontological principle"; see below) by virtue of the fact that something else (usually a mode of thinking or an object of thought but also actions; see "epistemic activities" below) is made possible (i.e., intelligible or coherent) by positing that 'something'. Transferring this structure into a naturalist setting may seem a titanic, or foolhardy, endeavor. However, much of the initial heavy lifting for discussing transcendental reasoning in science has already been developed by Hasok Chang, who in a number of sources has adapted this structure into a framework he calls "contingent transcendental arguments" (2008, 2009; see also his 2014).

The core stance of Chang's framework is given in his statement: "If we want to engage in a certain epistemic activity, then we must presume the truth of some particular [ontological] principles" (2008, 113).[4] An epistemic activity, following Chang, is any collection of actions ("operations") that are "intended to contribute toward the production or improvement of knowledge" (2014, 72). Examples of basic epistemic activities include counting, intervening, and conducting observations (see esp. Chang 2008, 127). "Ontological principles," then, are principles necessitated by an epistemic activity in that they enable said activity to be performed in the first place (discreteness, causality, and objectivity comprise ontological principles accompanying the foregoing activities). Thus, the "hallmark" (Chang 2009, 68) of ontological principles is that their denial should provoke a sense of nonsensicality rather than falsehood. In this way, performed epistemic activities become "intelligible." That we successfully perform certain activities, in other words, exonerates our presumption that certain principles attached to these activities exist.[5]

4. Chang (2008) originally referred to "metaphysical" principles, changing to the more palatable "ontological" principles in the following year (Chang 2009).

5. As Chang puts it, "pragmatic performability of activities [is] the ultimate basis of necessity" (2008, 132).

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Similarly, epistemic activities are "coherent" just in case performing that activity allows fulfilling some aim or goal that motivates taking those actions. Chang (2014, 73) speaks of inherent and external coherency, roughly corresponding to the intrinsic motivation for engaging in an activity (e.g., striking a match to ignite the tip) and the achievement aimed at accomplishing (lighting a Bunsen burner).

Importantly, Chang has with these initial steps already implemented several revisions toward making transcendental arguments amenable to naturalistic philosophy of science. I will focus on two. First, by grounding epistemic activities in coherence and intelligibility in the senses above (rather than, e.g., logical consistency or analyticity), he affords their evaluation by concrete, accessible criteria that, critically, place the assessment of an epistemic activity's 'success' within the purview of a scientific community. Insofar as an epistemic activity (say, an intervention) is deemed successful (publishable, replicable, and the like; all desirable aims), then invoking an ontological principle (i.e., causality) seems strongly justified. This partially addresses the second grievance against transcendental arguments in section 2, by placing the resources for inferring an ontological principle within a more cognitively realistic (i.e., bounded and fallibilistic) grounds. Fully addressing this grievance will require more revision to the notion of ontological principles, which I return to in section 4.

Second, basing the necessity of ontological principles on the performability of an activity likewise places them into a set of circumstances where they can be openly assessed as scientifically useful (or not, if it fails). I say here 'useful' rather than 'explanatory' because figuring into an explanation is only one way that an activity may be valuable. Since epistemic activities are aimed at the "production or improvement of knowledge," we may also perform an activity for other uses such as clarifying terminology, revising interpretations of concepts or theories, or other ways of improving knowledge. Thus, transcendental arguments need not be expected to qualify as explanations to be scientifically useful. Consider again the activity-principle pair of intervention-causality. Woodward's (2003) influential account of causality and causal explanation embodies this insight nicely in that interventions under Woodward's account do not explain causal relationships (this would be viciously circular, as interventions presume causality) but rather show how these relations can be made systematically intelligible when certain investigative activities involve interventions. Such considerations vindicate transcendental arguments from the first criticism above in that the presumption of an ontological principle for an epistemic activity does not need in itself to be an explanation, although it could later figure into explanations that are produced to improve our knowledge of the world (just as interventions provide a strong basis for causal explanations).

As it turns out, further revision to transcendental reasoning is required if it is to be of use in biology particularly. I turn in the next section to two challenges from biology that linger from the criticisms discussed in section 2.

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4. Ontological Principles for Limited Beings: Adaptive Design and Revisability. The last section laid out Chang's basic framework and two important revisions to transcendental reasoning implemented by this framework, which aid in making arguments derived from this reasoning amenable to naturalist philosophy of science. However, further extension of these revisions is needed to reconcile biological generalizations as candidates for ontological principles in light of the criticisms discussed in section 2. For this reason I address two further issues in this section: deriving 'necessity' in the face of (empirical) contingency and inferring nonexistent ontological principles from the performability of some epistemic activities.

Recall from the third criticism of transcendental arguments in section 2 that the necessitation provided by transcendental reasoning is at odds with the role of contingency in the living world. The main idea here is that generalizations about the workings of living systems often need not be or have been as they are now. Instead, other regularities could have been produced by nature, and the ones we have are not guaranteed to hold as evolutionary history progresses.

Before proceeding, it should be noted that contingency in biology can refer to several ideas. Beatty (1995, 2006), for instance, discusses two distinct but complementary notions of contingency in evolutionary biology, corresponding to *historical* and *causal* varieties. Historical contingencies refer to the fact that the sources of variation for evolution (e.g., that selection acts on) are not produced in a determinate but rather unforeseeable way. Classically, the 'random chance' of genetic mutations is cited as the source for this indeterminacy, but this may also reflect the availability (or unavailability) of evolvable traits, characters, or phenotypes that can respond to selection. The specific forms that evolve reflect only what the sources of variation allow. Causal varieties of contingency countenances the fact that most traits, events, or processes in evolution or development require or have required highly specific conditions to obtain, which are not guaranteed per se.

Both varieties of contingency appear to pose a problem for transcendental arguments in that, under Chang's framework, the performability of an epistemic activity is supposed to necessitate the principle in question. However, if due to contingency "nature [itself] *fails to necessitate* the truth of biological generalizations" (Beatty 1995, 53), then the ability to successfully perform an epistemic activity seems to require different grounds for their intelligibility (or coherence).

But does nature really fail to necessitate in biology? One important contextual point to Beatty's statement (and the spirit of Callebaut's citation of contingency in sec. 2) is that these instances speak to two things that are actually quite tangential to the nature of necessity in biology. One of these is the *lawlikeness* of biological generalizations, or, more generally, whether there are laws in the classical sense in biology, while the other is the expectation by some that ontological principles (or their surrogates, scientific laws) *determine* their

outcomes. The viability of (contingent) transcendental arguments in biology appears instead to concern more immediately the issue of whether some form of necessitation persists in biology in which epistemic activities in the field are made intelligible or coherent in the Changian senses discussed in the foregoing section. In this more focused sense, I believe that regardless of whether we attribute law-likeness to biological generalizations or expect ontological principles to deliver their outcomes deterministically, contingency may actually be a source for (some kind of) necessity.

Some examples of contingency in biology, such as expressing Mendelian traits, merely illustrate that one of multiple possible outcomes prevailed. An actual, expressed (Mendelian) trait is conditional on many things happening between, for example, meiotic segregation of gametes in both parents, egg-sperm fertilization, and finally expressing the trait in question during development and as an adult. Here, things simply could have been different. However, even such mundane examples can introduce necessity in certain activity-based circumstances. Receiving the correct blood type during a blood transfusion is one simple example of how a contingent principle (expressing O negative blood type, assuming both parents were heterozygous for this trait) can necessitate certain actions, such as the need to receive only O negative blood during a required transfusion, for example, due to an accident involving blood loss. Notice that with regard to the necessitation in this example we do not have to accept the status of an ontological state of affairs (expressing a particular Mendelian trait; here blood type) as a scientific law in the classical sense, nor do the circumstances determine a particular outcome (there is nothing metaphysically necessary in giving someone a needed blood transfusion). Instead, the conditions of successfully performing a particular activity—providing a blood transfusion—necessitates (i.e., requires we presume the truth of) a particular set of circumstances.

Now, it might be objected here that the foregoing example hardly rises to the occasion of a transcendental argument. Particularly, the "set of circumstances" we presume to be true seem strongly at odds with the transcendental character of principles that give transcendental arguments their namesake. This is all true. However, the point for the moment is that necessitation need not be a matter of tangential expectations regarding our ontological principles that contingency in biology directly provokes in the literature.

To better appreciate the foregoing point, and to embed it directly into a transcendental context, I propose turning to William Wimsatt's idea of *adaptive design* to recover (Changian) necessitation for transcendental arguments in biology (see esp. Wimsatt 2007, chap. 7). Adaptive design refers to a collection of principles that Wimsatt postulates in order to make sense of complex systems in science, particularly biology. These principles include heuristics, robustness, and most importantly *generative entrenchment*. I have discussed heuristics and

robustness elsewhere (Brooks and Eronen 2018) and will for this reason focus here on entrenchment.

Generative entrenchment refers to the idea that as a generative process (say, evolution or development) continues over time, intermediate products of this process may occur for contingent reasons but later acquire an increasingly necessary character over time due to the dependencies that accumulate around that product over time. This captures a putative source of necessitation, since as Wimsatt puts it: "With accumulating dependencies, seemingly arbitrary contingencies *can become profoundly necessary*, acting as generative structural elements for other contingencies added later" (2007, 135; emphasis added). Perhaps more importantly, generative entrenchment behaves as a truly ontological principle in the contingent, Changian sense. Specifically, Wimsatt specifies that postulating entrenchment is a requirement that we must presume in order to make sense of what we discover of complex systems such as epistatic influences in the evolution of proteins (Star et al. 2018) or evolution itself (in light of "contingent irreversibility," as discussed in the Major Transitions literature; see Szathmáry and Maynard Smith 1995). Again, Wimsatt is explicit here in that "we have no intrinsic reason for arguing that something is true because it is deeply generatively entrenched . . . [rather] . . . *We need it to be true*. Or, if not it, then something sufficiently like it to regenerate most of what follows from it also from the new variant principle" (2007, 142–43).

Thus, contingency in biological processes need not be a hindrance to deriving necessity in transcendental reasoning. In fact, necessitation is deeply congenial to our study of the nature of complex systems, an exemplary trait of practicing biology.

A second point of reconciliation with biology also concerns the status of ontological principles. Examples of ontological principles thus far have assumed their integrity as sources for enabling epistemic activities. Causality, discreteness, and objectivity, although objects of debate, are rarely decried as antiscientific or otherwise overly contentious. However, as epistemic activities become more complex or we investigate novel phenomena, our ability to infer principles we consider necessary becomes more tentative or even speculative. Brandon's cautionary observation looms large here in that what we infer as necessary may actually reflect our cognitive or material limitations (rather than states of affair in nature). Thus, transcendental reasoning must also be reconciled with *open-ended* assessment concerning what we accept as permissible ontological principles over time. The principles that we posit may be early placeholders, or just downright false, and the scientific community reserves the right to any time to revise, replace, or reject the principles we provide for such inferences.

Hans Driesch's vitalist interpretation of his famous experiments with sea urchin embryos is one historically instructive example for this issue. To recall, Driesch's most famous experiments separated newly formed blastoderms from

echinoderm eggs and observed that the intact separated structures were still able to develop into fully formed adults. He interpreted this as a vindication of vitalism, the idea that living processes require nonphysical principles to adequately explain them.

Interestingly, Driesch himself gives ample evidence for specifically interpreting his work as a transcendental argument. Speaking to his "methodology," Driesch reports that the most important question for interpreting experiments like his is not "why" (warum) or "how" (wie) they occurred but rather "first and foremost . . . what is the assumption for that which is happening?" (zu allererst . . . Was ist die Vorraussetzung dessen, was vorgeht?; 1899, 77). Driesch attended to this "assumption" in a deeply Kantian style, particularly in his later work.[6] Specifically, he inferred the notorious (ontological) principle of *entelechy*, roughly the tendency of the developing embryo to realize or manifest its final adult form, to explain why he was able to perform his experiments. Driesch declared: "The ultimate results of our indirect proofs of vitalism . . . *acquire their proper intelligible meaning only at the moment when the foundations of entelechy upon a special category of its own is appreciated*" (1908, 311; emphasis added).

Driesch's plea for vitalism also has all the hallmarks of a contingent transcendental argument as illustrated by Chang. First, his starting point comprises an epistemic activity, that is, performing a sophisticated experiment. Second, his primary inference for being able to perform that activity rested (for Driesch) on presuming the existence of a particular ontological principle (i.e., entelechy). Finally, he provided a series of aims and interests to support his contention that this inference was both intelligible and coherent. For one thing, his urchin experiments were highly successful; they were replicable, novel, and useful for gathering embryological data. For another, he provided an overarching aim he wished to fulfill by performing those experiments, namely, to demonstrate that there are laws basic to biology that are irreducible to the physical sciences.[7] The conditions for necessitating entelechy seem fulfilled, yet vitalism has been rejected, and entelechy deemed a false, metaphysical extravagance.

6. See especially his Gifford Lectures, published in 1908. There Driesch takes large aspects of Kant's transcendental approach as a method, and vindication, of his vitalism. For instance, at one point he portrayed his vitalistic project as a biologized version of Kant's work, saying: "We are faced here by a very fundamental problem of the theory of knowledge in its biological form. 'How is experience possible' was the epistemological question of Kant; 'how are the secondary faculties of [entelechy] possible' is the biological question" (Driesch 1908, 141).

7. "Der eigentliche Zweck dieser Arbeit eben nur der ist, zu zeigen, dass [es] in der That eine Art spezifisch-elementarer Gesetzlichkeit im Bereich der Lebensgeschehnisse giebt" (Driesch 1899, 77, 79–80).

However, this need not count as a counterexample to (revised) transcendental reasoning. History has in many ways not been kind to Driesch. Although primarily remembered (by philosophers) as a vitalist, Driesch was a prescient experimentalist remembered in biology for his experimental setups, initial data, and the terminology he used to articulate what his experiments exhibited (e.g., "equipotentiality"), where he anticipated later researchers (among others, Mangold and Spemann) in experimental embryology and developmental biology in the twentieth century (Oppenheimer 1970). In fact, Driesch's reputation continues to be well established in developmental biology, and the deep influence of his sea urchin experiments is still regularly noted by practicing scientists (e.g., Beloussov and Gordon 2018; Čapek and Müller 2019). Thus, the case of Driesch reveals a puzzle with respect to transcendental reasoning; the success of (some of) his epistemic activities is well established, but what does their success necessitate; that is, what made them performable? It certainly was not entelechy.

As it turns out, fully appreciating the impact of Driesch's insights for development required theoretical and experimental advances in a number of fields concerning the details of *self-organization*. Roth (2011) provides a review of these advances and claims that it was not until the 1970s that scientists could properly account for what Driesch had observed with his sea urchins. Two particularly important clusters of advances focused on modeling, mathematically describing, and articulating the mechanism of chemical oscillation, itself predicated on the ability to extend thermodynamics to far-from-equilibrium systems like the kinds seen in biology, and Alan Turing's diffusion models for morphogenesis, which postulated the notion of "morphogens," chemical substances whose dispersal defines morphogenetic formation patterns.[8] Once made intelligible by these and other efforts, self-organization became acknowledged as a robust, necessary component of biological processes and development in general.

5. Conclusion. Transcendental arguments are virtually absent from contemporary philosophy of science and particularly philosophy of biology. This is not unsurprising, as good arguments have been proffered for their seemingly inherent antinaturalist character. In this article, I have laid out a possible path for recouping arguments derived from transcendental reasoning in light of the Hasok Chang's project of conditionalizing such arguments on the success of our epistemic activities that necessitate certain ontological principles.

8. Interestingly, Roth actually claims that it was Kant who instigated the theoretical insight of the importance of self-regulation and self-organization for understanding biological systems, and Driesch was one of the experimental pioneers that contributed to elevating Kant's original insights into established science.

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