

Interstitial Life:

Some Remarks on Causality and Purpose in Biology

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The question of *purpose* has long haunted biology. Darwin's explanation of evolution by means of natural selection was intended, among other things, to get rid of teleological explanations of living things. Darwin explicitly answered the "argument from design" invoked most prominently in the nineteenth century by William Paley in his once-famous book *Natural Theology* (1802). Recapitulating what was already an old argument, Paley said that living organisms were so intricately structured that they could not have arisen at random, but must have been produced by the deliberate actions of some Designer. The evident purposiveness, and organized complexity, of living things strongly suggests that they were purposefully created. This argument is so intuitively appealing that it is still being made today by creationists, or proponents of so-called "intelligent design" (e.g., Behe 2006). Darwin was the first to explain the genesis of organic complexity in naturalistic terms, without appealing to supernatural forces. It is important to understand how radical a move this was. In his exposition of the logic of natural selection, Richard Dawkins (1987) insists that, prior to Darwin, there was simply *no* satisfactory explanation for organic complexity, aside from the theistic one. Even Hume, who ridiculed the argument from design in his *Dialogues Concerning Natural Religion* (1779), "did not offer any alternative explanation for apparent design, but left the question open" (6). For Dawkins, Darwinian natural selection is still the *only* theory that is able to account for the complex structures and properties exhibited by living things in cause-and-effect terms acceptable to modern science, without invoking prior intentions or purposes.

In other words, Darwin provides an immanent, non-teleological mechanism for the development of life. Given the theory of natural selection, it is no longer

necessary to invoke such teleological agencies as the hand of God, or the Lamarckian acquisition of striven-after qualities, or the workings of some inner vitalistic force like Bergson's *élan vital*. Nonetheless, even the most dedicated evolutionists are unable to avoid reverting to the language of purpose. After all, living organisms, and their parts, *are* evidently purposive in terms of how they grow, and how they relate to the world around them. It scarcely matters that this purposiveness, or intentionality, was never itself intended by any higher agency, but arose through the workings of natural selection. It still remains the case that biologists can only explain an organism by speaking *as if* its features (eyes, or reproductive behaviors, or whatever) were purposive. When we study living organisms, we cannot get away from what Michael Ruse, in his book *Darwin and Design: Does Evolution Have A Purpose?* (2003), calls "the metaphor of design" (274ff.). Even as Ruse defends the reductionist program of orthodox neodarwinism against the more holistic approaches of such biologists as Stephen Jay Gould and Stuart Kauffman, he concedes that it is impossible to eliminate metaphors (274ff.), teleological arguments (282ff.) and pragmatic modes of evaluation (286ff.) from biological discourse. "Darwinism does not have design built in as a premise," Ruse says, "but the design emerges as Darwinism does its work and some organisms get naturally selected over others" (269).

Ruse professes to find it unproblematic, and even "comforting" (270), that Darwinism both allows us and requires us to pursue an old-fashioned "understanding in terms of final causes" (289). I would like to suggest, however, that there is a greater tension than Ruse is willing to admit between the reductionist program of mainstream physical science, and the implications of an unavoidable appeal to purpose, design, and final causality whenever living organisms are in question. Edward O. Wilson's (1999) principle of "consilience," for instance, maintains that "all tangible phenomena, from the birth of stars to the workings of social institutions, are based on material processes that are ultimately reducible, however long and tortuous the sequences, to the laws of physics" (291). But if this is correct, then biological explanations of human culture and society, of the sort that Wilson copiously proffers, are just as dubious a stopgap as are the sociocultural explanations that Wilson rejects. If we are to assert reductionism, then we need to follow it all the way down. We should focus upon the quantum interactions of subatomic particles, rather than upon genes and genomes, or upon organisms and their adaptations to their environment. In that way, we can banish all talk of purposes and final causes. If, on the other hand, we are willing to accord a certain relative autonomy to the biological realm, and accept the existence of emergent properties

on this level that have a certain explanatory power of their own, then we have admitted teleology and purpose. And by the same logic, we should be willing to accept the explanatory power of higher levels of emergent complexity (social, cultural, economic, political, aesthetic, etc.) as well. There is no good reason for us to stop at the biological and genetic level, and assert against all evidence (as sociobiology and evolutionary psychology are wont to do) that everything having to do with human beings was somehow frozen in stone (or in DNA) at the end of the Pleistocene.

I have elsewhere (Shapiro 2003, 205-212) criticized the way that devotees of evolutionary psychology, in particular, tend to invoke “purpose,” attributed to such reified agencies as “evolution,” or “natural selection,” or “the genes,” in much the same way that Paley invoked the intentions of the Deity, as a kind of catch-all principle of explanation. I will not rehearse that argument in detail here. Suffice it to say that, if purpose and design have emerged in the course of biological evolution, then it is what Kant calls a *paralogism* to attribute such purpose to evolutionary processes themselves. Similarly, given that a certain biological trait came into being as a result of the fact that organisms possessing that trait were able to produce more viable offspring than competing organisms lacking it, it is a paralogism to infer that the purpose or goal of the trait, as it currently exists, is therefore to “maximiz[e] the number of copies of the genes that created it” (Pinker 1999, 43). The given trait – whether it be a physiological organ or a pattern of behavior – is likely to be purposive in itself (e.g., the eye serves for seeing; the male bowerbird builds a bower in order to attract a mate). But such purposes cannot be equated with the alleged “purpose” of maximizing the transmission and inheritance of the organism’s genes. The outcome of a process is not the same as the conditions that led to its existence in the first place. To equate the two is precisely to confuse the “efficient cause” that gave rise to the trait with the trait’s concrete action as “final cause.” I may well be more “reproductively fit” because I can see, but the purpose of my eyes is seeing, and *not* reproductive fitness. Even when (as in the case of the bowerbird’s building a bower) we find an actual purpose of a sexual and/or reproductive nature, it is a category error to translate this into overall evolutionary “purpose.” However a trait was initially selected for, and even as it continues to be selected in contrast to alternative traits, its actual functioning may well turn out to involve exaptations, repurposings, autonomous strivings, and other violations of strict adaptationist logic.

Like so much in modern thought, this dilemma over biological explanation finds

its clearest, and historically most crucial, exposition in the philosophy of Kant. In the the second half of the *Critique of Judgment* (1987), Kant formalizes this dilemma as what he calls the Antinomy of teleological judgment. On the one hand, Kant says, we *must* assume that the complex organization of living beings is “produced through the mere mechanism of nature”; indeed, no other explanation if possible. Ever since Galileo, Western science has proceeded on the basis of eliminating teleology and occult properties, and explaining everything in terms of efficient causes. And yet, on the other hand, mechanistic determinism “cannot provide our cognitive power with a basis on which we could explain the production of organized beings.” When we try to establish such a basis, we are *compelled* “to think a causality distinct from mechanism – viz., the causality of an (intelligent) world cause that acts according to purposes” (269). For “we cannot even think [living things] as organized beings without also thinking that they were produced intentionally” (281). In other words, we are unable to avoid the idea of purposive design, even though “we make no claim that this idea has reality” (269), and even though such an idea goes against everything that we know and believe about the phenomenal universe. When they look at living organisms, biologists are forced to accept “the maxim that nothing in such a creature is *gratuitous*. . . . Indeed, they can no more give up that teleological principle than they can this universal physical principle” (256).

Kant, of course, was writing long before Darwin. It is sometimes argued that Darwin’s discovery of a naturalistic basis, or “physical principle,” for the organized complexity of life – something that Kant considered to be impossible (282-283) – entirely obviates Kant’s arguments about teleological judgment. Yet Kant’s Antinomy still exists in contemporary biology, even though its location has been displaced. In the mainstream neodarwinian synthesis, any appeal to higher purposes is rejected; natural selection operates blindly, without foresight. At the same time, however, neodarwinian explanation depends entirely upon the maxim that “nothing in [living organisms] is *gratuitous*”: even the most minute features of living beings are assumed to possess adaptive significance. Selection itself – defined by population genetics as the change over time in the distribution of allele frequencies for a given gene in a given population – operates mechanistically, as the statistical outcome of a multitude of small, contingent encounters. But selection is rendered intelligible, in retrospect, only by means of the “teleological principle” that particular traits have been selected for because they are adaptive. Thus the theory of natural selection takes away teleology with one hand, but gives it back with the other. The “argument from design” is rejected as an appeal to a

transcendent, external cause, but restored as an immanent principle of emergent order.

As Ruse summarizes the matter, even though “there is no reason to think that biology calls for special life forces over and above the usual processes of physics and chemistry,” nonetheless “there does seem to be something distinctive about biological understanding – something having to do with purposes and ends in evolution. . . We have ‘final causes’ ” (268). Ruse concludes, almost in spite of himself, that “Kant was right in seeing that *we* do the science, and *we* try to make sense of the trilobite. . . looking at the trilobite as if it had intentions and interests. As if it had values” (288). For Ruse, as for Kant, the trilobite (even when it was alive) didn’t actually have any intentions or interests or values of its own; but we can only interpret it by looking at it as if it did, and judging it by analogy with our own intentions, interests, and values. For “the aim of science” is not “to give an unvarnished report on reality,” but rather “to make sense of reality” in our own terms (288). Starting from entirely naturalistic premises, Ruse ends up finding himself forced to reject positivist reductionism, and instead adopt a Kantian transcendental argument.

The problem with Ruse’s argument is his unexamined assumption that only human beings have intentions, interests, and values; while organisms like trilobites (and presumably also cats, fruit flies, trees, slime molds, and bacteria) do not. “The trilobite has no interests,” he writes; “it just is” (288). It is only we who comprehend it *in terms of* interests. But isn’t this a rather un-Darwinian reversion to the Cartesian idea that human beings alone have souls, while all other organisms are merely things, or machines? Of course, Kant himself already assumes this prejudice. I would like to suggest, however, that a post-Darwinian Kantianism can, and should, drop the anthropocentrism altogether. It should concentrate on the structure and consequences of Kant’s transcendental argument, while rejecting the idea that the argument applies only to human (or “rational”) minds.

In fact, this is precisely what Gilles Deleuze does, when he converts Kant’s transcendental idealism into what he calls a “transcendental empiricism.” For Deleuze, Kant’s discovery of “the prodigious realm of the transcendental” (1994, 135) is crucially important, but limited by the way that Kant’s own account of the transcendental “retains the form of the person, of personal consciousness, and of subjective identity” (1990, 98). In place of this, Deleuze posits an “impersonal and pre-individual transcendental field,” which “can not be determined as that of a consciousness” (102). This amounts to saying that Kant’s transcendental synthe-

ses have a general ontological significance, instead of a merely epistemological and psychological one. They apply to the inner being of all entities, rather than just to the way that we apprehend those entities. Deleuze, in short, proposes a Kantianism for trilobites, fruit flies, and birds, as well as for human beings.

Read in this manner, Kant implicitly proposes what Deleuze explicitly develops in *The Logic of Sense* (1990) as a theory of “double causality” (94-99). On the one hand, Deleuze says, there is real, or physical, causality: causes relate to other causes in the depths of matter. This is the materialist realm of efficient causes, of “bodies penetrating other bodies... of passions-bodies and of the infernal mixtures which they organize or submit to” (131). On the other hand, there is the idealized, or transcendental, “quasi-causality” of effects relating solely to other effects, on the surfaces of bodies or of things (6). This is the realm of intentions or final causes. Quasi-causality is “incorporeal... ideational or ‘fictive’,” rather than actual and effective; it works, not to constrain things to a predetermined destiny, but to “assur[e] the full autonomy of the effect” (94-95). And this autonomy, this splitting of the causal relation, “preserve[s]” or “grounds freedom,” liberating events from the destiny that weighs down upon them (6). An act is free, even though it is *also* causally determined, to the extent that the agent or actor is able “to be the mime of what effectively occurs, to double the actualization with a counter-actualization, the identification with a distance” (161). That is to say, Deleuze’s counter-actualizing “dancer” makes a *decision* that supplements causal efficacy and remains irreducible to it, without actually violating it.

Deleuze is really just giving a de-anthropomorphised, non-rationalist account of something that already happens in both Kant’s Second and Third Critiques. In the *Critique of Practical Reason* (2002), everything turns upon the gap between the rational subject and the empirical subject, and the corresponding distinction between “causality as freedom” and “causality as natural mechanism” (9). This distinction also takes the form of an Antinomy: “The determination of the causality of beings... can never be unconditioned, and yet for every series of conditions there must necessarily be something unconditioned, and hence there must be a causality that determines itself entirely on its own” (69). Kant’s solution to this Antinomy is that physical, efficient causality always obtains in the phenomenal world, but “a freely acting cause” can be conceived as operating *at the same time*, to the extent that the phenomenal being who wills and acts is “also regarded as a noumenon” (67).

Kant thus insists that linear, mechanistic causality is universally valid for all phe-

nomena. But at the same time, he *also* proposes a second kind of causality, one that is purposive and freely willed. This second causality does not negate the first, and does not offer any exceptions to it. Rather, “freedom” and “purpose” exist *alongside* “natural mechanism”: Derrida would say that they are *supplementary* to it. According to the Second Critique, “nothing corresponding to [the morally good] can be found in any sensible intuition” (90); this is precisely why the moral law, or “causality as freedom,” can only be a pure, empty form. The *content* of an action is *always* “pathological” or empirically determined, “depend[en]t on the natural law of following some impulse or inclination” (49). The second sort of causality, a free determination that operates according to moral law rather than natural law, may coexist with this “pathological” determination, but cannot suspend it. This is why Kant incessantly qualifies his affirmations of freedom, reminding us that “there is no intuition and hence no schema that can be laid at its basis for the sake of an application *in concreto*” (91), and that it is an “empty” concept theoretically speaking, that can be justified “for the sake not of the theoretical but merely of the practical use of reason” (75).

In the *Critique of Judgment*, Kant similarly solves the Antinomy of teleological judgment by differentiating between the claims made by the two sorts of causality. As normative physical science insists, mechanistic causality is the law of the phenomenal world, the way that things must necessarily appear to us. Purposive (teleological) causality is not altogether eliminated, but it can only be accorded a ghostly, supplemental status. Kant says that “we do not actually *observe* purposes in nature as intentional ones, but merely add this concept [to nature’s products] in our *thought*, as a guide for judgment in reflecting on these products” (282). Purpose is “a universal *regulative* principle” for coping with the universe (287); but we cannot apply it constitutively. The idea of “natural purpose” is only “a principle of reason for the power of judgment, not for the understanding” (289). That is to say, when we regard a given being as something that is alive, as an *organism*, we are rightly judging it to be an effectively purposive unity; but we do not thereby actually understand what impels it, or how it came to be.

The understanding has to do with a one-way, “descending series” of “efficient causes,” or “real causes.” But judgment in terms of purposes invokes a nonlinear (both ascending and descending) series of “final causes,” or “ideal causes” (251-252). The idea of purpose, or of final cause, involves a circular relation between parts and whole. The whole precedes the parts, in the sense that “the possibility of [a thing’s] parts (as concerns both their existence and their form) must depend

on their relation to the whole.” But the parts also precede and produce the whole, insofar as they mutually determine, and adapt to, one another: “the parts of the thing combine into the unity of a whole because they are reciprocally cause and effect of their form” (252). An organism must therefore be regarded as “both an *organized* and a *self-organizing* being.” It is both the passive effect of preceding, external causes, *and* something that is actively, immanently self-caused and self-generating. Only in this way can “the connection of *efficient causes*. . . at the same time be judged to be a *causation through final causes*” (253).

To what extent must final causality be taken into account, and to what extent can it safely be ignored? Kant’s own answer to this, of course, is starkly binary. Morality applies to human beings as rational agents, and not to any other entities. Teleological design applies to living organisms, and not to anything in the inorganic world. However, if we follow Deleuze’s revision of Kant, together with the general tendencies of modern science, we will tend rather to blur these boundaries. It is largely a matter of degree. In many inorganic physical processes, the scope of supplemental causality is vanishingly small; mechanistic, efficient causality accounts for everything that we are able to observe. But in cases of complexity, or of higher-order emergence, supplemental causality becomes far more important. “Deterministic chaos” is, like all empirical phenomena, entirely determined in principle (or, as Kant would say, “theoretically”) by linear cause and effect. But since its development is sensitive to differences in initial conditions too slight to be measured, it is not actually determinable ahead of time pragmatically (or, as Kant would say, “practically”). In these cases, linear, mechanistic causality is inadequate for the purposes of our understanding, and an explanation in terms of purpose, or “causation through final causes” becomes unavoidable. This is why Kant’s account of teleological circularity and “reciprocal cause and effect” is very much alive today: it lies at the heart of most versions of cybernetics, systems theory, and theories of self-organization.

The role of teleology and final causes is especially crucial when we get to those emergent processes of self-organization known as living things. Where Ruse, and other defenders of the neodarwinian paradigm, defend talk of purpose only as a rhetorical and epistemological necessity, other biological paradigms embrace this mode of explanation more wholeheartedly. In modern biology, Kantian “causation through final causes” can be traced in Bertalanffy’s General System Theory (1976), Humberto Maturana and Francisco Varela’s theory of autopoiesis (1991), Stuart Kauffman’s explorations of emergence (2000), Susan Oyama’s Develop-

mental Systems Theory (2000), James Lovelock's Gaia hypothesis (2000), and Lynn Margulis' accounts of symbiotic mergers (Margulis and Sagan 2002). None of these approaches dispute the central Darwinian claim that purposiveness in living organisms emerged through the efficient cause of natural selection. But they all insist that mechanistic causality must be supplemented by processes that involve reciprocity and feedback, autoproductioin, and some sort of innovation or "decision." In this way, they all resonate with Deleuze's account of double causality, as well as with Deleuze's (and Guattari's) interest in such things as lateral gene transfer, "aparallel evolution," and symbiosis (cf. Deleuze and Guattari 1987, 10).

Despite their considerable differences, all these approaches implicitly propose a common image of life, one that diverges sharply from that of the mainstream neodarwinist synthesis. According to the latter, genetic inheritance, when combined with occasional random mutation and the force of natural selection, is sufficient to account for biological variation. This is because life is essentially conservative, organized for the purposes of self-preservation and self-reproduction. Organisms strive to maintain homeostatic equilibrium in relation to their environment, and to perpetuate themselves through reproduction. Innovation and change are not primary processes, but forced adaptive reactions to environmental pressures. Life is not a vitalistic outpouring; it is better described as an inescapable compulsion. The image of a 'life force' that we have today is not anything like Bergson's *élan vital*; it is rather the virus, a mindlessly, relentlessly self-replicating bit of DNA or RNA. It would seem that organic beings only innovate when they are absolutely compelled to, and as it were in spite of themselves.

In contrast to the neodarwinist synthesis, the alternative approaches that I have mentioned all suggest that, at least to a certain extent, "the nature of selective pressures is creative and active," rather than merely negative and eliminative (Parisi 2004, 53). Inheritance, modified by random mutation and selection, is a necessary condition for evolutionary change – but not an altogether sufficient one. A supplemental, emergent factor is also required. The best philosophical account of what this might entail comes not from Deleuze, but from Alfred North Whitehead's "philosophy of organism" (1929/1978). Whitehead, like Kant and Deleuze, posits a double causality: efficient and final. Efficient, or mechanistic, causality is universal; it applies to all events or "occasions" in the universe. Final causality, for its part, does not suspend or interrupt the action of efficient causality, but supervenes upon it, accompanies it, demands to be recognized alongside it. For Whitehead, the final cause is the "decision" (43) by means of which an actual entity "con-

creases,” or becomes what it is. “However far the sphere of efficient causation be pushed in the determination of components of a concrescence. . . beyond the determination of these components there always remains the final reaction of the self-creative unity of the universe” (47). The point is “that ‘decided’ conditions are never such as to banish freedom. They only qualify it. There is always a contingency left open for immediate decision” (284). This contingency, this opening, is the point of every entity’s self-determining activity: its creative self-actualization or “self-production” (224).

Whitehead defines “life” itself (to the extent that a concept with such fuzzy boundaries can be defined at all) as “the origination of conceptual novelty – novelty of appetite” (102). By “appetition,” he means “a principle of unrest. . . an appetite towards a difference. . . something with a definite novelty” (32). Most broadly, “appetition” has to do with the fact that “all physical experience is accompanied by an appetite for, or against, its continuance: an example is the appetite of self-preservation” (32). But experience becomes more complex, aesthetically and conceptually, when the appetite pushes beyond itself, and does not merely work towards the preservation and continuation of whatever already exists. This is precisely the case with living beings. When an entity displays “appetite towards a difference” – Whitehead gives the simple example of “thirst” – the initial physical experience is supplemented and expanded by a “novel conceptual prehension,” an “envisagement” (34) of something that is not already given, not (yet) actual. Even “at a low level,” such a process “shows the germ of a free imagination” (32).

Whitehead’s theory of life is thus also a theory of desire. It is insufficient to interpret something like an animal’s thirst, and its consequent behavior of searching for water, as merely a mechanism for maintaining (or returning to) a state of homeostatic equilibrium. “Appetition towards a difference” seeks transformation, not preservation. For Whitehead, life cannot be adequately defined in terms of concepts like Spinoza’s *conatus*, or even Maturana and Varela’s *autopoiesis*. Rather, an entity is alive precisely to the extent that it envisions difference, and thereby strives for something other than the mere continuation of what it already is. “‘Life’ means novelty. . . A single occasion is alive when the subjective aim which determines its process of concrescence has introduced a novelty of definiteness not to be found in the inherited data of its primary phase” (104). Appetition is what Whitehead calls a “conceptual prehension”: it involves the grasping towards, and then the making-definite of, something that has no prior existence in the “inherited data” (i.e., something that, prior to the appetite, was merely po-

tential).

If life is appetite, then it must be understood, not as a matter of continuity or endurance (for things like stones endure much longer, and more successfully, than living things do), nor even in terms of response to stimulus (for “the mere response to stimulus is characteristic of all societies whether inorganic or alive” – 104); but only in terms of “*originality* of response to stimulus” (emphasis added). Life is “a bid for freedom,” and a process that “disturbs the inherited ‘responsive’ adjustment of subjective forms” (104). It happens “when there is intense experience without the shackle of reiteration from the past” (105). In sum, Whitehead maintains “the doctrine that an organism is ‘alive’ when in some measure its reactions are inexplicable by *any* tradition of pure physical inheritance” (104). Being alive means being able to make unforeseen decisions.

This evidently goes against the currently fashionable belief that everything an organism does is predetermined by its genes. But it fits rather well with some of the most interesting current research. When biologists actually look at the concrete behavior of living organisms, they continually discover the important role of “decision” in this behavior. This is not only the case for mammals and other “higher” animals. Even “bacteria are sensitive, communicative and decisive organisms. . . bacterial behaviour is highly flexible and involves complicated decision-making” (Devitt 2007). Slime molds can negotiate mazes and choose one path over another (Nakagaki, Yamada, and Toth 2000). Plants do not have brains or central nervous systems, but “decisions are made continually as plants grow,” concerning such matters as the placement of roots, shoots, and leaves, and orientation with regard to sunlight (Trewavas 2005, 414). In the animal kingdom, even fruit flies exhibit “spontaneous behavior” that is non-deterministic, unpredictable, “nonlinear and unstable.” This behavioral variability cannot be attributed to “residual deviations due to extrinsic random noise.” Rather, it has an “intrinsic” origin: “spontaneity (‘voluntariness’) [is] a biological trait even in flies” (Maye et al. 2007). In sum, it would seem that *all* living organisms make decisions that are not causally programmed or predetermined. We must posit that “cognition is part of basic biological function, like respiration” (Devitt 2007, quoting Pamela Lyon). Indeed, there is good evidence that, in multicellular organisms, not only does the entire organism spontaneously generate novelty, but “each cell has a certain intelligence to make decisions on its own” (Albrecht-Buehler 1998).

Thus, biologists have come to see cognition, or “information processing,” at work everywhere in the living world: “all organisms, including bacteria, the most prim-

itive (fundamental) ones, must be able to sense the environment and perform internal information processing for thriving on latent information embedded in the complexity of their environment” (Ben Jacob, Shapira, and Tauber 2006, 496). Organisms would then make decisions – which are “free,” in the sense that they are not pre-programmed, mechanistically forced, or determined in advance – in accordance with this cognitive processing. This fits quite well with Whitehead’s account of “conceptual prehension” as the “valuation” (240) of possibilities for change (33), the envisioning of “conditioned alternatives” that are then “reduced to coherence” (224). But it is getting things backwards to see this whole process as the *result* of cognition or information processing. For “conceptual prehension” basically means “appetition” (33). It deals in abstract potentialities, and not just concrete actualities; but it is emotional, and desiring, before it is cognitive. Following Whitehead, we should say that it is the very act of *decision* (conceptual prehension, valuation in accordance with subjective aim, active selection) that makes cognition possible – rather than cognition providing the grounds for decision. And this applies all the way from bacteria to human beings, for whom, as Whitehead puts it, “the final decision. . . constituting the ultimate modification of subjective aim, is the foundation of our experience of responsibility, of approbation or of disapprobation, of self-approval or of self-reproach, of freedom, of emphasis” (47). We don’t make decisions because we are free and responsible; rather, we are free and responsible because – and precisely to the extent that – we make decisions.

Life itself is characterized by indeterminacy, non-closure, and what Whitehead calls “spontaneity of conceptual reaction” (105). It necessarily involves “a certain absoluteness of self-enjoyment,” together with “self-creation,” defined as “the transformation of the potential into the actual” (1938/1968, 150-151). All this does not imply any sort of mysticism or vitalism, however; it can be accounted for in wholly Darwinian terms. In fruit fly brains no less than in human ones, “the nonlinear processes underlying spontaneous behavior initiation have evolved to generate behavioral indeterminacy” (Maye et al. 2007, 6). That is to say, strict determinism no longer applies to living things, or applies to them only to a limited extent, because “freedom,” or the ability to generate indeterminacy, has itself been developed and elaborated in the course of evolution. As Morse Peckham speculated long ago, “randomness has a survival value. . . The brain’s potentiality for the production of random responses is evolutionarily selected for survival. As evolutionary development increases and more complex organisms come into existence, a result of that randomness, the brain’s potentiality for randomness ac-

cumulates and increases with each emerging species” (1979, 165). The power of making an unguided, and unforeseeable, decision has proven to be evolutionarily adaptive. Some simple life processes can be regulated through preprogrammed behavior; but “more complex interactions require behavioral indeterminism” in order to be effective (Maye et al. 2007, 8). Organisms that remain inflexible tend to perish; the flexible ones survive, by transforming themselves instead of merely perpetuating themselves. In this way, the “appetition of self-preservation” itself creates a counter-appetition for transformation and difference. Life has evolved so as to crave, and to generate, novelty.

Of course, the sort of “freedom” described by Whitehead, and recently discovered in fruit flies, is not the same as Kant’s notion of noumenal moral freedom, or other traditional notions of “free will.” Whiteheadian freedom is not absolute in this sense. It is, however, self-generated, and irreducible either to external contingency or to internal predetermination. As the scientists involved in the fruit fly study put it, “free” behavior exists in “the middle ground between chance and necessity,” or in “a brain function which appears evolutionarily designed to always spontaneously vary ongoing behavior” (Brembs 2007). Such spontaneous variation may be seen as an empiricist conversion, or a phenomenalization, of Kant’s notion of freedom. In Whitehead’s account of final cause and decision, as in Deleuze’s account of quasi-causality and the virtual, the ghost, or the trace, that the noumenal leaves in the phenomenal world is more an absence than a presence, more a vacuum than a force. If life is a locus of appetition and decision, this can only be because, as Whitehead suggests, “life is a characteristic of ‘empty space’... Life lurks in the interstices of each living cell, and in the interstices of the brain” (1929/1978, 105-106). Life involves a kind of subtraction, a rupturing or emptying-out of the chains of physical causality. As a result of this de-linking, “the transmission of physical influence, through the empty space within [the animal body], has not been entirely in conformity with the physical laws holding for inorganic societies” (106). These empty spaces or interstices are the realm of the potential, or of the virtual. Interstitial life points towards a futurity that remains open: one that is not entirely determined by the present.

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