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THREE TASKS FOR (HARD INTERACTIONIST) DUALISTS

Opponents of psychophysical dualism hold that the problems of dualism are many – and insurmountable. I have answered to this allegation elsewhere (in my book *The Two Sides of Being*). In this paper I will take a look at what are the problems of dualism if one has a positive attitude towards dualism and indeed accepts it as the basically correct metaphysical interpretation of the mind-body relation. Perhaps, therefore, one should rather speak of *tasks* than of problems. What are the *tasks* of dualism? Or rather: what are the tasks for *dualists*, be they scientists or philosophers? In the end, this question will lead us into investigating whether classical physics is indeed deterministic. But the first question to be asked is this: What is dualism?

I will restrict my attention to psychophysical dualism; accordingly, I shall use the word ›dualism‹ in the sense of ›psychophysical dualism‹. Broadly conceived, *dualism* is the doctrine that there is a nonphysical side to the mental: not everything that is mental is physical.[1] The doctrine seems plausible and harmless enough. But at the beginning of the 21st century – at the latest – it has mutated from a doctrine that seemed to most philosophers obviously true to a doctrine that seems to most philosophers in the western hemisphere obviously false. In fact, dualism is today more or less openly regarded as a doctrine the asserting of which is both intellectually disqualifying and reprehensible in a quasi-moral sense. This, in the olden times, was the very way to look upon the heresy of atheism. Curiously, dualism has turned into a modern heresy against the ruling modern orthodoxy.

There are various forms of dualism: property dualism, substance dualism, event dualism. *Full dualism* is the doctrine that nonphysical mental substances have nonphysical mental properties and are undergoing, in the course of time, nonphysical mental events. There are several varieties of full dualism. If it is enhanced by the doctrine that no nonphysical mental entity causes any physical event, then we have the epiphenomenalistic variety of full dualism. In contrast,

[1] I suppose some who call themselves ›dualists‹ will consider this a broadly Cartesian conception of dualism, and propose a non-Cartesian conception instead. But a doctrine that does not entail the thesis that not everything mental is physical I would not consider to be dualistic at all.

if it is enhanced by the doctrine that some nonphysical mental substances cause some physical events, we have one of *several* non-epiphenomenalistic – in other words, *interactionist* – varieties of full dualism.

People who, in addition to full dualism, assert the causation of physical events not only by nonphysical mental events, but also by nonphysical mental substances certainly maintain the kind of dualism that is most offensive and ridiculous to physicalists. Let me call this kind of dualism *hard dualism*. Note that the repugnancy of hard dualism to physicalists can be considerably reduced by merely taking to heart the simple conceptual fact that the existence of a nonphysical causal agent does not ipso facto imply the existence of a *supernatural* agent.[2] As far as the conceptual situation is concerned, a nonphysical causal agent can be as much a part of nature as any physical event. In other words, if there were no *natural* nonphysical causal agents, then this would have to be the case for reasons that are not of a purely conceptual nature.

I do believe that hard dualism is true. But, assuming its truth, what are the *problems* of hard dualism – or rather, what are the *tasks* a hard dualist has to tackle? Think of hard dualism as defining a research program. What are the items on the list? I will offer a few such items, tasks for dualists that seem central to me. In doing so, I will speak simply of ›dualism‹ and ›dualists‹. But one should keep in mind that I have in mind *hard dualism* and *hard dualists*.

1. First task: descriptive phenomenology

Unless one is acting like the conservative intellectuals who refused to look through Galileo's telescope (see Brecht's play, *The Life of Galileo*), one has to admit that besides the world outside of one's body and the world inside of one's body there is – at least – a third world: the world of one's phenomenal consciousness. Have you (gentle reader) ever seen the space between railroad tracks turn into a very rapid dirt-colored torrent, running in opposite direction to the accelerating train? That apparent torrent is neither in your body nor outside of it, nor somehow in between; it is not a spatiotemporal part of the physical world, nor does its being merely consist in its linguistic description, as Daniel Dennett would have it (see his book *Consciousness Explained*). No, that torrent is a concrete nonphysical entity: it is a phenomenon, an appearance. The appearance we are considering is illusory – that is, what it presents as existing in the outside world does not in fact exist. But that does certainly not compromise its – *nonphysical* – real-existence qua appearance, qua a certain mental event.

[2] The fallacious inference of *x is supernatural* from *x is nonphysical* persists in spite of David Chalmers' conception of a »naturalistic dualism« (see Chalmers 1996, 128).

One task for dualists is to *systematically* describe the phenomenal world, the world of appearances. One of the effects of doing so (another one being the gaining of an immense amount of *psychological* knowledge), I expect to be the regaining of a proper sense of the reality of the phenomenal - or *inner* - world. Needless to say, the current philosophy of mind - 90 % percent of which is eager to reduce the mental to what is not mental - shows no signs of a proper sense of the reality of the inner world.

It should be noted that the world outside of one's body, just as the world inside of it, is only present to us insofar as parts of it are the intentional objects of appearances, of phenomena. Thus it is a part - and indeed the main part - of describing the phenomenal world to delineate the ways in which physical objects and the minds of other living beings are present to us in experience.

The task I have in mind is, of course, not a new task. It was famously proposed by Edmund Husserl, who, in addition to proposing it, also worked very hard, and unfortunately with increasing solitariness, to fulfill it. The task, however, is too great for any single human being to fulfill. Like physical science, descriptive phenomenology must be an *intersubjective* undertaking.

And it *can* be such an undertaking; for although the phenomenal consciousnesses of different people are indeed boxes into which no one but the owner can look (as Wittgenstein observed), we can - and do - proceed on the assumption that what the boxes contain is fairly similar, and indeed basically the same, for everyone. The truth of this assumption is strongly suggested, though not proven, by the fact that we do have an intersubjective language about subjective experiences. An imperfect language, no doubt. But presumably it can be improved by the systematic efforts of trained specialists: phenomenologists.

The intersubjective similarity of subjective experience is just one more aspect of the remarkable epistemological luck we human beings enjoy, another aspect of it being, for example, the constancy of physical regularities. Holding that there is such intersubjective similarity and that there is such constancy is, of course, ultimately a matter of faith, and we may count on it that the skeptics of all ages will never become tired of inferring the irrationality of an assumption from the uncertainty of its being true. This irrationality of the skeptics should not keep us from going ahead with our epistemic projects, whether it is the specification of the laws of nature, or the description of the intersubjective structure of subjective appearance.

2. Second task: correlation research

Though the phenomenal world of each of us is a third world apart from the world inside of our body and apart from the world outside of it, it is certainly not unrelated to these latter worlds. Far from it. And hence there is a second task for dualists: to describe as precisely as possible the relationship between the phenomenal world of a subject and the beings which are not phenomena, meaning: not phenomena for the subject concerned. A prominent class of non-phenomena is constituted by the physical entities. And therefore a prominent part of the indicated second task for dualists is *psychophysics*, broadly conceived.[3]

In fact, in recent years one particular branch of broadly conceived psychophysics seems to have made considerable advances. I am referring to *correlation research* – the search for the neural correlates of subjective experiences.[4] It should be noted that everyone who engages in such research is willy-nilly adopting a dualistic stance and is doing the work of a dualist who is undertaking to fulfill my second task for dualists. For researchers who are looking for the neural correlate of a subjective experience are not intending to correlate a brain state with itself or with another brain state, nor are they intending to correlate a brain state with behavior, linguistic or otherwise. They are intending to correlate a brain state with a *subjective experience*, which, being nonphysical and subjective, is neither inside nor outside the body of the subject who has the experience.

In what sense, then, can brain state and subjective experience be correlated? My own answer to this crucial question (expounded in my book *The Two Sides of Being*) is that correlated brain states and subjective experiences are, by natural necessity (that is, due to laws of nature), *causally equivalent*, where causal equivalence means that they have the same causes and the same effects.[5] But if a brain state and a subjective experience are causally equivalent, then the subjective experience will have physical effects, since the brain state itself will certainly have physical effects. Thus, the causal equivalence of brain states with subjective experiences implies, under dualism, the *nonphysical causation* of physical events. How can *this* be?

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[3] But it is only a part even with regard to physical entities. Phenomenologists, for example, will explore the *intentional relation* between subjective experiences and physical entities, and in doing so they are certainly not doing psychophysics.

[4] A closer look reveals that the progress made is not as great as it is often claimed to be. The correlations that have, to date, been established between what is happening in consciousness and what is happening in the brain cannot even be called rough. Some physicalistic philosophers have for this very reason (it being the *unofficial* reason, of course), adopted the desperate position of mental eliminativism (as the only way to save their physicalism). By eliminating the mental, they are also eliminating correlation research.

[5] Note that physicalists *must believe* (whereas dualists *need not, but can believe*) that every subjective experience is causally equivalent to a physical event. For if some subjective experience were not causally equivalent to *any* physical event, then it would follow that it is itself *not physical*. This is simply a consequence of the logic of the concept of causal equivalence. On the other hand, a dualist's belief in the nomological causal equivalence of subjective experiences with certain physical events is likely to be motivated by his desire to connect the physical with the mental as closely as is possible from his dualistic point of view.

It is a curious fact of the history of philosophy that so many philosophers have complained about the incomprehensibility of nonphysical mental causation of physical events, considering that the overwhelming majority of the many philosophical conceptions of causation on offer does not give any grounds for supposing that there is anything particularly incomprehensible about the nonphysical causation of physical events. It should be noted that the principles of causal closure of the physical world – constantly invoked against the nonphysical causation of the physical – are neither principles of the logic of causation nor principles of physics, but postulates of materialist metaphysics. As such, the closure principles are, of course, begging the very question which is at issue.

But does not physics itself tell against the nonphysical causation of the physical? It does not. In the first place, it is rather unclear whether the concept of causation is indispensable for physics. The concept of *force* is the place where causation must come into physics if it comes into physics at all, and it must be admitted that there is much causal talk surrounding that concept, even among physicists. But this causal talk seems to be entirely due to extra-scientific motivations and associations. For, regarded purely as a concept of *physics*, the (net) *force* a particle is subjected to at a time t is definable as the (net) change of momentum that the particle undergoes in an infinitesimally small interval of time surrounding t,[6] in analogy to the definition of the particle's (net) acceleration at t, which is defined as the (net) change of velocity that it undergoes in an infinitesimally small time-interval surrounding t. There certainly seems to be not a glimpse of causation in the suggested definition of *force*.

It is alleged again and again that the nonphysical causation of physical events is bound to violate received physics because it, allegedly, entails the violation of the law of the preservation of energy, or the violation of the law of the preservation of momentum. Repetition does not make false allegations any less false. First, in physics, the mentioned preservation laws are always asserted under the condition that the physical system with regard to which they are asserted is a so-called *closed system*: that no energy or momentum is coming into the system from entities that are outside of it, or is going out of the system to entities outside of it. Now, physics is silent on the question whether *the entire physical world* is a closed system. Moreover, it does not seem to be an analytic truth that the physical world is such a system. It follows that in order to have the nonphysical causation of physical events conflict with the preservation laws, it is necessary to go beyond physics and to assume the *metaphysical* hypothesis that the physical world is a closed system.

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6 This definition follows Newton's original formulation of his Second Law of Motion. Since it does not presuppose the constancy of mass, it is more general than the usual definition of force, according to which it is the product of mass and acceleration.

Making this assumption is a necessary condition for obtaining a conflict; but, note, it is not a sufficient one. For suppose, for the sake of the argument, the physical world were indeed a *closed system*. Consider then: does the occurrence of an instance of nonphysical causation of a physical event necessarily entail that the sum total of energy or of momentum in the physical world is any greater or smaller than before – *in spite of* the physical world being a closed system, as we have supposed for the sake of the argument? Suppose the instance of nonphysical causation we are considering is due to a subjective experience, by natural necessity causally equivalent with a brain state. It is evident that *this* kind of nonphysical causation, which is entirely in step with physical causation, violates neither the law of the preservation of energy nor the law of the preservation of momentum if *physical causation* violates neither law. And everybody agrees that physical causation violates neither one of the two laws, even supposing that the physical world is a closed system. Thus, there is no objection that comes from the direction of physics against conceiving of the correlation between brain states and subjective experiences as – nomologically established – causal equivalence.

3. Third task: the exploration of nonphysical mental causation of the physical without accompanying physical causation

But what about nonphysical causation of physical events *without* equivalent physical causation, say, without *any* accompanying physical causation at all? Dualists, it must be admitted, are rather interested in this type of nonphysical causation; *hard dualists* can hardly avoid believing in it. Would not the occurrence of nonphysical causation of physical events without accompanying physical causation get into conflict with physics?

No, it would not, not even under the metaphysical supposition that the physical world is a closed system: because an instance of nonphysical causation of a physical event without accompanying physical causation would leave the sum total of energy and momentum unchanged. It would merely involve a redistribution of energy and momentum. Redistributions of energy and momentum are, of course, happening constantly, and normally, it seems, one need not invoke nonphysical causation for having them come about. But, as most modern physicists hold, at least some of these redistributions are *not* determined by the energy/momentum distributions of the past. If this is true, then the physical past leaves a lacuna of determination that need not be left entirely to chance, but that can be, at least partly, filled by *additional* determination coming purely from a nonphysical source. In an indeterministic physical world, there *is* room for the nonphysical – specifically, the nonphysical *mental* – causation of physical events without accompanying physical causation.

It is a third, and the most challenging, task for dualists to explore this type of nonphysical causation. Let me call it *purely nonphysical* mental causation of the physical. Purely nonphysical mental causation of the physical, if it occurred, would not originate in subjective experiences, since subjective experiences are causes only in unison with their physical causal equivalents (at least in my eyes). Purely nonphysical mental causation of the physical would originate in the mental subject, in the nonphysical individual, wholly present at each moment of its existence, which is the center of consciousness: in the nonphysical substantial *self*. Since purely nonphysical mental causation of the physical presupposes physical *indeterminism* and originates in a substantial *nonphysical mental agent*, I will also call this kind of causation *free nonphysical agency*.

Supposing that free nonphysical agency exists – physicalists, of course, do everything to make this supposition appear absurd –, the fundamental question to be answered by dualists, if they are to fulfill the third task that I have specified for them above, is this: how does free agency fit naturally into a dualistic framework – in such a manner that it does not get into conflict with anything we know about the brain, perhaps even in such a manner that free agency is positively supported by some things we know about the brain?

As far as we bodily existing human beings *know*, the nonphysical mental subject does not exist without a functioning brain.[7] But although the nonphysical mental subject, as far as we know, depends for its nonphysical existence on the brain, it is not a superfluous ghostly excrescence of the brain, but has certain *evolved functions*, via the brain, for the organism as a whole. Its first function is that of being the center of another nonphysical product of the brain: of consciousness. A mental subject is a subject of consciousness. Its second function is that of being a free agent, acting, via the brain and body, on the behalf of the organism, in the service of its survival (or at least its well-being), *within a certain scope of prior indetermination*.[8] In addition to being a subject of consciousness, a mental subject is a subject of free agency – of free agency that is *guided* by the (non-determinative) information provided to it in consciousness.

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[7] But it is metaphysically possible that the mental subject exist without a functioning brain, and due to divine grace (but *not* due to the normal course of nature), this is perhaps (at some time) actually the case.

[8] *Avoidance* is one important type of antecedently undetermined physical action that a mental subject freely undertakes for its organism. It will hardly be considered surprising that this view of avoidance collides with Dennett's: »If we want to make sense of the biological world, we need a concept of avoidance that applies liberally to events in the history of life on Earth, whether or not that history is determined. This, I submit, is the *proper* concept of avoidance, as real as avoidance could ever be« (Dennett 2003, 60).

In the light of this last remark, it emerges that the first function of the mental subject – its being the subject of consciousness – is subordinate to its second function – its being the subject of free agency. And incidentally, we can now see what consciousness is *good for* (taking this seemingly teleological question, as evolution theorists are wont to do, in the following *non-teleological* sense: what is the reason for the persistence of consciousness in the course of evolution): it effectively provides the subject of consciousness with the information needed for acting successfully on the behalf of the organism, the organism to which consciousness (precisely speaking: a *particular* consciousness) and its subject (a *particular* subject of consciousness) are connected.

The difficult question is how the nonphysical mental subject manages to do all this. If there is an answer, it must be provided by the brain. I maintain that the brain is, among other things, (1) an instrument for the detection of macroscopic indetermination in the environment of the organism (including, as its limit, the organism itself) and (2) an instrument for restricting the detected macroscopic indetermination to the advantage of the organism. In short, I maintain that the brain is a DOMINDAR (Detector Of Macroscopic INDetermination, And Restrictor). This is a *bold* assertion because it has not seemed to most people that there is enough macroscopic indetermination in the physical world[9] to be either detected or restricted by anything. This, I believe, is a false impression.

But let me first show that the brain certainly *seems* to be a DOMINDAR. Suppose someone, George (precisely speaking: George-in-the-body), fleeing from his deadly enemies, comes to a crossroads. What is his brain doing? It prominently represents – in the foreground of consciousness, to the subject of George's consciousness, which in fact is George himself, I maintain – four alternative items as things he could do within the immediate future (and in the background of consciousness, an indefinite number of further alternative items as things he could also do): turn back, turn right, turn left, go straight ahead. If this representation of alternatives of action is veridical – and it certainly seems veridical to George (and would seem veridical to us if we were in George's place) –, then George's brain has served as a detector of macroscopic indetermination in the environment of its organism; for the representation in question is veridical only if at the time of the representation, given the entire physical past and all the laws of nature, the organism can indeed move in one or the other of four alternative ways (at least!): turn back, turn right, turn left, go straight ahead.

And George's brain not only appears to be a detector of macroscopic indetermination in the described situation, it also appears to be the restrictor of this indetermination. For once George has decided what to do (on the basis of the

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9 Indetermination is of course not *in* the physical world in the sense of being more or less literally a part of it. The quantity of indetermination *in* the physical world at a time t depends on the quantity of physically possible further world-courses that veer away from each other after time t.

conscious representations his brain makes him have), his brain will implement his decision and accordingly appear to *restrict* the previously apparent indetermination in the environment of George's body. Say, George effectively decides to go straight ahead, likely enough in the light of a brief rational deliberation, taking into account, say, the high probability of a helicopter waiting for him one mile ahead; then it is his brain that makes George's body (and with it George-in-the-body) *go straight ahead* (in the way so well explored by neurophysiology), excluding (or ›closing‹) thereby all the other alternatives for George and his body that previously appeared to be open to him at this particular juncture of his career.

Thus, it must be concluded that the brain *seems* to be a DOMINDAR. But is it in fact? If the macroscopic physical world is a deterministic world, or practically deterministic world, then the appearance that the brain is a DOMINDAR is an illusion;[10] for then there is certainly not enough indetermination in the macroscopic physical world to be either detected or restricted. But, assuming that macroscopic determinism rules in the physical world, one may well ask why the brain in each moment of conscious existence represents to the subject of consciousness alternatives of action which that subject does not in fact have, systematically misleading it. *If* macroscopic determinism rules in the physical world and we nevertheless for some reason have to have consciousness, why then do we not at least have a consciousness that truthfully tells us in each moment of conscious existence: *this*, and *this alone*, is what I *must* do? I have not seen a plausible answer to this question. The best that can be done by the supporters of macroscopic physical determinism may well be this: consciousness and the consciousness of free choice is just a freak of evolution. This is *very* unlikely, but nevertheless possible, and therefore I will not rest my case against assuming macroscopic physical determinism merely on the implausibility of the evolutionary freakishness of consciousness in general and of the consciousness of having free choice in particular (see Section 7).

4. The Libet-Experiment and the Brain as a DOMINDAR

This is the appropriate place for briefly addressing what the much-discussed Libet-experiment means for the brain's being a DOMINDAR. A detector of macroscopic indetermination and restrictor can be such a thing in two ways: *in its own right*, or *instrumentally for something else*. As I have presented matters, the brain is – among many, many other things, of course – an *instrumental* DOMIN-

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[10] The brain may still be a *potential* DOMINDAR. For more on potential DOMINDARs, see Section 6.

DAR *for something else*, namely, for the nonphysical self, which is at once the subject of consciousness and of agency. In my opinion, the brain is an instrument of detection and restriction of indetermination for that self, and not in its own right. This view of the matter has the advantage of *not* turning consciousness and self into phenomena that are superfluous from the biological point of view.

But it does have the disadvantage that it is vulnerable to a standard interpretation of the result of the Libet-experiment. This experiment is standardly taken to show that the brain does not wait for the self to initiate action, that it initiates action on its own, the self merely echoing the brain's decision. If this were the correct view of the matter, then the brain *could* still be a DOMINDAR – nothing in the standard interpretation of the result of the Libet-experiment tells against that. But it would have to be a DOMINDAR *in its own right*, and *not* instrumentally for the self.

Fortunately, the standard interpretation of the result of the Libet-experiment is by no means forced upon us. The standard interpretation is based on the problematic assumption that the moment when the self decides what to do is identical with the moment it becomes conscious of deciding what to do. Suppose the self's decision is in fact, as it should be, infinitesimally prior to the instrumental initiation of action by the brain, but the self becomes *conscious* of deciding only after the brain has already instrumentally initiated action, and therefore only after the self has already decided. Is this an absurd supposition? It is not. For making an informed decision, the self needs to be conscious of the facts relevant for the decision prior to making the decision; but for making the decision, and for making it in an informed way, the self certainly does not need to be conscious of making the decision at the very same time it makes it.

Being conscious of (presently) making a decision is not relevant for making the decision, neither regarding the *intending* of the decision (of course not), nor regarding its being actually made. The consciousness of making a decision has a different role to play in the economy of action, a role for which it is not necessary that the consciousness of making a decision occur at the very time when the decision is being made. Well, what *is* that role? It is this: the fact that we have decided so-and-so is likely to be in its turn something we need to be informed of in order to make further informed decisions; but for remembering that we have decided so-and-so, we must have been conscious of deciding so-and-so; this is why we become conscious of (presently) deciding so-and-so.

And the consciousness of a state of affairs *P* being presently the case is always somewhat later than the actual fact of *P*'s being the case; it is hardly surprising that the consciousness of making a decision is no exception to this general rule, which is due to the dependence of consciousness on neurophysiology. What is important from the biological point of view is that, in general, the consciousness of something being presently the case does not come too late for the self to react beneficially to the actual fact which is already in the past (which, note, need not preclude its still obtaining at present). For example, it is important from the biological point of view that, usually, the consciousness of several alternative possibilities being open does not come too late for the self to make a decision on which one of them is to be realized, and that, usually, the consciousness of making a decision does not come too late for the self to *revoke* that decision – which decision, indeed, has already been made, but which might still be kept from becoming fully effective.

5. How the brain can be a DOMINDAR

It is a necessary condition of the brain's being a DOMINDAR that there is indetermination in the macroscopic physical world, indetermination which is relevant for the survival of organisms, and enough of it to be detectable. Suppose the brain is in fact a DOMINDAR and there is a lot of biologically relevant indetermination in the macroscopic physical world. How does the brain detect it? And how does the brain transform what it has detected into the consciousness of possibilities of action *now* open to the subject of consciousness and agency?

Nobody, to date, knows the answer to these questions. Nobody, it seems to me, *looks* for an answer to these questions. The reason for this situation is that most researchers regard the macroscopic physical world as evolving deterministically (or *practically* deterministically, if they wish to honor what they believe to be the subatomically small probability that quantum indeterminism makes itself felt in the physical macro-world). The fact that much of what happens in the physical macro-world is entirely beyond the pale of predictability does not disturb the usual researchers in their dogmatic slumbers; they have so thoroughly internalized the lesson from chaos theory that unpredictability is no sure sign of indetermination, that they ignore the fact that unpredictability must nevertheless be regarded to indicate indetermination with a probability greater than 0.5 – in the absence of contrary evidence (and an a priori belief in determinism is *no* such evidence). It also does not disturb them that if determinism is taken to rule in the physical macro-world, then brains must be regarded as incessantly providing their users with ineradicable illusions that have no evolutionary point to them at all.

I have a few speculations to offer as to how the brain is a DOMINDAR. First of all, the brain is a fallible DOMINDAR: not always there is in fact the indetermination in the physical world that the brain tells us there is. Second, the brain does not tell us of *all* the indetermination there is in the environment of our body. We may be sure that some of this indetermination is not noticed by the brain at all, indetermination that is merely at the subatomic level, for instance. But probably there is also *macroscopic* indetermination in the environment of our body (which environment is taken to include, as its limit, the body itself, as I said) that the brain does not notice. From the indetermination the brain notices, it selects the indetermination worth reporting according to *relevancy* (for the survival, or at least the well-being, of the organism) and *restrictability* (since the biological point of detecting and reporting indetermination is to subsequently restrict that indetermination advantageously). I am not saying, however, that all physical indetermination that the brain reports to the self is biologically relevant to the organism and restrictable by the self of the organism. As in other areas of life, we may count on it that there is no perfect fit between a biological faculty and its evolutionary purpose. Sometimes a biological faculty is in error, failing to fulfill its evolutionary purpose, and sometimes it works – ›meaninglessly‹ – in excess of it.

Finally, the indetermination selected by the brain as worth reporting is classified according to relative importance, so that the self, in consciousness, is ultimately presented with a relatively clear spectrum of weighted alternatives open to it. Then the decision what to do is up to the self.

The crucial question is this: how does the brain manage to notice action-relevant macroscopic physical indetermination? The brain is a macroscopic organ monitoring the rest of the body, the outside of the body, and – least of all – itself. The monitoring is effected via the transmission of physical signals. The brain registers indetermination at a time t in the system that consists of brain, rest of the body, and outside of the body if the totality of the physical signals processed by the brain strikes at t a symmetrical pattern regarding future developments. In such a situation it becomes impossible for the brain to predict how, in certain respects, things will continue to happen. The brain registers this situation as a case of indetermination, and as a case of indetermination in which it is itself involved: in such a manner that the indetermination extends also to a relevant part of its own future activity. The brain may sometimes be wrong about this; for although in some cases the brain cannot predict how things will continue to happen, it is doubtlessly in some cases entirely determined how they will continue to happen – due to factors that are hidden to the brain. The important thing is that we cannot assume a priori that the brain *must always* be wrong when it translates unpredictability as indetermination. More likely than not, the brain is more often than not quite right in making this translation. In the final section of this paper, I will provide argument that is aiming to remove what is widely regarded as *the strongest objection* to this macro-indeterministic stance. Here, I offer, in support of it, the following evolution-theoretic considerations:

Evolution has led to the development of organisms with a monitoring and governing organ: the brain. But if determinism ruled in the physical macro-world, *brains*, we can take it, would never have developed. For what would have been the evolutionary advantage of their developing? If determinism ruled in the physical macro-world, then there would be nothing in that world that needs controlling, and hence nothing would need to be monitored or governed by any organ. For under determinism, everything happens automatically, with absolute precision and with inexorable necessity. Thus, unless there is indetermination of considerable extent in the physical macro-world, the emergence of brains is *absolutely pointless* from the evolutionary point of view. This is true if brains are regarded as entities that, under macroscopic physical indeterminism, would be DOMINDARs. But it is also true if we consider brains merely as highly complex *multi-possibility reactors*, much more complex than other multi-possibility reactors: cars, pianos, computers, etc., but nevertheless *reactors* of the multi-possibility type, which, if they function well, yield – according to the laws of nature that govern them, without any margin of indetermination – a specific physical output for each actualized physical input out of a set that comprises *several* possible physical inputs. Under macroscopic physical determinism, the structural complexity of *every* apparatus, natural or artificial, is *pointless* that makes in advance provision for realizing at a time *t* one or the other of several incompatible alternatives regarding the physical macro-world[11] – where each of these alternatives is possible at time *t*. Why provide for the realization of one or the other among several such alternatives – even if only in such a manner that the realization can merely be a law-determined *reaction* to a given physical condition, as in a multi-possibility reactor – *if*, under macroscopic physical determinism, it is true of only *one thing* at any moment in time that it *can* happen in the physical macro-world (namely, the one that does in fact happen)? When evolution ran a course that led, let's suppose, merely by (microscopic) accidental mutation and subsequent natural selection to the development of macroscopic devices that are geared for implementing *choices* (between at least two incompatible alternatives that are each possible at the time), had evolution then forgotten that macroscopic physical determinism is true? Was it ignoring it?

I am not saying, of course, that the development of such devices is *logically incompatible* with macroscopic physical determinism; for this determinism could, in principle, be of such a kind that the emergence of, say, multi-possibility reactors was itself determined.[12] This would be an *absurd* – that is, an *unnecessarily expensive* – course for nature to take,[13] and therefore a rather unlikely course (even for a complete mechanist regarding nature it remains true that nature *normally* follows the course which is the most economical), but it is *not* a logically impossible one.

Therefore, in asserting that if determinism ruled in the physical macro-world brains would never have developed, I am relying on an implicit inference to the best explanation.[14] Made explicit, it is the following inference: Organismic

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[11] In the car, this provision is manifested by the steering wheel; in the piano, it is manifested by the piano keyboard; in the computer, it is manifested by the computer keyboard.

[12] Daniel Dennett describes how this could be in 2003, ch. 2.

[13] Against the Dennettian speculations mentioned in the previous footnote, it should be remembered that nature certainly has no interest in making itself interesting (to *whom*?) by superfluous complexity.

[14] Compare: an inference to the best explanation is also at the basis of asserting the counterfactual ›If he were not at home, the light would not be on‹.

devices geared for implementing choices between several incompatible but possible alternatives which regard the physical macro-world are widespread throughout natural history, even highly complex devices of this kind, the most prominent examples being brains. The best explanation of this uncontroversial fact is that there are indeed innumerable *choices* that are organismically implemented, that is: that there do indeed exist innumerable organism-dependent realizations of one among several incompatible but at the moment possible alternatives regarding the physical macro-world. And this can only be the case if determinism is, to a considerable extent, *false*, even in the physical macro-world.

Inferences to the best explanation are fallible. But as long as there is no explanation of *the geared-for-implementing-choices fact* which is both better than the explanation that has just been offered *and* preserves macroscopic physical determinism,[15] I prefer to regard the impressive emergence of brains in the course of evolution as an indication of the great extent to which the terrestrial physical macro-world is undetermined (*prior* to additional determination). *Given* this massive macro-indetermination, the unpredictability with which brains are confronted in their monitoring and governing activity must indeed more often than not betoken indetermination.

Once it is accepted that the brain is often right in translating unpredictability as indetermination, and as indetermination about which something can be done (via the brain), the question arises in what manner it is determined *what will be done*; that is, the question arises in what manner it is determined how the detected indetermination will be restricted. There are two *salient* models for this. The first model can do without consciousness; it simply consists in this: the brain contains a physical chance generator (that is, a generator of *genuine* physical chance events: physical events without sufficient cause), and determining which alternative to realize from the several realizable alternatives the brain has detected is left to cerebral gambling (and subsequent mechanical cerebral processes), for which procedure, of course, consciousness is not essential. The second model cannot do without consciousness; for, according to it, consciousness is precisely the nonphysical medium in which several realizable alternatives the brain has detected are presented by the brain to the nonphysical self (under normal conditions, quite faithfully), who then, in the light of consciousness, makes an *at least rudimentarily rational decision* regarding which alternative to realize – a decision which may, but need not necessarily, be preceded by deliberation, which decision under normal conditions is quite faithfully put into effect by the brain, and which far too often turns out to be *the correct decision* than to be with any likelihood the result of a mere chance process. The instigation by the self of the brain to go into action in a certain manner is indeed an occurrence of nonphysical causation of the physical

[15] It is, of course, quite unwarranted to assume that any explanation that preserves determinism in the physical macro-world *must ipso facto* be better than any explanation that does not.

without accompanying physical causation. But this occurrence of nonphysical causation of the physical cannot interfere with physical causation and the laws of physics, because it is purely and simply the beginning of the realization of one among several *physical possibilities* – involving brain, rest of the body, and outer environment – that the laws of physics, the entire physical past and therefore the sum total of physical causation could not by itself exclude from happening.

And what about the, supposedly, big sticks that all physicalists carry even if they speak softly[16]: the principles of causal closure, the allegedly trusty weapons they are so very quick to wield if the world is to be made safe for physicalism[17]? Given that there is macroscopic indetermination in the physical world – indetermination that needs to be restricted somehow, since reality *will* continue in a unique way –, it is unwarranted metaphysical dogmatism to believe without reservation in the principles of causal closure of the physical world, be it the strong closure principle, according to which every cause of a physical event must itself be physical, or be it the weak closure principle, according to which every physical event that has a cause at all also has a physical cause.

Which of the two afore-mentioned models of action-determination is the correct one? Well, quite possibly they are realized side by side, each being correct in some cases. In any case, hard dualists will insist that the second model is not only feasible, and not only appears to be realized, but is *in fact* realized. The problem for hard dualists is that hardly anybody in the philosophical community nowadays believes this. Another bad reason for this attitude of disbelief – a reason that I have not yet touched on – is the following:

It is agreed on all sides that a rational decision is not a chance event. But most philosophers these days find it very difficult to distinguish between a rational decision and an event that is causally determined by a complex of desires and beliefs to which the event is, in addition, rationally adapted. In their eyes, what else could a rational decision be but just such an event? But a ›decision‹ in this widely accepted sense is not a *decision* properly speaking, because it is event-causally determined. One might as well call the turning back of a stone that has been thrown straight up into the air ›a decision‹, ›*its* decision‹. Moreover, in view of its event-causal determination, the so-called rationality of a commonly so-called rational decision is merely an irrelevant garnish. A rational decision *properly speaking* is determined only by the *decision maker*, freely (which implies: in a relevant situation of macroscopic prior indetermination), and *in the light* of his or her desires and beliefs, to which desires and beliefs the decision is rationally adapted by the choice of the decision maker, but which desires and beliefs *do not* cause it.

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16 Cf. a famous saying by Theodore Roosevelt, referring to diplomacy.

17 Cf. an equally famous saying by Woodrow Wilson, referring to democracy.

6. An abstract description of certain potential DOMINDARs and multi-possibility reactors[18]

For seeing more clearly in these matters, it is worth the trouble to give an abstract description of *finite time-invariant* multi-possibility reactors and *finite time-invariant potential* DOMINDARs. The description is abstract specifically in the regard that it abstracts from the macro-physical embedding of reactors and DOMINDARs, and also from the aspect of information-processing relating to the latter.

R is a (well-functioning) *finite multi-possibility reactor invariant in* T if and only if R is a device that guarantees for each moment t in the non-empty set of moments T the truth of a specific set of non-logical conditionals:

$$\textit{If } C_1 \textit{ at } t, \textit{ then } E_1 \textit{ at } t+\Delta$$
$$\vdots$$
$$\textit{If } C_n \textit{ at } t, \textit{ then } E_n \textit{ at } t+\Delta,$$

where, for each moment t in T, n is *the same* natural number greater than 1, Δ *the same* reaction-time, $C_1, \ldots, C_n$ *the same* antecedent in-principle-possibilities that logically exclude each other, $E_1, \ldots, E_n$ *the same* consequent in-principle-possibilities that logically exclude each other.

A *finite potential DOMINDAR invariant in* T is a device consisting of a (well-functioning) finite multi-possibility reactor invariant in T, R, and a (well-functioning) operative unit U with regard to R, which device guarantees that – at least at some time t in T and for some i and some j in $1, \ldots, n(R)$ with $i \neq j$ – U *can in principle* realize E_i at $t+\Delta$ by realizing C_i at t, and *can in principle* realize E_j at $t+\Delta$ by realizing C_j at t (where E_i, E_j, C_i, C_j refer to the consequents, respectively antecedents, of the conditionals specific for R, and Δ to the reaction time specific for R).

Clearly, neither the existence of finite time-invariant multi-possibility reactors nor the existence of finite time-invariant potential DOMINDARs is logically incompatible with determinism.[19] Under determinism, it has for ever been determined and hence necessary *which one*, if any, of the antecedent in-principle-possibilities $C_1, \ldots, C_n$ is realized at any time t, and also *which one*, if any, of the consequent in-principle-possibilities $E_1, \ldots, E_n$ is realized at $t+\Delta$. But this need not block the truth of any of the conditionals *If* C_1 *at t, then* E_1 *at* $t+\Delta, \ldots,$ *If* C_n *at t, then* E_n *at* $t+\Delta$, for any time t in T; nor, indeed, need it block the existence

[18] Multi-possibility reactors resemble Gary Drescher's *situation-action machines*. His *choice machines*, on the other hand, resemble DOMINDARs, though much more remotely. See Dennett's exposition on Drescher's situation-action machines and choice machines in Dennett 2003, 163.

[19] In fact, *compatibilists* (in the debate about free will) believe that the existence of suitably situated finite time-invariant multi-possibility reactors of suitable kinds is all that is needed *for making us free* even under determinism.

of a operative unit U that – at least at some time t in T and for some i and some j in 1, ..., n with $i \neq j$ – *can in principle* realize E_i at $t+\Delta$ by realizing C_i at t, and *can in principle* realize E_j at $t+\Delta$ by realizing C_j at t. Under determinism, it is *not* the case that U *can* realize E_i at $t+\Delta$ by realizing C_i at t, and *can* also realize E_j at $t+\Delta$ by realizing C_j at t; but this is quite compatible with U's being *in principle* able to realize E_i at $t+\Delta$ by realizing C_i at t, and also *in principle* able to realize E_j at $t+\Delta$ by realizing C_j at t.

Nevertheless, under determinism, finite time-invariant multi-possibility reactors and finite time-invariant potential DOMINDARs are like so many shiny tools lying around *unused*. Or *are* they used after all, namely, to deceive unsuspecting philosophers into becoming libertarians? But this is not the way nature works.

7. Is classical physics deterministic?

The existence of indetermination in the physical world is a necessary condition for dualists to have any chance to fulfill the third task that I have specified for them above: to explore nonphysical mental causation of physical events without accompanying physical causation. For without the existence of indetermination in the physical world, there could not be nonphysical causation – mental or otherwise – of physical events *without* accompanying physical causation. Now, quantum physics is usually taken to imply that there is indeed indetermination in the physical world. Hence the necessary condition for there to be nonphysical mental causation of physical events without accompanying physical causation is in fact fulfilled. But as long as existent physical indetermination is taken to be confined to the physical micro-world, purely nonphysical mental causation of the physical – originating, for example, in human selves – is not going to be taken seriously at all.

Classical physics, so the saying goes, is true in the physical macro-world to an exorbitantly high degree of approximation, and classical physics is deterministic, so the saying goes. It is questionable whether classical physics is true in the physical macro-world to an exorbitantly high degree of approximation (given that quantum physics rules in the physical *micro-world*). But I will not go into this. The question which I want to address at the end of this paper is whether classical physics is in fact *deterministic*.[20]

By *classical physics* I mean physics as it was prior to the revolution brought about by quantum theory. Putting the beginning of that revolution in the year

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20 That classical physics is deterministic – in what I will call *the interesting sense* below – has been denied by Earman in his well-known book, *A Primer on Determinism*. My own arguments, which will lead to the same conclusion, are certainly of a much more elementary nature than his.

1900 (when Max Planck made his great discovery), classical physics is therefore understood to be physics as it was at the end of the 19th century (hence classical physics is non-relativistic, since Einstein's reconceptualization of space and time came later). In effect, I will confine my attention to classical mechanics.

Consider, then, a very simple physical system within the physical world: just one material object X moving along on its path. Consider that system at a certain time t. According to classical physics, X has at t a determinate position, a determinate mass, and a determinate velocity. Do these data and the laws of classical physics by themselves *determine* the position, mass, and velocity of X at, say, $t+5$ *sec*? It seems not; there is another factor that must also be taken into account: it is the (net) force that X is subject to at t. In other words, *assuming* that the mass of X is constant at all moments t' between (and including) t and $t+5$ *sec*, we must also take into account the (net) acceleration of X at t. But let's suppose for simplicity's sake that the acceleration of X at t is 0. Is it now determined which position, velocity and acceleration X will have at $t+5$ *sec*?

No, of course not. If we want determination, we must add special suppositions – suppositions that guarantee *determination*, but at the same time take, so to speak, all the *sap* out of it. Here is one such supposition:

> The acceleration of X (hence also the force X is subject to) is 0 at all moments t' between (and including) t and $t+5$ sec.

If this is true, then X is bound to have at $t+5$ sec (and at all moments t' in between t and $t+5$ sec) the very same velocity that it had at t, *provided* that changes in velocity cannot happen abruptly[21] – which disruption, however, is excluded by Newton's First Law (the Law of Inertia); and if we put the quantity of the velocity of X at t as r m/sec, then X is bound to have at $t+5$ sec a position that is $5r$ m distant from the position where X was at t, in the direction of the velocity of X at t.

But does this result – a fairly trivial one, given the above supposition of constant zero acceleration – mean that the acceleration, velocity, and position of X at $t+5$ sec is, according to classical physics, *determined* by the acceleration, velocity, and position of X at t? It seems not. I might as well say that the amount of money I will have in 5 days is *determined* – according to classical economics – by the amount of money I now have, when all I mean to say is that in five days I will have the same amount of money I now have, *supposing* that I neither spend nor give away nor lose any of the money I now have in the ensuing 120 hours.

But is there not a sense in which classical physics is *properly speaking* deterministic? After all, everybody is supposing classical physics to be deterministic

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21 Otherwise the following could happen: the acceleration of X at t' is 0, and the velocity of X at t' is, say, 5 m/sec, and at the moments t'' after t' the velocity of X at t'' is 3 m/sec (the acceleration of X at t'' still being 0).

– deterministic in the *proper sense* of the word. Here it must be noted that there are *two* senses in which classical physics can be said to be, properly speaking, *deterministic*: one can mean by this *that the laws of classical physics are deterministic (i. e., non-probabilistic) laws*; or one can mean by this *that the physical world must evolve deterministically if classical physics is true*. It is very important to realize that these two senses are not equivalent. Classical physics is certainly deterministic in the first sense. But this does not by itself entail that it is also deterministic in the second sense – which is the sense that is relevant here, *the interesting sense*. Classical physics being deterministic in the first sense will entail its being deterministic in the second sense *only if* – and *if* – the laws of classical physics, besides being deterministic laws, are sufficient to describe the further evolution of the physical world *completely* if they are provided a *complete* momentary state of the physical world as the condition to work on, for example, *its initial state* (if it has one). Accordingly, the crucial question that must be answered when one is trying to decide whether classical physics is deterministic *in the interesting sense* – the sense from now on employed – is this: are the laws of classical physics, besides being deterministic laws, sufficient to describe the further evolution of the physical world *completely* if they are provided a *complete* momentary state of that world as the condition to work on?

Consider the entire physical world (here conceived of as fitting the laws of classical, 19th-century physics), and not merely some small physical system within it. Does not the determinate position, mass, velocity, and acceleration of *all* particles taken together at a moment of time *t determine*, according to the laws of classical physics, what will be the determinate position, mass, velocity, and acceleration of *all* particles at, say, $t+5$ *sec*?

No, the former total state does not by itself determine, according to classical physics, the latter. To guarantee determination one must make, among other *additional assumptions*, the following assumption:

(i) The physical world is a closed system.

If hypothesis (i) is not assumed, the entire physical world is as liable to be disturbed from the outside as is the above-considered smallish physical system within that world. But this hypothesis, as I had occasion to observe earlier, is not analytically true and not a principle of physics; nor is it a principle of *classical* physics, if classical physics is to be an empirical science. Hypothesis (i) is a *metaphysical assumption*, exceeding what can be empirically ascertained about the physical world.[22] Taking classical physics to be an empirical science, and therefore *neutral* regarding the metaphysical question whether the physical world is a closed system or not, we can conclude that classical physics is, as a matter of fact, *not deterministic* –

[22] Nevertheless, in the light of the Big Bang being an empirical fact, the metaphysical assumption that the physical world is a closed system does not appear as plausible as it used to.

because it does not include a hypothesis whose inclusion is necessary for rendering it deterministic.

Now suppose we extend classical physics to form a *metaphysics* – call it ›classical superphysics‹ – by adding to classical physics, *to the (by and large) empirical basis*, (a) the hypothesis that the physical world is a closed system, and (b) *at least two other hypotheses*, which I shall immediately consider below. Thus, if classical superphysics is true, so must be classical physics; but the converse of this is not valid, since there are models of classical physics which are not models of classical superphysics. This relationship between classical physics and superphysics is often obscured by the fact that the truth of the three hypotheses just mentioned is taken for granted. Under such – philosophically accidental – circumstances, classical physics appears to be *identical* with classical superphysics.

In contrast to classical physics, classical superphysics *is* deterministic (in the interesting sense): it is simply defined to have all that is needed for this; but its chance of being true is, obviously, considerably less than the chance of being true that classical physics has. Its chance to be true is so much less than the chance of classical physics to be true that there is not much reason to believe in classical superphysics – unless, of course, one's metaphysical equanimity absolutely depends on believing in it. But unfortunately *the empirical science of classical physics* has constantly been – and still is – confused with *the larger metaphysical system of classical superphysics*, with the deplorably irrational effect that the considerable empirical authority of the former is without subtraction spuriously transformed into the same amount of metaphysical authority of the latter.

What are the other two hypotheses I just mentioned as being included in classical superphysics, which hypotheses, together with hypothesis (i) and the principles of classical physics, are responsible for classical superphysics' deterministic nature? It is the hypothesis that

(ii) the principles of classical physics are fit to describe the evolution in time of an infinitely complex object: the entire physical world,

and the hypothesis that

(iii) the concepts incorporated in the laws of classical physics allow a complete momentary specification of motion.

Neither of these two hypotheses is obviously true; in fact, they can easily appear to be false.

Consider hypothesis (ii). The principles of classical physics that describe change refer to only a few entities at a time. This will (in principle) do if, and only if, the entire physical world is nothing over and above a huge collection of fields and particles. For then it will be guaranteed that its evolution in time is just the sum of the evolution in time of all its members. But it is doubtful whether the physical world is just a collection of fields and particles. It may have the nature of a whole whose behavior is not – not entirely, at least – a function of the behavior of its parts. If this is in fact the case (and quantum physics, by the way, provides evidence that it is), then the principles of classical physics will not be fit to describe the evolution in time of the entire physical world, and hence classical superphysics will be false, since one of the hypotheses defining it is false, and classical physics, in its turn, will not only not entail physical determinism (which we have already seen), but not even betoken it – not even if classical physics is true and is helped by the metaphysical hypothesis that the physical world is a closed system.

Consider hypothesis (iii). What could be doubtful about this hypothesis? – I will not address the empty possibility that there might be hidden variables of motion that classical physics does not take into account. What I have to offer is much more palpable. The rate and direction of the change of spatial location are captured by the concept of *velocity*. And, of course, velocity is not the only kinematic concept: the rate and direction of the change of velocity are captured by the concept of *acceleration*. But this is not the end of it. Not only velocities change, but also accelerations. Hence there is room for applying the concept of *second-order acceleration*, which is the concept that captures the rate and direction of the change of (first-order) acceleration. But of course second-order accelerations change, too. Hence there is room for applying the concept of *third-order acceleration*, which is the concept that captures the rate and direction of the change of second-order acceleration. And so on. We are, therefore, confronted with an infinite hierarchy of *kinematic concepts* – and, corresponding to it, with an infinite hierarchy of *dynamic concepts*: (first-order) force, second-order force, third-order force, … –, the applicability of none of which concepts can be a priori excluded. But classical physics – as represented by its laws – confines its attention to merely *two* kinematic concepts (and, correspondingly, to only *one* dynamic concept), the kinematic concepts that stand at the beginning of the envisaged infinite hierarchy: *velocity* and *acceleration*; these two are the kinematic concepts that classical physics is focused on in its momentary specifications of motion. This remarkable restrictedness will be unproblematic if the other kinematic concepts of the hierarchy are *not really needed* for giving a complete momentary specification of motion (as would, for example, be the case if their values were somehow determined by the values of the two initial kinematic concepts, or if one could simply assume what one, in fact, cannot assume: that the values of all higher-order accelerations are equal to 0 at all times). But it seems quite unwarranted to suppose that higher-order accelerations are ›not really needed‹. The concept of second-order acceleration, for example, comes to mind for reasons that are entirely analogous to the reasons for introducing the concept of (first-order) acceleration, and it is agreed on all sides that the concept of acceleration is *needed* for giving a complete momentary specification of the motion of a particle. Why, then, should there not be some cases, at least, where the concept of second-order acceleration is also *needed* for that specification?

These considerations have consequences for the question of physical determinism, as is easily seen. Let the mass, position, velocity, and acceleration of every particle in the physical world at a moment of time *t* be determinate, and let the physical world be a closed system that – let's assume – is simply the sum of all its elements. Given this basis, Pierre Simon de Laplace, for one, was confident that the further course of the physical world is determined down to the smallest detail by the laws of classical physics. But how could he be so confident, considering that these laws do not refer to second-, third-, fourth-, fifth- and all the rest of higher-order accelerations or the corresponding higher-order forces? Whether, for example, the second-order acceleration of a particle X is at *t* 5 m/sec^3 or 3 m/sec^3 in direction D – is not this going to make a difference for the future of the physical world? This is as likely to make a difference for the future of the physical world as it is likely to make a difference for that future whether the acceleration of particle X at *t* is 5 m/sec^2 or 3 m/sec^2 in direction D. And, significantly, the second-order acceleration of X at *t* is just as little fixed merely by the position, velocity, and acceleration of X at *t* as the acceleration of X at *t* is merely fixed by X's position and velocity at *t*. Laplace certainly thought that the totality of the force-laws of classical physics (for example, Newton's law of gravitation, and any other such law, known or not) fixed the acceleration of every particle in the world at any moment *given* the position and velocity of every particle in the world at that moment. But even this – coming to think of it – was a very audacious presumption; regarding higher-order accelerations, however, we are left quite in the dark by classical physics.

Thus the conclusion appears to be unavoidable that the concepts incorporated in the laws of classical physics do not allow a complete momentary specification of motion.[23] But this can only mean that the question of determinism for the physical world is, from the standpoint of classical physics, wide open. Let a momentary state of motion be *total* if it specifies, for *every* particle, the momentary value of a kinematic concept, and let it be *complete for a particle* X if it specifies for X the momentary value of *every* kinematic concept (position, velocity, acceleration, second-order acceleration, third-order acceleration, etc.). From a point of view *prior* to quantum physics (and relativistic physics), it *is* plausible to assume that there is a *universally complete* (i.e., *for every particle complete*, hence also total) momentary state of motion for each moment of (absolute) time *t*, in which state of motion the momentary values of position, velocity, acceleration, second-order acceleration, third-order acceleration, etc. (*ad infinitum*) are for each particle precisely fixed and determinate. But even from *that* point of view, there is no reason to assume that the *fully adequate* laws (going beyond the laws of classical physics) that rule these universally complete momentary states of motion are deterministic, or even to assume that there are *any* fully adequate laws that rule

[23] For more on this, see the Appendix to this paper.

them. Indeed, the deterministic laws of classical physics apply where they apply, and highly useful they are, but regarding the question of determinism for the physical world, they are *inconclusive*.

If what has been said above is correct, as I believe it is, then *classical superphysics* is, again, false, since another of the hypotheses defining it is false, and, again, *classical physics* will not betoken physical determinism – as physical determinism is usually understood: comprehensive determinism on the basis of the physical laws and a momentary state (of motion) of the physical world. The contrary impression that classical physics *does* betoken physical determinism is produced by the spell of special, simplifying *extra* assumptions in the background, assumptions regarding the temporal evolution of accelerations, higher-order or not, and by illicitly extrapolating determinism that holds in smallish special systems (like the solar system) to the physical world as a whole. *True*: the physical world might yet be a deterministic system. But the assumption that it *is* a deterministic system is a baseless metaphysical postulate, having no support in physics – even if we disregard quantum physics and confine our attention to classical physics (leaving it unexamined whether classical physics is in fact true in the physical macro-world).

Summing up: classical physics, which is an empirical science, is not deterministic; classical superphysics, which is a metaphysics built on top of classical physics (and containing it), *is* deterministic, but false. As we know today, classical physics is false, too. It is often asserted that classical physics is at least true in the physical macro-world to an exorbitantly high degree of approximation, and that it is therefore *excluding*, for all practical purposes, the occurrence of indetermination in that world. The first assertion *is* doubtful. But even if it were true, macro-determinists could draw little comfort from it. For classical physics itself is not deterministic. Thus one must indeed take seriously – and, in the light of *undefeated* bio-psychological evidence, consider *probable* – the hypothesis that indetermination is prevalent also in the physical macro-world, and already for reasons that have nothing to do with quantum physics.

Appendix: Higher-order accelerations and forces, computability and determinism

In physics, the concepts of (first-order) *acceleration* and (first-order) *force* are introduced as differential quotients in the following way:

> Let v be the momentary velocity of a particle, m its momentary mass, and p its momentary momentum, $p = m \cdot v$. Then the (net) momentary acceleration, a, of the particle is $\mathrm{d}v/\mathrm{d}t$, and the (net) momentary force, F, the particle is subjected to is $\mathrm{d}p/\mathrm{d}t$.

In classical (therefore non-relativistic) physics, the constancy of mass can be assumed, and using the equations $p = m \cdot v$ and $a = \mathrm{d}v/\mathrm{d}t$, we obtain from $F = \mathrm{d}p/\mathrm{d}t$:

$$F = \mathrm{d}(m \cdot v)/\mathrm{d}t = m \cdot (\mathrm{d}v/\mathrm{d}t) = m \cdot a.$$

The concepts of *second-order acceleration* and *second-order force* are introduced as differential quotients in the following way:

> The (net) momentary second-order acceleration, a^*, of a particle is $\mathrm{d}a/\mathrm{d}t$, and the (net) momentary second-order force, F^*, the particle is subjected to is $\mathrm{d}F/\mathrm{d}t$.

Assuming the constancy of mass and using the equations $F = m \cdot a$ and $a^* = \mathrm{d}a/\mathrm{d}t$, we obtain from $F^* = \mathrm{d}F/\mathrm{d}t$:

$$F^* = \mathrm{d}(m \cdot a)/\mathrm{d}t = m \cdot (\mathrm{d}a/\mathrm{d}t) = m \cdot a^*.$$

The concepts of the other higher-order accelerations – a^{**}, a^{***}, a^{****}, … – and the other higher-order forces – F^{**}, F^{***}, F^{****}, … – follow suit. Hence it can be shown (in classical physics) that, for any given particle and any time t with $v(t)$, $a(t)$, and $a^{*\cdots*}(t) > 0$,

$$p(t)/v(t) = F(t)/a(t) = F^{*\cdots*}(t)/a^{*\cdots*}(t) = m.$$

The concepts of second-order acceleration and second-order force are sometimes used by physicists (and used frequently enough for these concepts to have been given idiomatic names: the former is called ›jerk,‹ the latter ›yank‹). Thus, there is some recognition that position, velocity, and acceleration are not all there is to the momentary state of motion of a particle.

Each and every higher-order kinematic or dynamic function is easily definable within the conceptual framework of classical physics (we have just seen how). This is not the problem for someone who believes that classical physics entails determinism for the physical world. Rather, the problem consists (1) in the fact that every single particle has, at any moment in time t, in addition to its position (or location) $l(t)$, connected to it an infinite sequence of kinematic values: $v(t)$, $a(t)$, $a^*(t)$, $a^{**}(t)$, $a^{***}(t)$, … ∞, *which sequence might easily be not compressible* (in virtue of the laws of classical physics, or in any other manner), and (2) in the fact that the laws of classical physics do not take incompressible infinite sequences of kinematic values as input.[24] It has been observed, correctly, that determinism does not entail (corresponding) computability (nor computability determinism; see below). But this must not make us forget that computability is the only rational

[24] It seems safe to assume that appropriately adapted analogues of Newton's Three Laws of Motion hold for each higher-order force. In fact, we have just seen that this is true of Newton's Second Law. But this is of no help regarding the point in question.

epistemic indicator of determinism we could ever have. Where computability gives out, we have no clue that determinism is true.

The original Laplacian assertion of physical determinism was that, given $l(t)$ and $v(t)$ for *all* particles (point-masses, to be exact), where t is some moment in time, $a(t)$ is *in principle* computable for *all* particles on the basis of the force-laws of classical physics, and that *therefore* $l(t')$ and $v(t')$ – and $a(t')$, given $l(t')$, $v(t')$, and the force-laws – are *in principle* computable, and thus *determined, for all particles at any other moment in time* t'. Thus the Laplacian assertion leaves higher-order accelerations and forces and their possible influence on the course of the physical world quite out of the picture – as if there weren't any such things. In special cases, indeed, the force-laws of classical physics suffice to calculate also higher-order accelerations (as in the case of a pendulum, swinging freely under the sole influence of gravity, disregarding friction); but there can be no generalizing of these special cases. The problematic nature of the Laplacian assertion of physical determinism is also apparent in the fact that if the accelerations of some particles are subject to change in between t and t', then the methods of integration are essential for the computation of their locations between t and t', and these methods can only be applied (even by the Laplacian Demon) if the varying values of velocity for a particle plot a *describable* continuous function between t and t'. But whence is it taken that this necessary condition is fulfilled? And in particular, whence is it taken that this necessary condition is fulfilled if the Laplacian assertion of physical determinism is to imply more about *the physical future* than the trivial proposition that the physical future will be so and so if it will be so and so?

The necessary condition in question is often taken to be fulfilled in a rather simple way, as the following considerations will reveal. The infinite sequence $l(t)$, $v(t)$, $a(t)$, $a^{*}(t)$, $a^{**}(t)$, $a^{***}(t)$, … ∞ for a particle X is compressible at all moments t in a closed interval of real time, T, if (but of course *not* only if) some member $f_n[t]$ of that sequence is *constant* during T; for then the infinitely many members of the sequence that follow $f_n[t]$ are all rendered equal to 0, at all moments in T. A situation of compressibility of this type is (implicitly) assumed in many kinematic applications of physics; for (implicitly) assuming it is a particularly simple way of making an infinite sequence of kinematic values manageable. Of course, there is always the question whether the assumption is veridical – a question that may not be answerable in a definitive way. But if the value of, say, a higher-order acceleration for a particle X is indeed *constant* in T – say, taking the simplest case, $a^{*}(t)$ for X is 1 m/sec^3 in direction D, for each moment t in T –, then, on the basis of this constant value, the values of all corresponding lower-order kinematic functions for X – in the example: l, v, and a – are *computable* at each moment t in T, *except* for their initial values at the first moment t_0 in T, which values must be given – say, $l(t_0)$ for X is 0 m in all directions, $v(t_0)$ is 0 m/sec in all directions, $a(t_0)$ is 0 m/sec^2 in all directions. But, in the first place, the computability in question has nothing to do with physics proper and its empirical laws, but is almost entirely a matter of mathematics and the definitions of the kinematic concepts involved (the only thing not conceptually necessary about it is the T-constant value of the higher-order acceleration, and the T-initial values of the corresponding lower-order kinematic functions); and in the second place, it has nothing to do with determinism.[25] It is unfortunate that paradigms of computability essentially similar to the one just described have nonetheless contributed considerably to inculcating the idea that classical physics is deterministic.

References

Chalmers, D. (1996), *The Conscious Mind*, New York/Oxford: Oxford University Press.

Dennett, D. C. (1991), *Consciousness Explained*, Boston/New York/London: Little, Brown and Company.

Dennett, D. C. (2003), *Freedom Evolves*, London: Allen Lane.

Drescher, G. (1991), *Made-Up Minds: A Constructivist Approach to Artificial Intelligence*, Cambridge, Mass.: MIT Press.

Earman, J. (1986), *A Primer on Determinism*, Dordrecht: Reidel.

Husserl, E. (1982), *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy. First Book*, translated by F. Kersten, The Hague/Boston: M. Nijhoff.

Meixner, U. (2004), *The Two Sides of Being*, Paderborn: mentis.

Wittgenstein, L. (1953), *Philosophical Investigations*, German and English, translated by G. E. M. Anscombe, New York: Macmillan.

[25] On the basis of the computability in question, the future of particle X within the time-interval T *cannot* be regarded as being determined by its state of motion at t_0 and the laws of nature. Why not? Because a massive piece of information about that future is already fed into the computation: the constant value of the lowest kinematic function which has a constant value in T.