Introduction*

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The use of dispositional terms – be it as explanatory tools in physical theories (causal powers), in theories of chance (propensities), or theories of mind – has a long history in scientific theorizing, but so does the controversy concerning its legitimacy. There are, naturally, some aspects of dispositional discourse which are more accepted than others, aspects which moreover can be described in every-day terms by using dispositional predicates such as 'is fragile', 'is flexible', or 'is soluble': thus, to assert that a glass *a* is fragile is generally meant to support, in some sense, a conditional, namely that

(I) if *a* were dropped, it would break.

Such *subjunctive conditionals* – if supported by a dispositional ascription – characterise in hypothetical (but not necessarily counterfactual[1]) terms situations or sequences of events taken to be *manifestations* or *displays* of the disposition in question. Moreover, it seems uncontroversial that, in describing such manifestations, these subjunctive conditionals only involve 'manifest predicates', such as 'is dropped' and 'breaks' in our example.[2] Implicit in the

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[1] The subjunctive mood may be the most natural mood to express these conditionals, but only under the proviso [?] that we drop the counterfactual connotations usually associated with it in English.

[2] To find non-dispositional, or manifest, predicates of things we must turn to those describing events – predicates like "bends," "breaks," "burns," "dissolves," "looks orange," or "tests square." To apply such a predicate is to say that something specific actually happens with respect to the thing in question.' [N. Goodman (1965), *Fact, Fiction and Forecast*, New York, p. 41.]

hypothetical characterisation of dispositional manifestations – and to a large extent the source of many of the problems for dispositions – is the undisputed view that they need not always actually be manifest. It is this fact which provides one, if not *the* reason why dispositional ascriptions have been said to be fundamentally different from ascriptions of occurrent properties: a piece of glass may conceivably change its shape (a paradigmatically occurrent property), say from being spherical to being a polyhedron, but while it is spherical it is meant to be manifestly so at all times.[3] Last, but not least, there seems to be a general expectation that the ascription of a disposition ought to provide some kind of explanation concerning its manifestations, as is reflected in the schema which ROM HARRÉ calls the 'logical form of dispositions,' namely

(II) 'If x is (where to be, had been) in circumstances *A*, then it will (would) display occurrent property *B*, by virtue of an unobserved state *C*'[4]

The historical role of disposition in scientific thought is illustrated in the first half of HARRÉ's essay, where he discusses some of the attempts to solve the problem of whether and how the world is knowable to us who are only aware of the effects material things have on us. In NEWTON's time, he reminds us, there were two main metaphysical schemes available to natural philosophers to account for the observed properties of material things, namely micro-explanations in terms of unobserved atomic structures and causal power explanations. In his survey, HARRÉ looks at different *dispositional approaches* – that is, metaphysical theories which can be interpreted as attempts at establishing an ontology permitting the use of the disposition schema (II) in analysing the notion of a causal power – which have been put forward to this end since the seventeenth century. Any metaphysical theory of this type will face the 'non-manifestation problem' of dispositions, and HARRÉ distinguishes two types of solutions which he discusses in detail by considering, in particular, the views put forward by LOCKE in Book I, Chapter XXI of his *Essay* (1689), and by KANT in his *Metaphysische Anfangsgründe der Naturwissenschaft*[5] (1786).

[3] Indeed, it seems to be only in virtue of not having to display themselves that dispositions can have the sort of "ontologically fatal" manifestations of our example: once fragility actually manifests itself in the manner described in (I), the glass ceases to exist.

[4] Harré (this volume) p. 19

[5] Translated into English by E.B. Bax in *Kant's Prolegomena and Metaphysical Foundations of Natural Science*, London, 1883.

LOCKE's solution is simple: the ascription of the relevant disposition is legitimized even when it is not exercised because the state *C* it is grounded in is nothing but a cluster of (occurrent) primary qualities. The upshot of this sort of grounding is, of course, that causal powers *qua* unanalysable properties are eliminated from the fabric of the real world. The same is true of BOYLE's metaphysics, which HARRÉ considers to be in many respects superior to LOCKE's, if only because BOYLE does not transgress into a resemblance theory of ideas: 'Locke, misunderstanding the scientists' [BOYLES's] distinction between observed and unobserved qualities of material things, made all their real qualities unobserved, initiating three hundred years of confusion.'[6]

An alternative solution to the non-manifestation problem, which soon superseded the sort of reductionist schemes advocated by LOCKE and BOYLE, was to adopt a 'dynamical' ontology – i.e. to admit causal powers as primitive (unanalysable) and unobservable constitutents of the real world. GREEN, REID and BOSCOVICH[7] all favoured some variant of this dynamicist scheme. Its most sophisticated expression, according to HARRÉ, is that given in KANT's *Metaphysische Anfangsgründe*, where a unified dispositional account of both primary and secondary qualities as perceived by us is proposed. In KANT's system 'there are two fundamental powers which are to be ascribed as the basic properties to the punctiform elementary beings of the physical world. There is a positive power and a negative power and there are only these. These powers are manifested as forces, which produce a disposition (tendency) in other punctiform bodies to move with certain accelerations and in certain directions.'[8]

The move to adopt such an ontology allows for a purely dynamical solution to the non-manifestation problem in that it enables one to interpret the grounding property *C* in HARRÉ's dispositional scheme as such a primitive causal power. Yet is such a move legitimate? At least two conditions must be met for this to be the case. In a first instance, there is the logico-semantical requirement that the powers introduced be well-individuated, i.e. that one can give criteria as to when they are different and when are the same. Secondly, it has to be shown that the sort of ultimate, irreducible powers considered here can indeed legitimately be seen as *real properties.* These issues, however, are neither peculiar to eighteenth century metaphysics nor to dynamicist onto-

[6] *Op. cit.* p. 21
[7] Roger Joseph Boscovich S.J. (1711–1787)
R. Green (1678–1730)
Thomas Reid (1710–1796)
[8] Harré *op. cit.* p. 22

logies, indeed, they have been central in the dispute concerning the status of dispositions in the philosophy of science in the present century, which is why I propose a brief digression to sketch the views of some of the main protagonists in this recent debate.[9]

CARNAP's account of dispositions is an attempt to define ('explicate') dispositional predicates in terms of manifest predicates and logical expressions. The most natural choice of manifest predicates for such a reduction, say of the dispositional term $S(a)$ = 'a is soluble,' are the predicates of the associated subjunctive conditional:

(1) If a were put in water it would dissolve

(i.e. the predicates 'being put in water' and 'dissolves'[10]). The key to such an explication is meant to be found on the basis of the 'material correlate' of (1):

(2) a is put in water $\rightarrow$ a dissolves.

As it stands, (2) is clearly too weak to capture the meaning of '$S(a)$', and so the stronger

(3) $(\forall t)[W(a, t) \rightarrow D(a, t)]$,

– with $W(a, t)$ = 'a is put in water at t' and $D(a, t)$ = 'a dissolves at t' – is considered as possible *explicans* of the concept of being fragile. The resulting explicated concept, however, turns out to have the undesired feature of holding of any object which is never put in water. To overcome this, CARNAP moves to

(4) $(\forall t)[W(a, t) \rightarrow (S(a) \Leftrightarrow D(a, t))]$

which clearly avoids any entailments concerning the solubility of such objects. And yet, this move is again by no means uncontroversial: whereas it would have been reasonably clear how the dispositional predicate 'D' could have been eliminated, had the explication by means of (3) proven to be adequate, it does not seem obvious how a reductions could be achieved by means of the 'reductions sentence' (4). It has moreover been objected that both (3) and (4)

[9] In this I shall rely heavily on D.H. Mellor's 'In Defense of Dispositions', *Philosophical Review* Vol. 83 (1974) pp. 157–81, which I strongly recommend to anyone who is interested in arguments supporting the reality of unanalysable basic dispositions.

[10] An immediate problem with this attempt arises in the case of 'generic' dispositions – i.e. dispositions with many diverse types of manifestations (cf. G. Ryle, *The Concept of Mind* (1949), Peregrine Books London 1986, p. 114: 'the verbs which we report the different exercises of generic tendencies, capacities and liabilities are apt to differ from the verbs with which we name the disposition.') for they will not be adequately captured if the explicated concept is given in terms of the manifest predicates of just one of them, and it is not obvious whether a disjunctive adaptation might overcome this problem.

result in solubility/insolubility being *immutable* properties of objects. One could, of course, argue with PAP that dispositions are necessary properties of their bearers, in the sense that if a has a disposition and b does not, then a must be numerically different from b.[11] As concerns dispositions in general,[12] such a defense seems to me too Procrustean to be acceptable. Alternatively, we could follow STORER and interpret solubility explicitly as a time-dependent predicate:[13]

$$(5) \qquad (\forall t)[W(a, t) \rightarrow (S(a, t) \Leftrightarrow D(a, t)],$$

a move which MELLOR dismisses by commenting that 'what (5) says is plausible enough (and half true[14]), that whenever a is put in water it dissolves if and only if it is then soluble. But this is no news, and meets no objection to dispositions. Carnap's account is not right; but it is not trivial, as (5) is.'[15]

In Chapter 5 of *The Concept of Mind*, RYLE discusses the logic of dispositional statements. He first reminds us that sameness of grammatical form does not necessarily go hand in hand with sameness of use. In particular, he claims, 'there are lots of significant (affirmative and negative) indicative sentences which have functions other than of reporting facts.'[16] Amongst the latter are, says RYLE, all significant statements of natural laws which are true or false but which do not state the same sort of truths or falsehoods asserted by factual statements.[17] 'A law is used as, so to speak, an inference ticket (a season ticket) which licenses its possessors to move from asserting factual statements to asserting other factual statements.'[18] Even though dispositional statements

[11] Pap's argument is actually that dispositions are determined by natural kinds, which, in turn, are meant to be necessary properties in this sense. See A. Pap, *An Introduction to the Philosophy of Science*, New York 1962.

[12] It may well be that certain dispositions, such as the ones associated with the causal powers that Harré ascribes to his basic individuals, are indeed necessary properties in this sense. Nonetheless, as concerns dispositions generally, I tend to agree with Mellor who takes it as self-evident that they are mutable properties of their bearers.

[13] T. Storer, 'On defining Soluble', *Analysis*, Vol. 2 (1950–51).

[14] Mellor, I take it, would only be prepared to accept '$(\forall t)[W(a, t) \rightarrow D(a, t))$'. The 'other half' is meant to be false, since, according to him, a substance's dissolving when put into water cannot entail that it is soluble (see *op. cit.* p. 178).

[15] *Op. cit.* p. 161. I quite agree with this assessement of (5) as concerns its plausability and triviality. However, to me this simply indicates that (5) is not to be interpreted in terms of some reduction, but rather as an *axiom* for the (first-order) 'calculus of solubility', where 'S', 'D', and 'W' are all treated on a par as primitive terms. – Note, incidentally, that there is nothing in (5) which would single out 'S' as the term being reduced.

[16] *Op. cit.* p. 115.

[17] A factual statements, for Ryle, is one which asserts (or denies) that a mentioned concrete object (or a class of such objects) possess a certain attribute. All statements of mathematics and most of the ones of physics are thus *not* factual in this sense.

[18] *Op. cit.* p. 117.

(such as '*a* is soluble') are not statements of law – for they do mention particular things – they resemble laws, in RYLE's view, 'in being partly "variable" or "open." To say that this lump of sugar is soluble is to say that it would dissolve, if submerged anywhere, at any time and in any parcel of water.' [19] The resemblance is meant to be functional, which is to say that – in spite of sharing the grammatical form with factual statements – the function of '*a* is soluble' is not to make an attributive assertion about *a*, but to license certain inferences involving *a*. There is, for RYLE, therefore no problem of non-manifest dispositional properties, for the simple reason that there are no such properties at all. And yet, season tickets, be they for inferences or railway journeys, are not worth the paper they are written on if they are not backed by some licensing authority. One could, of course, adopt a regularity view and refer to the truth of the relevant law (dispositional) statement as sufficient authority in this respect. Such a move, however, does seem to be particularly unsatisfactory from an explanatory point of view: if one requires the licensing for a dispositional statement to have any explanatory force, there seems to be only one candidate for such a job, namely a property or state of the object referred to. In other words, if we wish some explanation – not just of the fact that a lump of sugar has dissolved (which can be given in deductive-nomological fashion by referring to the fact of it having been immersed in water and evoking the relevant 'solubility inference ticket'), but of the inference ticket itself – we have to introduce some grounding *property* or *state* of the disposition.

This, indeed, was ARMSTRONG's view in *A Materialist Theory of Mind*, [20] where the authority is taken to be some non-dispositional property providing what he calls the 'categorical basis' for applying the dispositional predicate: 'to speak of an object's having a dispositional property entails that the object is in some non-dispositional state or that it has some property (there exists a "categorical basis") which is responsible for the object manifesting certain behaviour in certain circumstances, manifestations whose nature makes the dispositional property the particular dispositional property it is'. [21] ARMSTRONG's solution to be non-manifestation problem is hence nothing else than a reduction to occurrent properties: he may well be a realist as concerns dispositions, but his 'Realist' position is certainly not that of a dispositionalist, if by that we mean someone who accepts the possibility of unanalysable basic dispositions. [22]

[19] *Op. cit.* p. 119.
[20] Routledge & Kegan Paul, London 1968 (in particular ch. 6, sec. 6).
[21] *Op. cit.* p. 86.
[22] Indeed, he presents 'an *a priori* argument which purports to prove the truth of the Realist account of dispositions,' [*op. cit.* pp. 164 f.] which Mellor discusses and rejects for being inconclusive.

MELLOR, in contrast, is unquestionably a dispositionalist: one of the stated aims of his 'In Defense of Dispositions' is to show that, a concerns reality, dispositions fare no worse than occurrent properties. [23] The proper role of dispositions, he tells us, is to explain their displays. Yet if a disposition lacks other criteria than the displays it is supposed to explain, it can hardly be regarded as providing a satisfactory explanation: 'explanatory dispositions require some independent basis for their ascription between displays, but the basis need only be another disposition.' [24] This precondition to possessing genuine explanatory power is indeed one of the two criteria MELLOR adopts to characterise real properties, and he points out a correspondence to *Nagel's* requirement 'to characterize as physically real only things that can be identified in ways other than, and independently of, the procedures used to define these things.' [25] The other criterion is a 'principle of connectivity,' which is again an explanatory principle, roughly speaking requiring 'that things cannot differ in just one property, since if they did, the difference would be inexplicable', [26] similar to the view (attributed to CLERK MAXWELL) that 'if a quantity is connected to other effects which are independently defined then it is a physical state, if not then it is a mere scientific concept.' [27] These principles are ontological as well as explanatory, and the identity of (real) properties, *Mellor* tells us, is *shown* by their role in explanation and *specified* by theory. [28] It is thus for physical theory 'to identify the property that *inter alia* supports 'fragile'. [...] But the distinction is not well put as that between "dispositions" and "real properties" since none but dispositional predicates need to be used to do the job'. [29] MELLOR's account, I believe, could provide a basis for a solution to HARRÉ's problem of how people could be brought 'to accept ungrounded, bare powers as the root properties of the basic constituents of the universe.' [30]

[23] Dispositions 'no more reify possible events than they require actual ones. They do not peculiarly entail subjunctive conditionals, nor are they peculiarly subject to the problem of induction. The problem is not that they are unobservable' [*op. cit.* pp. 173 f.]

[24] *Op. cit.* p. 174.

[25] E. Nagel, *The Structure of Science*, New York: 1961, p. 147.

[26] Mellor [1974], p. 175.

[27] *Op. cit.* p. 175.

[28] 'Intertial mass, for example, is shown to be a single property by the explanatory role Newtonian theory prescribes for it. We *could* construe a thing's inertial mass as a mere conjunction of two properties, one displayed in accelerations under forces up to (say) 1 newton, the other displayed in accelerations under greater forces. Each would have plenty of independent displays as far as our first principle goes; and any difference in one of these properties is always accompanied by a difference in the other. But we do not admit that such difference explains the other; Newtonian theory prescribes in effect that each merely manifests one underlying difference, in inertial mass, which itself therefore calls for further explanation.' [*op. cit.* p. 176].

[29] *Op. cit.* p. 177.

[30] Harré (this volume) p. 27

Realists, HARRÉ reminds us at the beginning of his essay, need to show that there are properties characteristic of the unobservable processes which their theories postulate as being responsible for what we can observe, properties which are at once independent of human sensibility and conceivable by human beings. In the third part of his essay, following his historical expositions, he turns to the related specific question of how we can have 'real causal powers which are nevertheless sensitive to the fact that the dispositions with which they endow physical particulars are relative to the particular apparatus in which they are manifested?' [30] He argues that the answer is to be found in a conceptually clarified ('demystified') version of BOHR's philosophy of science, which treats 'phenomena' as the focal point of the scientific enterprise, entities, that is, which are produced in a characteristic and indissoluble interaction between the generic 'stuff' of the world and our measurement apparatus. HARRÉ sees a deep affinity between this view and the KANTian theory about the way in which the experiential world is organized by means of the schematisms. The problem, of course, is whether such a view can be classified as realist. HARRÉ believes that this can be done, or rather that certain types of anti-realist relativisms can be avoided, provided that BOHR's philosophy is reinterpreted in terms of the GIBSONian [32] concept of *affordances*, which are dispositions 'the display of which occurs in circumstances created by, or relevant to, human interests.' [33] In the fourth and final section, HARRÉ turns to the role of powers in contemporary physics. The first issue he draws our attention to is that of the generic application of power/disposition concepts in electromagnetism. He discusses the application of the concept of causal powers to the analysis of 'charge' and 'field' and arrives at the conclusion that an ontology of basic powerful particulars not only can, but must suffice as basic ontology, i.e. as 'the nature of the world'. After a brief discussion of some problems with agentive causality – in which he compares this and MADDEN's [34] views with those of ARONSON – HARRÉ moves to an intriguing analysis of the identity conditions for physical powers, charges and forces. The issues addressed are, in particular, the sorts of identity expressed by 'same electron', 'same quark', and 'same power', [35] and why electrons or quarks should be candidates for the role of logical subjects to which causal powers are ascribed.

[31] *Op. cit.* p. 24
[32] J.J. Gibson, American cognitive psychologist.
[33] *Op. cit.* p. 25
[34] R. Harré and E.H. Madden, *Causal Powers*, Oxford: Blackwell 1973.
[35] As far as 'quark identity' and 'power identity' are concerned, Harré considers and rejects both the numerical and the qualitative identity of particulars and suggests that they ought to be analysed in analogy to Wittgenstein's treatment of sameness of pain.

JERROLD ARONSON's paper has two objectives. The major objective is to explore in what way FEYNMAN's formulation of quantum mechanics can be used to explain why the relative probability of finding a particle at a particular location equals the square of the wave function rather than the wave function itself. The other objective is to show how *Harré's* ontology of properties, dispositions and affordances nicely dovetails with FEYNMAN's formulation, given that suitable adjustments are made. This becomes clear once one sees how the alternative or possible path ontology leads to insights concerning the BORN interpretation.

In section two, the mystery of the BORN interpretation is introduced and a solution proposed by S.W. HAWKING is discussed. The overall conclusion of this section is that HAWKING's solution is inadequate but its use of FEINMAN path integrals suggests that one looks to FEYNMAN alternative path formulation of quantum mechanics for the answer to the mystery.

The essential features of FEYNMANian quantum mechanics are laid out in section three, including an explication of the three FEYNMAN rules of determining relative probalities. In doing so, it is shown how a tension develops between scaler and vector representations of possibilities and probabilities, that the notion of interfering possibilities, which lies at the heart of FEYNMAN's formulation, appears to be incompatible with the intuition that probabilities are proportional to the number of possibilities. Resolving this apparent contradiction is the key to understanding the BORN interpretation.

In section four, a first attempt is made to explain why the wave function squared gives the correct probability. This attempt involves adding a forth rule to the three FEYNMAN rules and introducing a "relativized unit probability amplitude." It is contended that the failure to relativize the unit amplitude of an alternative path is a major source of the mystery of the BORN interpretation. In the next section a deeper, full-blown explanation of why ψ^2 gives the correct probabilities is presented. Then problems with this account are discussed. The last section, finally, addresses the issue of the fit between the alternative path ontology with HARRÉ's relational ontology.

NANCY CARTWRIGHT's essay is concerned with the question as to which comes first, laws or capacities? As the relation between them is usually pictured, the two are depressingly symmetric and singling one out as more fundamental than the other often seems a matter of metaphysical whim. The paper argues that contrary to the fiction one usually constructs, laws are few and far between. With a few exceptions – like those for the planetary system – they exist only when we make them. To get a "law of nature" you need a stable arrangement of components with fixed capacities, well oiled, well shielded and repeatedly set running – one needs a *nomological machine.* Capacities do

not then line up one-by-one with laws that dictate what will happen when the capacity is realised. Capacities can be harnessed in different ways in different circumstances to do very different kinds of things. There is no limit to what they can do and there is no law, in the usual empiricist's sense of that term, that lays down the formula for calculating it. The defence of capacities, then, goes hand-in-hand with an attack on the axiomatisation image of theory. You do not get new laws by long chains of derivations from old. You have to build them – and that requires more the skills of the engineer than those of the logician.

RICHARD SWINBURNE begins his essay by reminding us of two important theses put forward by HARRÉ and MADDEN in *Causal Powers*, namely (1) 'that among the intrinsic properties which constitute the natures of individual things are their causal powers and liabilities' and (2) 'that causing is just the exercise of agency, not further analysable.'[36] He then turns to discuss the different versions of the empiricist programme which has dominated the discussion of causation for the past two hundred years, with its basic postulate that causation is a relation between events which is reducible to something more fundamental. Amongst the empiricist theories he considers are, in particular, HUME's classical regularity analysis, DAVID LEWIS's conterfactual account – based on counterfactuals of the form 'if *c* ('the cause') had not occurred, then *e* ('the effect') would not have occurred', explicated in terms of LEWIS's own possible worlds semantics – and the 'causal fork' programme advocated by SALMON and REICHENBACH, in which causal dependence is analysed in terms of assessing the probability of pairs of co-occurring events, given other events occurring in either temporal direction of the time of co-occurrence.

Anyone who rejects the reductionist programme of the empiricist and adopts causation as an unanalysable notion, SWINBURNE tells us, must give an account of how we get epistemic access to this concept. His own account of how this is achieved is based, on the one hand, on basic intentional contributions of an agent to an action (which he calls 'basic tryings') and, on the other, on certain causally basic actions. The two are linked epistemically in that 'our understanding of ourselves as trying just is an understanding of ourselves as performing a causally basic action,'[37] and this link, according to SWINBURNE cannot merely be an empirical discovery, but constitutes an *a priori* presupposition of acting itself. The key for our understanding of causality is thus intentional causality which, in turn, gives us epistemic access to the more general

[36] Swinburne (this volume) p. 79
[37] *Op. cit.* p. 87

notion. Indeed, for SWINBURNE, the basic notion of causality is not only unanalysable, but it lends itself to analyse one of the most important categories in philosophy of science, namely that of laws of nature: 'Laws of nature are just regularities – not in what follows what, but in what causes what. [...] The regularities in nature are either caused or coincidental. There is no third possibility.'[38]

[38] *Op. cit.* p. 91