Measurement-Theoretic Accounts of Propositional Attitudes

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Abstract

In the late 1970s and early 1980s a number of philosophers, notably Churchland, Field, Stalnaker, Dennett, and Davidson, began to argue that propositional attitude predicates (such as *believes that it's sunny outside*) are a species of measure predicate, analogous in important ways to numerical predicates by which we attribute physical magnitudes (such as mass, length, and temperature). Other philosophers, including myself, have subsequently developed the idea in greater detail. In this paper I sketch the general outlines of measurement-theoretic accounts of propositional attitudes, explaining in the briefest terms the basic idea of such accounts, why some have thought such accounts plausible, how these accounts might go, what their implications might be both for our conception of propositional attitudes and for their role in cognitive scientific theorizing, and where the potential problems with such accounts might lie.

1. The Basic Idea of Measurement-Theoretic Accounts of the Attitudes

By most accounts, propositional attitudes are relations. At least the sentences by which speakers attribute propositional attitudes have a (dyadic) relational logical form, and this fact alone is often thought sufficient to establish that propositional attitudes are relations. The relational nature of propositional attitudes, it seems, can simply be 'read off' the relational logical form of attitude attributions. Yet it has proved notoriously difficult to specify both the nature of the particulars to which possessors of propositional attitudes are supposedly related as well as the nature of the relation that possessors bear to these particulars, especially if one holds, as proponents of relational conceptions of propositional attitudes typically do, that these particulars are both causally efficacious (in the production of behavior, thought, and affect) and also semantically evaluable. The difficulty is only compounded when one undertakes to explain in terms of the nature of these particulars the various semantic puzzles that have driven so much philosophical theorizing about the attitudes, especially when one undertakes such an explanation in the context of a plausible formal semantics for natural language. Faced with these difficulties, it is hardly surprising that philosophers have been unable to agree on the nature of these particulars, variously holding them to be Fregean senses, Russellian propositions, intensional isomorphisms, mental representations, sentences of a public language, sentences of a non-public language of thought, or perhaps even more exotic entities such as Richard's (1990) 'Russellian annotated matrices' (RAMs) or Larson and Ludlow's (1993) 'interpreted logical forms' (ILFs).

   Not all philosophers buy into a relational conception of the attitudes: some defend a non-relational conception according to which propositional attitudes are monadic properties of their possessors, typically dispositional or functional states. But here, too, there is a problem: how do we square the supposedly non-relational nature of propositional

attitudes with the apparently relational logical form of attitude attributions? Some non-relationalists (e.g., Quine 1960:216) have bit the bullet, arguing that appearances notwith-standing the predicates by which we attribute propositional attitudes are not relational at all, but are instead monadic. The terms that compose these predicates are said to behave syncategorematically, much in the way that the terms in the expressions 'kicked the bucket' and 'bought the farm' seem to behave on the idiomatic reading 'died'. What looks to be a relational predicate, they argue, is in fact a monadic predicate in which the constituent terms are semantically 'fused', such that we can imagine these terms being linked by invisible hyphens (e.g., *believes-that-Bill-will-be-late*). These philosophers make light of the fact that this fusion view is at odds with the observation that we can quantify over the predicate's *that*-clause, and even over the subject position of the embedded sentence, concluding for example from the fact that Jones believes that Bill will be late, both that there is something that Jones believes and that there is someone who Jones believes will be late, something that we cannot do in the case of the above idiomatic expressions (under their idiomatic interpretation). They also make light of the obvious productivity of our scheme for predicating propositional attitudes, a productivity which again is miss-ing in the case of the idiomatic expressions. These problems suggest that if we are going to be non-relationalists about the attitudes, and I think that there are very good reasons for being such, then we are going to have to find some way of abandoning the assump-tion shared by relationalists and non-relationalists alike, that the adicity of propositional attitudes must match the adicity of the predicates by which we standardly attribute them.

Beginning in the late 1970s, a number of philosophers, notably Churchland, Field, Stal-naker, Dennett, and Davidson, began to argue that our difficulty understanding the nature of propositional attitudes stems from our misunderstanding the natural language predicates by which we attribute them.[1] In particular, they argued that propositional attitude predi-cates function very much like the numerical measure predicates by which we attribute var-ious physical magnitudes such as length, mass, and temperature. The fundamental idea of these proposed measurement-theoretic accounts of attitude predicates was this: The sentences by which we attribute propositional attitudes are indeed relational in logical form, and hence do express relations, but the relations that such predicates express are not relations that are in any way constitutive of the possessor's possession of the propositional attitudes attributed by these predicates. To say that a subject has a certain propositional attitude is no more to say that the subject stands in a substantive psychological relation to the particular that is the referent of the *that*-clause than is to say that an object has a tem-perature of 18°C to say that the object stands in a substantive physical relation to the num-ber 18. Rather it is to attribute to that subject a certain psychological state or property which is specified by means of its location in a representational domain, in just the way that we specify the temperature of an object by means of its location on a numerical scale. The referents of *that*-clauses, like numbers, are simply abstract entities used to represent measurement-theoretically the propositional attitudes of those to whom these attitudes are attributed. They are not, in any sense, the psychological 'objects' of these states.

The philosophers mentioned above were attracted to the idea that attitude predicates might be a kind of measure predicate for a variety of reasons. Churchland (1979) and Field (1981) saw in the idea a way of avoiding what they regarded as a metaphysically vexing commitment in psychology to propositions. Stalnaker (1984) saw in the idea a way of blunting the intuitive force of what he terms the 'linguistic picture' of propositional atti-tudes (defended by Field (1978) and Fodor (1975, 1987) among others), a view which he describes as 'undertak[ing] to explain thought by speech' (1984:5). As Stalnaker saw it, the measurement analogy makes conceptual room for the 'pragmatic picture' of the attitudes

that he favors, according to which propositional attitudes 'should be understood primarily in terms of the role that they play in the characterization and explanation of action' (1984:4). Dennett (1987) and Davidson (1989) saw in the measurement idea, not simply a way of avoiding a vexing commitment to propositions, but also a way of avoiding altogether a relational account of the attitudes. Dennett points out (1987:125n) that while we attribute a particular mass to an object by relating that object to a particular real number, we don't suppose that the object's having the mass that it does is a matter of its being related to that number. Having the mass that it does is an intrinsic (monadic) property of the object; relating the object to some particular number is just a way of specifying the property in question. Perhaps, Dennett suggests, the same is true for propositional attitudes: we attribute them to an individual by relating that individual to a particular, but propositional attitudes are not themselves relations that their possessors bear to these particulars. Davidson, for his part, insists that it does not follow from the fact that we specify what a thinker thinks by relating him to a certain object that the thinker bears any psychological relation to that object. We are, he says, 'free to divorce the semantic need for content-specifying objects from the idea that there must be *any objects at all* [emphasis mine] with which someone who has an attitude is in psychic touch' (1989:9). According to Davidson, the analogy then between measuring weight and attributing states of belief is this:

> Just as in measuring weight we need a collection of entities that have a structure in which we can reflect the relations between weighty objects, so in attributing states of belief (and other propositional attitudes) we need a collection of entities related in ways that will allow us to keep track of the relevant properties of the various psychological states.
> [...] we needn't suppose that there are such entities as beliefs. Nor do we have to invent objects to serve as the 'objects of beliefs' or what is before the mind or in the brain. For the entities we mention to help specify a state of mind do not have to play any psychological or epistemological role at all, just as numbers play no physical role. (Davidson 1989:11).

The chief virtue of a measurement-theoretic account of the attitudes, as Dennett and Davidson see it, besides getting right the nature of attitude predicates, is precisely that it enables one to embrace a relational conception of attitude attributions without thereby having to embrace a relational conception of the attitudes themselves. To be a non-relationalist about the attitudes, one does not have to be a non-relationalist about attitude predicates. The nature of propositional attitudes simply cannot be 'read off' the sentences by which we attribute them.

In this brief essay, it is not possible to present a detailed exposition of the proposal that attitude predicates are measure predicates, nor of the import of this proposal for our conception of the attitudes themselves.[2] I will instead only sketch the general outlines of measurement-theoretic accounts of propositional attitudes, explaining in only the briefest terms why some philosophers have thought such accounts plausible, how these accounts might go, what their implications might be both for our conception of propositional attitudes and for their role in cognitive scientific theorizing, and where the potential problems with such accounts might lie. I begin with a brief description of the representational theory of numerical measurement upon which measurement-theoretic accounts of the attitudes are modeled.

2. *The Representational Theory of Numerical Measurement*

Numerical measurement is the systematic assignment of real numbers to objects in order to represent those of the object's properties that are capable of instantiation in different

degrees, properties which we call 'physical magnitudes'. Such numerical assignments are possible, because the physical magnitudes to be measured satisfy certain well-defined empirical conditions that guarantee the existence of a numerical assignment on the real numbers that 'respects' the relevant empirical relations among quantities of a given magnitude. For present purposes we can think of such an assignment on the reals as 'respecting' the relevant empirical relations among quantities of some physical magnitude just in case it preserves and counter-preserves these relations on the reals – 'preserves' in the sense that every such empirical relation among quantities of some magnitude has a surrogate relation among the real number representatives of these quantities, 'counterpreserves' in the sense that there is no relation among the real number representatives of these quantities that is not the surrogate of some empirical relation among these quantities. Having made such an assignment, we can then attribute a particular quantity of some magnitude to an object simply by attributing to that object the relevant magnitude-type specifying relation to the numerical representative of that quantity (e.g., *having a mass of 5 kilos*).

The great virtue of various measurement schemes for the numerical representation of physical magnitudes is that they enable us to reason 'surrogatively,' as Swoyer (1987) puts it, about the empirical relations among the measured quantities of some magnitude by reasoning directly about the numerical relations that hold among their representatives (concluding, e.g., that a mass represented by the number 5 on the kilogram scale is greater than a mass represented by the number 4 on that same scale because $5 > 4$, that a mass represented by the number 2 on this scale is identical in mass to the combined mass of two masses each represented by 1 on this scale, because $1 + 1 = 2$, and so on).

The representational *theory* of numerical measurement (numerical measurement theory, for short) studies the formal and empirical conditions that make possible sound surrogative reasoning about physical magnitudes in terms of real numbers.[4] Early work in the late 1800s and early 1900s focused almost exclusively on what has come to be called the 'representation problem', the problem of specifying the conditions that an empirical system must satisfy in order for provably there to exist an assignment of real numbers to objects that respects the empirical relations among quantities of these magnitudes.[5] Numerical measurement theory does this by proving a so-called 'representation theorem', typically by proving that the numerical relational structure on the reals is homomorphic (in a sense of this term that is stronger than that employed in set theory) to the empirical relational structure of the represented quantities of the measured physical magnitude. But the assignment of numbers to quantities is not unique: there will be different numerical assignments, i.e., different scales (e.g., metric and avoirdupois scales for weight, the Centigrade and Farenheit scales for temperature), each of which faithfully represents all the relevant empirical facts about the magnitude being measured. Measurement theory proves that a certain set of distinct assignments of numbers to quantities are all equally faithful representations of the empirical facts by proving a so-called 'uniqueness theorem', where this theorem provides a formal characterization of the class of homomorphisms all of which specify relation-respecting representations of some physical magnitude on the reals. Proof of a representation theorem assures us of the soundness of our surrogative reasoning, while proof of a uniqueness theorem informs us what counts as empirically equivalent real number representations of quantities of the measured physical magnitude.

3. Generalization of Numerical Measurement Theory to Propositional Attitude Predicates

In the decades since World War II numerical measurement theory has been extended beyond the physical magnitudes to other domains, e.g., to the geometrical spaces

described by various analytical geometries – domains where what gets represented are not physical magnitudes and where what does the representing are not the reals, but in which one is nonetheless concerned to prove that certain representation schemes respect certain relations defined over one or another represented domain. In effect, the representational theory of numerical measurement has been generalized to include a wide range of formal representational schemes, all of which support surrogative reasoning about relations defined over some domain of represented objects (or properties) in terms of relations defined over some domain of representing objects. Measurement-theoretic accounts of propositional attitudes are one such a generalization: they propose to extend representational measurement theory to the natural language representation of propositional attitudes, where, as with the numerical measurement of physical magnitudes, the aim would be to establish that there is a mapping of propositional attitudes into their natural language representatives that 'respects' the relevant empirical properties of the attitudes, such that our surrogative reasoning about propositional attitudes in terms of these representatives is provably sound.

Measurement-theoretic accounts of propositional attitude predicates assume that such predicates presume and reflect a systematic assignment of representative entities to propositional attitudes of a particular attitude type (say, believing), where these representative entities are specified by the *that*-clauses of attitude predicates in much the way that representatives of quantities of a physical magnitude are specified by the numeral in numerical magnitude predicates. Given such an assignment, we can attribute a specific attitude of that attitude type to an individual simply by attributing to that individual a relation to the entity that is the representative of that specific attitude. On these proposed measurement-theoretic accounts, a propositional attitude attribution of the form, e.g., *x believes that p* will be true just in case x possesses a propositional attitude of the type specified by the attitude verb (viz., believing) whose representative is specified by the attribution's *that*-clause. And because the relational structure of these representatives respects the relevant empirical relations among attitudes, we can reason surrogatively about relations among attitudes by reasoning directly about relations among their representatives (concluding, e.g., that a person who is in a belief state whose natural language representative is of the form 'p → q' and who comes to be in a belief state whose natural language representative is of the form 'p' will in so doing also come to be in a belief state whose natural language representative is of the form 'q', because (p & (p → q)) ⊢ q.

4. Why Attitude Predicates Might be Measure Predicates

Whether attitude predicates are measure predicates can be answered definitively only by providing a formal measurement theory for these predicates that proves the requisite representation and uniqueness theorems. The best we can do here is mention some of the reasons that proponents of measurement-theoretic accounts have offered for why attitude predicates might be measure predicates. To begin with, there are a number of striking similarities that these predicates bear to numerical magnitude predicates. Just as the numbers that are the referents of the numerical terms in numerical magnitude predicates function as representatives of the magnitudes that these predicates attribute, so the referents of the *that*-clauses in attributions of the form *x believes that p* function as the representatives of the attitudes that they attribute: *That*-clauses serve to individuate different attitudes of the same attitude type in much the way that numerical terms serve in numerical magnitude predicates to individuate different quantities of the same magnitude. *That*-clauses, like the numerical terms that appear in numerical magnitude predicates, appear to be singular

terms: one can quantify over them and form *wh*-questions that question the argument position occupied by the *that*-clause. There are a number of other similarities between these two sorts of predicates (for discussion see Matthews 2007), but the crucial similarity, the one that motivates the supposition that propositional attitude predicates might be measure predicates, is the role that these predicates play in our reasoning about propositional attitudes: We reason surrogatively about propositional attitudes by means of these predicates in just the way that we reason surrogatively about physical magnitudes by means of numerical magnitude predicates. The only apparent difference is that we *recognize* the surrogative character of our reasoning about physical magnitudes, presumably because of our familiarity with different systems of measurement, whereas we are much more prone to overlook the surrogative character of our reasoning about propositional attitudes: we are much more inclined to imagine that propositional attitudes are intrinsically linguistic in character than we are inclined to imagine that physical magnitudes are intrinsically numerical in character (though I for one find it pretty hard to hold clearly in mind the idea that the numbers on my bathroom scale are just a convenient way of representing certain unwelcome and essentially non-numerical truths about my body mass). We tend to think of propositional attitudes not simply as intrinsically linguistic but also as language specific, forgetting that different natural languages, say English and German, can assign different natural language representatives to the same propositional attitude and yet nonetheless preserve the same empirical relations among propositional attitudes, in much the way that different numerical scales can assign different numbers to the same quantity of a magnitude and yet nonetheless preserve the same empirical relations among quantities.

The similarities that propositional attitude predicates bear to numerical magnitude predicates don't establish that the former are measure predicates, but they do provide reasons for taking seriously the idea that these predicates *might* be a kind of measure predicate. And these reasons become more compelling when one considers certain troubles with the relational conception of the attitudes that seem to force even relationalists towards a measurement-theoretic account of the attitudes. On the relational conception, propositional attitudes are relations between the possessor of the attitude and a particular that is the 'object' of the attitude. But in working out a formal semantics for attitude attributions, a number of contemporary relationalists, e.g., Richard (1990) and Larson and Segal (1995), have concluded that they get into trouble if they identify the referent of the attribution's *that*-clause with the object to which the possessor of the attitude supposedly stands in some psychological relation. It is difficult to find objects of a sort that can account for the usual semantic puzzles (e.g., failures of substitution) and at the same time be the sort of object to which the possessors of propositional attitudes can plausibly be said to bear a psychological relation. It is equally difficult to explain the recognized context-sensitivity of attitude reports on the assumption that the referent of the *that*-clause is an object that is both semantically evaluable and causally efficacious. These relationalists have attempted to avoid these difficulties by distinguishing the referent of the *that*-clause, what Richard calls the 'semantical object' of the attitude, from the object to which the possessor of the attitude is psychologically related, what Richard calls the 'psychological object' of the attitude. Distinguishing semantical from psychological objects of the attitudes enables these relationalists to avoid certain difficult problems that afflict traditional relational views, but it raises two obvious questions: How do the semantical objects manage to represent the psychological objects, and how do users know just what psychological state is being attributed by a given attitude predicate? To assume that there is an answer to these questions is effectively to assume that a measurement theory can be provided for attitude predicates, because this is precisely what a measurement theory for

propositional attitudes and their predicates would provide, namely an account of how the natural language representatives of propositional attitudes manage to track the particular attitudes of which they are the representatives and thus how the predicates that advert to these representatives manage to be informative. Without such an account, relationalists such as Richard and Larson & Segal have no account of how this is possible. More traditional relationalists are in even worse shape, because lacking the sort of distinction that Richard and Larson & Segal draw, they cannot easily see that there is a substantive question to be answered here about the nature of our natural language representation of propositional attitudes, one that distinguishes clearly properties of our natural language representatives of the attitudes from properties of the represented attitudes.

5. What a Measurement-Theoretic Account of Propositional Attitude Predicates Would Look Like

A fully developed measurement-theoretic account of propositional attitude predicates would take the same form as for other sorts of measure predicate, providing: (i) a specification of the representing relational structure of our natural language representations of propositional attitudes (an analogue of the numerical relational structures of our natural language representations of physical magnitudes), (ii) a specification of the represented empirical relational structure of propositional attitudes (an analogue of the represented empirical relational structure of the physical magnitudes), (iii) a characterization of the set of morphisms that map the represented empirical relational structure into the representing relational structure which is its image, and (iv) proofs of a representational theorem and a uniqueness theorem for this set of morphisms so characterized. Because much of our puzzlement focuses on attitude attributions, the account should also provide an explanation of (v) why we should have developed the particular attribution practices we have, and (vi) why we should expect the various puzzles that have so dominated philosophical theorizing about the attitudes. A proposed account might even go on to speculate as to (vii) the intrinsic nature of propositional attitudes that would explain why the domain of propositional attitudes has the empirical structure that it does, understanding that such speculation would not, strictly speaking, be part of a measurement-theoretic account of the attitudes.

   We cannot at present specify either the relational structure of our natural language representations of propositional attitudes or the empirical relational structure of propositional attitudes themselves with the precision needed to support a formal proof of the requisite representation and uniqueness theorems. But we can provide enough by way of a characterization to get some sense of how the proofs might go, and what they might entail as regards the nature of propositional attitudes (for details, see Matthews 2007). In the space remaining in this section, I shall focus on the empirical structure of the attitudes that seems to emerge out of a measurement-theoretical account of the attitudes, a structure that, as Dennett and Davidson saw, leaves room for, if it doesn't in fact favor, a *non*-relational conception of the attitudes. I begin by saying something about the structure of our natural language representation of propositional attitudes, i.e., the structure in which the empirical structure of the attitudes finds its image.

5.1 THE STRUCTURE OF OUR LINGUISTIC REPRESENTATIONS OF PROPOSITIONAL ATTITUDES

This formal relational structure will consist of a domain of objects, the 'representatives' of specific propositional attitudes, and various relations (including monadic properties) defined on that domain. Given the many linguistic properties of the sentences embedded

in the *that*-clauses of attitude attributions that we can exploit in individuating propositional attitudes of a given attitude type (e.g., Jones may believe that Smith is a lawyer, but not that he is an attorney; he may believe that JFK went to /havahd/, but not that he went to /harverd/; he may believe that e.e. cummings was a great poet, but not that E.E. Cummings was, and so on), it seems reasonable to conclude that the representatives of propositional attitudes are entities with all the syntactic, semantic, pragmatic, phonological, phonetic, and even orthographic properties of declarative utterances, including also various inferential relations. Call these entities, which are basically Larson and Ludlow's (1993) ILFs on steroids, 'interpreted utterance forms' (IUFs, for short). They are arguably just the sort of rich linguistic entity that Davidson (1968) had in mind as the entities that speakers use to 'samesay' what others said. Of course, we intuitively don't think of the representatives of propositional attitudes in such linguistic terms. We rather think of the representative of a propositional attitude as something like a 'state of affairs' described in a particular way, specifically as the state of affairs to which possessors of the attitude are characteristically related in quite specific behavioral, cognitive, and affective ways. Thinking of IUFs in these terms seems to involve nothing more than a harmless reification of the IUF, though it is a reification that is important for understanding why we specify propositional attitudes in this particular way, one that facilitates our surrogative reasoning about propositional attitudes.

5.2 THE EMPIRICAL STRUCTURE OF THE ATTITUDES

The empirical structure of the attitudes is similarly a formal relational structure consisting of a domain of objects or properties of some sort, and various relations (including monadic properties) defined over this domain. But this structure is not given to us in anything like the way that the structure of our natural language representations of the attitudes is given. It must be *inferred*, both from the structure of our natural language representations of the attitudes, on the assumption that the relations defined on the domain of the latter 'respect' the empirical relations defined over the psychological states that are the attitudes,[6] and from the explanatory role (and surrogative role, more generally) of propositional attitudes in commonsense explanations of behavior, thought, and affect.

The objects that constitute the empirical domain could, as proponents of a representationalist theory of propositional attitudes would have it (e.g., Fodor 1987), be mental representations, and in this sense a measurement–theoretical account of attitude predicates could in principle be married with a relational account of propositional attitudes themselves. But most measurement theorists have found little empirical reason to suppose this to be the case, inasmuch as representationalist accounts invariably end up imputing more structure to propositional attitudes than is necessary to explain our surrogative reasoning in terms of them.[7] If we ask what minimally must be true of these psychological states that are the attitudes if they are to be the sorts of states that both find an image in our natural language representations of the attitudes and also support the sort of commonsense surrogative reasoning that we engage in using propositional attitude predicates, it seems enough that these attitudes be certain psychological 'aptitudes' of their possessors. By this I mean simply that they must be states *apt* to produce certain characteristic effects, both in the sense that they are the sort of states that can produce such effects and in the sense that in the appropriate context they do produce such effects, where these effects include both the behavior and the other mental states, both cognitive and effective, that we take to be the characteristic effects of propositional attitudes.[8] There might be, and surely is, more to these states than just being aptitudes, but nothing about commonsense

propositional attitude explanatory practice or the nature of our natural language representations of the attitudes requires it. In particular, nothing seems to require that propositional attitudes have the intentionality, semantic evaluability, and inferential involvement that many philosophers commonly associate with the attitudes – properties that may be not of propositional attitudes themselves, but of our the natural language *representatives* of the attitudes, albeit ones that are the images of certain properties of propositional attitudes. The crucial point to be emphasized here is that a measurement-theoretic approach enables us to ask what properties propositional attitudes must, as a bare minimum, possess in order to support the sort of surrogative reasoning that we engage in using propositional attitude predicates, and the answer to this question seems to be that their being aptitudes for the behavior, cognition and affect that we associate with particular propositional attitudes is enough. Arguably this is also enough for a metaphysics of the attitudes, which is, after all, presumably concerned with those properties that are necessarily had by all propositional attitudes.

Assuming that these aptitudes which are the attitudes are simply states that involve the instantiation of a property at a time, then the mapping of propositional attitudes into their natural language representatives will be (like the case of the mapping of physical magnitudes into their real number representatives) a *trans-type mapping* of properties into objects, in this case of aptitudes into IUFs. The relations defined over this domain of aptitudes will consist of various causal and material constitutive relations, relations that find their image primarily in the inferential relations defined over IUFs.

There is obviously a lot more that needs to be said to motivate any particular account of the empirical structure of the attitudes. Most crucially, we need at very least informal sketches of both a representation theorem and an uniqueness theorem to convince us that this account captures what we intuitively take to be the conceptually salient features of propositional attitudes, especially if the account does not attribute to these aptitude states any intentional or semantic properties of the sort presumed by representationalist theories of propositional attitudes. We also need to be convinced that this account can handle all the usual semantic puzzles about propositional attitudes, puzzles that are the focus of so much philosophical discussion. A measurement-theoretic account which treats propositional attitudes as aptitudes can do as well in this regard as tradition accounts, for it has all the explanatory and individuative resources of the traditional accounts, but like Richard's and Larson & Segal's relationalist accounts mentioned above, it apportions those resources differently between the attitudes and their natural language representatives. It may in fact do better inasmuch as it, like Richard's and Larson & Segal's accounts, has the resources for accounting for the context sensitivity of the truth conditions of propositional attitude attributions.

6. Some Implications of Proposed Measurement-Theoretic Accounts

A measurement-theoretic account of propositional attitudes, which treats attitude predicates as a kind of measure predicate, does not itself provide an argument against relational accounts of the attitudes, but it does show that there is no easy inference from the fact that the predicates by which we attribute propositional attitudes are relational to the conclusion that propositional attitudes themselves are relational. Such an account underscores the need to distinguish carefully, in a way that relationalists typically do not, between our natural language representation of propositional attitudes and the attitudes themselves. It is very easy to mistake what are in fact properties of, and relations among, the former for properties of, and relations among, the latter. Once one distinguishes clearly between

representatives and representeds, it becomes apparent that it is going to take pretty subtle empirical arguments for the claim it is propositional attitudes, rather than their natural language representatives, that have the semantic, intentional, and inferential properties that representationalists attribute to them. Maybe such arguments can be provided, but they have yet to be provided.

But what would it be like to discover that the semantic, intentional, and inferential properties that representationalists commonly take to be properties of the attitudes were in fact properties of our natural language representatives of the attitudes? We could still be realists about the attitudes: there really would be such things, and they would still have the causal efficacy that we associate with them, but they would have turned out not to possess these above-mentioned properties. At most, they would possess properties that have these properties as images in our natural language representatives of the attitudes. Thus, for example, propositional attitudes would turn out to have a kind of behavioral, cognitive, and affective 'directedness' towards the states of affairs that reify the IUFs that are the attitude's natural language representative – a directedness that in the case of belief, would exhibit itself in the way beliefs modify or shape our behavior in pursuit of various desired goals. But this directedness would not look much like the linguistic intentionality that representationalists often attribute to the attitudes. Attitudes would similarly not have the well-articulated inferential properties that linguistic entities can bear to one another, though again they would stand in relations that find an image in the inferential relations among IUFs. In some cases the imaged relations would turn out to be constitutive, while in other cases the imaged relations would turn out to be causal, but it is fair to say that these relations will turn out to be considerably more limited than the inferential relations between IUFs. But this is not the calamity that some might imagine, for the inferential story that representationalists have tried to tell turns out to be empirically unsupported (see Matthews 2007:69–84), and in any event representationalists have never been able to extend their story beyond inferential relations within a single attitude type, since it has been quite unclear how to take account of the logical contribution of different attitude types, as specified by the attitude verb.

If, as I suggested above, propositional attitudes turn out not to have semantic, intentional, and inferential properties in any usual linguistic sense of these terms, this will have some important consequences for the so-called 'psychosemantics' project in philosophy of mind. The long-pursued (and by virtually all accounts unsuccessful) project of providing a naturalistic 'psychosemantics' for the mental particulars that representationalists take to be propositional attitudes (or the relata thereof) would turn out to be completely misguided. There presumably are cognitive representations of the sort that computational cognitive psychological theories traffic in, and these representations may stand in need of a psychosemantics of some sort (maybe even a measurement-theoretic psychosemantics), but propositional attitudes are not themselves representations (or relations thereto) and are therefore not the sort of thing that can be given, much less need, any psychosemantics.

More important than this consequence for the psychosemantics project (which many philosophers have now abandoned) is the consequence for the role of propositional attitudes in computational cognitive scientific theorizing. Many representationalists have wanted to conceive of commonsense propositional attitude psychology as a kind of 'proto cognitive science', which adverts in its explanations to the very same sort of explanatory theoretical primitives, namely propositional attitudes, that will figure in a developed scientific cognitive science. They assume that the architecture of a developed computational cognitive science is prefigured in our commonsense psychology. If, as the proposed measurement–theoretic construal would have it, propositional attitudes are aptitudes, then

our commonsense propositional attitude psychology is, explanatorily speaking, pretty shallow, for aptitudes are a kind of disposition, and dispositional explanations are explanatorily pretty shallow – maybe not as shallow as Molière imagined, but shallow nonetheless. Explanatory shallowness is not a defect for the workaday explanatory purposes to which our commonsense propositional attitude psychology has evolved and to which it is put, but it is a defect if one proposes to discern in this commonsense psychology the theoretical primitives of a developed scientific cognitive psychology.[9]

On the proposed measurement-theoretic construal of attitudes as aptitudes, to attribute a propositional attitude is not to say anything about the mechanisms or processes possession of which is constitutive of this aptitude. In particular, it is not to say anything about the computational processes and mechanisms that may be responsible for the production of the effects we associate with the aptitude, not even about such representations as these processes and mechanisms may employ. Very often the propositional attitudes that we are pre-theoretically inclined to attribute to an individual in virtue of that individual's having the cognitive competence which is the focus of study simply have no counterpart in any of the model's data structures (for discussion, see Matthews 2007:55–69); these propositional attitudes are, as Dennett would put it, innocently emergent properties of the hypothesized computational mechanisms and processes of the model.

So what, then, is the role of propositional attitude attributions in computational cognitive scientific theorizing if it is not to provide the theorist a window onto computational processes and data structures? One well-known proposal, endorsed by Chomsky (1980) among others, is to see the knowledge attributions in terms of which we commonly specify individuals' cognitive competences as providing an informal specification of what Marr (1982) called the 'theory of the computation', where by this Marr meant a specification of the mathematical function computed in the course of the exercise of some cognitive capacity. Marr himself does not explicitly endorse such a proposal; however, in developing a theory of the computation for early vision, Marr and his collaborators often avail themselves of propositional attitude descriptions, describing the human visual system as knowing this, assuming that, and so on. Indeed, Marr begins his 1982 book by describing the visual system as that of enabling us to 'know what's where' in our immediate environment. Marr and his collaborators seem to use propositional attitude descriptions as a way to develop an informal specification of the cognitive competence that it will be the task of the theory of the computation to specify in formal terms. The proposed measurement-theoretic account of the attitudes as aptitudes finds support in Chomsky's proposal and Marr's practice: propositional attitude descriptions provide a way of describing an individual's aptitudes (or capacities) for behavior, thought, and affect that abstracts away from algorithmic (and implementation) details, but nonetheless provides essential information regarding functions that the individual is able to compute and which specify his/her cognitive competences. Cognitive researchers use these descriptions in the initial stage of theory construction to develop a characterization of the competence to be explained, and then once this propositional attitude characterization is in hand, they set about specifying a computational mechanism that generally satisfies this dispositional characterization, constructing first a mathematical specification of the function computed by the device, and only then specifying the algorithms and accompanying representations that compute this function (for discussion and illustration, see Matthews 2007:55–69, 242–9).

In addition to their role in developing a theory of the computation, a role that is fully congruent with, and indeed predicted by, the measurement-theoretic account that takes propositional attitudes to be aptitudes, propositional attitude descriptions play a second, justificatory role in computational cognitive psychological theorizing. This role, which

Egan (1995, 2003) emphasizes, serves to demonstrate that the proposed computational theory does in fact explain what it claims to explain. The explananda of computational cognitive theories of cognitive competences are invariably couched in propositional attitude terms such that presented with a formal computational theory someone might reasonably wonder whether the theory does in fact explain what it is claimed to explain. A standard way of answering this question, Egan argues, is to show that the computational mechanism hypothesized by the theory satisfies just the propositional attitude description that we are pre-theoretically inclined to attribute to possessors of this cognitive capacity, thus bringing us back to explananda from which the theorizing began. Thus, we may, based on its molar input/output behavior, describe a computational device that, for example, models the Tunisian desert ant's specific capacity for path integration (see Gallistel 1990) as one that, like this desert ant, *knows* at any point along a simulated foraging trajectory the distance from, and bearing to, its starting point to a degree of accuracy that is that of the ant being modeled. The congruence in propositional attitude descriptions justifies the claim that the computational model explains the ant's competence. Here again this justificatory role is fully consonant with, and predicted by, the measurement-theoretical account of attitudes as aptitudes, since nothing about this justificatory role reaches beyond the commonsense idea that an individual's propositional attitudes are manifest in their effects.

This is not to deny that theorists don't sometimes take propositional attitude descriptions to provide suggestions regarding the sorts of representations that hypothesized computational mechanisms must have available to them. This is entirely reasonable on the proposed construal, for in order to possess the sort of aptitudes that the account takes propositional attitudes to be, the possessor of these aptitudes is going to have to have significant representational capacities, specifically the capacity to represent in some fashion the states of affairs that are the semantic contents of what I earlier called IUFs, since otherwise the possessors of these aptitudes couldn't behave in a directed fashion towards these states of affairs. A measurement-theoretic construal of attitudes as aptitudes doesn't deny the existence of cognitive representations; it only denies that propositional attitudes themselves are relations to representations. But in point of fact, it is striking how often in the course of developing a computational model along these lines, suggestions about representational data structures drawn from propositional attitude descriptions end up being abandoned for various theoretical reasons, most notably pressures of computational tractability and efficiency, so that in these cases too, like those discussed above, what propositional attitude descriptions turn out to have brought to computational cognitive scientific theorizing is an informal characterization of the molar input/output behavior of the device, and in that sense only a rough, informal characterization of the function computed by the device over the domain that these propositional attitude descriptions range. None of this is particularly surprising, unless one comes to the matter already convinced that our commonsense propositional attitude psychology is proto cognitive science. Propositional attitudes turn out to play only a modest, but nevertheless important role in computational cognitive scientific theorizing, a role that is well predicted by the measurement-theoretic account of attitudes as aptitudes.

7. *Potential Problems for Measurement-Theoretic Accounts*

Measurement-theoretic accounts have not yet been developed in sufficient detail to reveal any serious problems, but any problems that might emerge can be expected to be of two sorts: those that concern specific hypotheses regarding the relational structure either of

our natural language representations of propositional attitudes or of the attitudes them-selves, and those that concern the general representation scheme that measurement-theo-retic accounts impute to our practice of attributing and reasoning about propositional attitudes. The former sort of potential problems are just the ones that have traditionally concerned philosophers of mind and language since Frege – how to understand both propositional attitudes and the predicates by which we attribute them, but with this important difference: measurement-theoretic accounts provide a disciplined framework within which to address these questions, one that makes it possible to pose these ques-tions in a precise manner. The second sort of potential problems has to do with the gen-eral sort of representation scheme that measurement-theoretic accounts presume. These accounts presume that our practice of attributing and reasoning about the attitudes exploits a scheme of representation which is formally very similar to the schemes used in better understood numeral measurement practices. The virtue of proposed measurement-theoretic accounts of the attitudes is that they offer a precise criterion for determining the empirical adequacy of these accounts, namely, whether one can prove the requisite repre-sentation and uniqueness theorems. It seems reasonable to expect that our practice of attributing and reasoning about propositional attitudes will turn out to be amenable to a measurement-theoretic explanation only under some degree of idealization – that, after all, is also true of measurement-theoretic accounts of the numerical measurement of phys-ical magnitudes. The question is whether, under whatever the degree of idealization is required to construct an empirically adequate measurement theory for propositional atti-tudes, the resulting account will turn out to be sufficiently illuminating and sufficiently preserving of the essential features of our practice of attributing and reasoning about propositional attitudes as to justify the conclusion that this practice is indeed of a kind of measurement practice. The proof will be in the demonstration.

Short Biography

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Notes

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[1] See Churchland 1979:105; Field 1981:113–4; Stalnaker 1984:11; Dennett 1987:113–25; Swoyer 1987:281–3; Davidson 1989; Matthews 1994, 2007.
[2] For a detailed development of a measurement-theoretic account of the attitudes, see Matthews 2007. For critical discussion and further development of the account, see Dresner 2010.
[3] For details, see Matthews 2007:133–4.
[4] See, e.g., Krantz et al. 1971 and Narens 1985.
[5] For a nice historical presentation of numerical measurement theory, see Díez 1997.
[6] This assumption is justified by the success of surrogative reasoning using these predicates.
[7] For a general discussion of over-assignment of structure, see Dresner 2004.
[8] Some propositional attitudes (remembering, learning, etc.) are individuated not simply by their aptitude for cer-tain characteristic effects but also for the manner or way in which their possessor comes to have the aptitudes in question, the attitude predicate's main verb specifying the latter, the *that*-clause specifying the former. This, in itself, is not enough to make the proposed construal functionalist in any usual sense of this term because there is no appeal in the individuation of propositional attitudes to any particular psychological theory, commonsense or otherwise;

rather, propositional attitudes are construed simply as mental magnitudes, which like the physical magnitudes can figure in various empirical laws.

[9] The idea that our commonsense propositional attitude psychology is proto cognitive science was probably always implausible on its face given their divergent explanatory interests, the former being concerned with individual behavior, thought, and affect, the latter being concerned with widely shared cognitive competences.

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