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MASS TERMS, COUNT NOUNS, AND CHANGE*

From early childhood we learn to distinguish compact, enduring things from the stuffs of which they are constituted. We count the former and measure the latter. We treat things as stable points of reference for action and experience; stuffs we think of as amorphous and protean.

Traditionally, philosophers have confronted these intuitive distinctions with categories like form and matter, substance and substrate, mode and extension. A linguistic analogue of these category pairs, albeit a rough one, is the distinction between physical-object count nouns and mass terms. Mass terms are nouns like 'water', 'wood', 'calcium', 'gravel' which under the relevant reading may be modified by the phrases 'how much' and 'very little' and which resist pluralization, the indefinite article 'a', and modifiers like 'how many' and 'quite numerous'. Physical-object count nouns under the relevant reading tolerate the listed syntactical modifications which mass terms exclude and exclude those which mass terms tolerate. From a semantical viewpoint, if a mass term applies severally to two isolated objects (portions of stuff), it usually also applies to the result of lumping them (or, better, considering them) together. Physical-object count nouns, on the other hand, tend not to apply cumulatively. Mass terms are typically used to measure the masses – count nouns, to number the multitudes.

The match between our rough linguistic distinction and the intuitive thing-stuff distinction is not exact. Not all mass terms are intuitively true of stuffs. 'Fruit', 'clothing', 'apparatus', 'hardware' are not. Some expressions which intuitively do, at least sometimes, apply to stuffs are not mass terms – 'quantity', 'aggregate' and perhaps 'part' and 'piece'. Still, the parallel between the distinctions is close enough to warrant the view that by giving a formal theory of sentences containing typical count nouns and mass terms, one will also be clarifying the logical and ontological content of the intuitions about stuffs and things which we have inherited from childhood and our philosophical tradition.

My plan in this paper is to develop two formal accounts of some sentences

about change which crucially involve relations between mass terms and count nouns. A formal account will consist in showing how to represent the relevant natural-language sentences, or at least the relevant components of them, in a language whose syntax and semantics we clearly understand. For present purposes we will need little more than quantification theory supplemented with predicate constants. The point of a formal account is not to explicate the 'force', 'sense' or application conditions of particular natural-language words or phrases. Rather it is to render more evident the logical implications and ontological commitments of the unanalyzed sentences by exhibiting the formal roles of the parts of the sentences and explicating their contributions to the truth conditions of the wholes.

What criteria enter into choosing a best formal account is a complicated and vexed issue. But roughly, we take as evidence certain intuitions of native speakers that seem to bear on interpreting the sentences, such as intuitions about paraphrases, ambiguity, grammatical form, truth conditions, obvious implications. And we try to represent the natural-language sentences in such a way as to account for our evidence with as simple a logic and primitive predicate basis, and with as simple and clear an ontology, as possible. These requirements apply not only to the logic and the ontological commitments of the semantical theory, but also to the logic and ontology that the theory attributes to the natural object-language sentences. The aim is not to prohibit attributing baroque logics or ontologies to sentences of natural languages. It is merely to discourage doing so (ceteris paribus) if a simpler attribution is available. The reason for this stricture is the broad methodological principle that we should avoid attributing unnecessary complication or irrationality to the beliefs or presuppositions of those (here, native speakers) whose utterances we are trying to interpret. The attempt to simplify one's formal representations of natural-language sentences should be carried out with an eye on a theory of syntax for those sentences. Whereas the formal representations are to provide the basis for semantical interpretations of the natural-language expressions, they should not be such as to complicate transformation rules that connect 'deep' representations with surface sentences. We shall return to methodological issues near the end of the paper.

Although we shall develop our two accounts as *linguistic* theories, their development will bear on traditional philosophical questions. One of the

approaches resembles the sort of reductionism about physical objects that takes only a few sorts of objects as basic and 'constructs' all others in terms of them. The other resembles a more 'common sense' viewpoint. I shall be pushing the 'reductionist' view as far as it can go as a representation of natural discourse in order to throw light on one-place predication as applied to physical objects – or more materially and narrowly, on what it is to be a physical object, whether a thing or some stuff, of a certain *kind*. Of course, arriving at a best representation of natural discourse about stuffs and things does not determine a best account of stuffs and things themselves. There is room for argument over whether natural discourse should be revised, discarded, or reduced. But the linguistic investigation is a long first step toward dealing with the metaphysical issues.

Two very old problems about change will provide the bulk of the intuitive, linguistic evidence with which our formal accounts are designed to deal. One of them is the Aristotelian problem of how to talk systematically about physical changes that occur in the form of some stuff or in the matter of a thing. The other is the problem, associated with Heraclitus, of explaining formally why from the premise that rivers are water we do not conclude that successive bathings in the same river are successive bathings in the same water.[1]

1. CHANGES IN MATTER AND FORM

The matter of which a given thing is constituted often changes without that thing's ceasing to exist. Proverbially, a ship may be rebuilt plank by plank until it is completely reconstituted. A river changes its water continually. The flesh and bone of a person's body is entirely replaced every several years. Moreover, in the case of many things, the kind of stuff of which they are made may change. A lake of water may become a lake of oil, yet remain the same lake. By replacing parts of a given engine over a period of time, one might change it from being made of steel to being made of aluminum.[2]

These considerations might lead one to adopt one of two representations of sentences describing changes in the matter of an object. On one approach, one might hold that the sentence,

(1)   That engine was once steel, but it is now aluminum

should be represented as

(2) $(\exists t)$ (Steel (that engine, t) & Aluminum (that engine, now)
         & Is-before (t, now)),

where 't' ranges over times and 'Steel (that engine, t)' is read 'that engine
is steel at t'. On this approach, mass-term predicates are relativized to a
time. Mass terms like 'steel' and 'aluminum' are on this view regarded
intuitively as expressing temporally relative properties of sortally identified
things.[3] Let us call the approach to sentences like (1) which (2) typifies
'*the Relational Approach*', the distinguishing feature being that mass terms
(and later, other common nouns) are consistently represented as rela-
tional predicates.

A second way of handling (1) is to represent it as treating a certain
relation between the engine and some steel at one time and between the
engine and some aluminum at another. Thus:

(3) $(\exists t)\,(\exists y)\,(\exists z)$ (Steel (y) & C(that engine, y, t) &
         Aluminum (z) & C(that engine, z, now) & Is-before (t, now)),

where 'C' is read, '_____ is constituted of _____ at ...'. Alternatively (and
non-equivalently), 'C' could be read, '_____ (spatially) coincides with
_____ at...'. On either reading 'C' is true of ordered triples consisting of
two physical objects (e.g. some steel and an engine) and a time. Let us
call the type of analysis illustrated by (3) '*the C-Approach*'.

A possible reason for preferring (2) to (3) is the desire to maintain the
principle that no two physical objects can as wholes occupy the same
space at the same time. If (1) is true and (3) represents (1), then the prin-
ciple is violated; for 'C' purports to express a relation between physical
objects which are spatially indistinguishable at time t, but which are not
identical because only one (the engine) is later constituted of some
aluminum. By treating mass terms themselves as relational, (2) does not
yield this consequence. Although the principle is a fruitful topic for
discussion, I shall not linger over it in the present context because it can
be shown implausible without recourse to mass terms. For example, a
rope and a hammock (woven from the rope alone) may be spatially
indistinguishable at a given time, and not be identical.

Before discussing further what is at stake between the two approaches,
we should bring into view another class of sentences which are relevantly

similar to (1). These are sentences which intuitively describe changes in the form of some given stuff. Focus, for instance, on

(4)   Once this gold was a ball, but now it is a statue.

The Relational Approach as we have so far characterized it will have difficulty with (4). A possible representation is

(5) $(\exists x)\,(\exists y)\,(\exists t)\,$(Ball (x) & Gold (x, t) & Statue (y)
            & Gold $(y,$ now$)$ & Before $(t,$ now$)$ & $S\,(x, t, y,$ now$))$,

where '$S\,(x, t, y,$ now$)$' is read 'x is made of the same stuff at t as y is now' or 'x at t is same-stuffed with y now'. The primitive 'S' must be understood to express not just sameness of *kind* of stuff, but sameness of actual stuff. The problem with the representation is that despite the reading it gives 'S', it does not imply (as (4) intuitively does) that there is something which at both times exists, or that something at the earlier time is re-identified at the later time – namely the very gold which takes on the two different shapes. Other relational predicates besides 'S' are possible, but they raise the same difficulty.

Sentences like (4) seem to be mirror images of sentences like (1). Re-identification of the gold via (4) is analogous to reidentification of the engine via (1); change in the form of the gold is analogous to change in the matter of the engine. *These considerations tend to undermine attempts to distinguish count-noun predicates from mass-term predicates on the basis of the number of their argument places.*

A proponent of the Relational Approach to (1) can respond to this situation by extending its relativization strategy to (4). We shall henceforth construe the Approach more broadly than we have so far characterized it. Earlier only mass terms were relativized; now, count nouns themselves go relational:

(5') $(\exists t)\,$(Ball (this gold, t) & Statue (this gold, now)
            & Is-before $(t,$ now$))$.

We shall postpone for a while the problem of how the Relational Approach is to construe the singular terms 'this engine' and 'this gold' in (2) and (5'). The C-Approach, which we applied to (1), can be utilized without

substantial revision to represent (4). On this view, (4) goes into

(6) $(\exists y)\,(\exists z)\,(\exists t)\,(\text{Ball}\,(y)\ \&\ C\,(y,\ \text{this gold},\ t)\ \&\ \text{Statue}\,(z)$
          $\&\ C\,(z,\ \text{this gold},\ \text{now})\ \&\ \text{Is-before}\,(t,\ \text{now})).$

The differences between the two approaches may now be given initial generalized characterizations from both linguistic and ontological points of view. Linguistically, both approaches recognize that the 'is' in sentences like (1) and (4) is not the 'is' of identity. The Relational Approach interprets it as the 'is' of tensed predication; the C-Approach represents it by a non-logical primitive like 'constitutes' or 'coincides with'. Ontologically, the Relational Approach takes ordinary stuffs and things to be phases of something more basic (or less cautiously, as changeable properties of a substratum); the C-Approach construes stuffs and things as fundamental kinds of objects. A common impulse is to want to reject the Relational Approach out of hand, claiming that the 'is' in (1) and (4) just *means* 'is made of' or that stuffs and things are obviously not mere modes of a substratum. Although such intuitions, especially those about predication, have some force, uncritical acceptance of them tends to prevent one from understanding a philosophically interesting network of considerations underlying them.[4]

It should be noted that (4) does not involve what are ordinarily thought of as phase sortals. The usual examples of phase sortals are count-nouns like 'sapling', or 'boy' which are applicable to organisms at only one phase of their growth, or like 'pauper' or 'banker' which are closely related to adjectives or verbs and which may apply to an object during only a stage in its history. From the usual examples one receives the impression that phase sortals are a pretty restricted lot. 'River', 'ball', 'statue', 'molecule', 'engine', 'pebble', 'animal', 'dog', 'tree', and so forth would certainly seem not to be included among them. A test often relied upon for distinguishing phase sortals from 'permanence' sortals is that the latter but not the former will truthfully substitute for 'F' in the schema

(NP) $(x)\,(x$ is an F at some time t & it is not the case that x is
          an F at some other time $t' \rightarrow x$ does not exist at t'),

where the first and third occurrences of 'is' are intuitively read as predicative copulation.[5]

The Relational Approach to sentences like (4) is unusual in that it

suggests that according to this test the vast majority of count nouns should be represented as phase sortals. Thus something (the gold) is a ball at one time and is not a ball at a later time without ceasing to exist. So the test shows 'ball' to be a phase sortal. Similar arguments could be applied to most other count nouns, including those which have seemed to apply to natural kinds. To put the matter in a more traditional way: the Relational Approach holds that there are very few sorts of individuals or substances. Objects that we often think of as such are on reflection seen to be phases of something more basic.

What is it then that is more basic on the Relational Approach? In representing the sentences about change that we shall discuss, the Approach will nowhere be forced to be explicit about its ontology. A necessary condition for a theory to be explicit about its ontology is for it to contain primitive, *one-place* predicates which must be satisfied in order for the sentences of the theory to be true. The condition focuses on one-place predicates as opposed to relational predicates because we may always ask of the latter what kind of things are the relata. Among one-place predicates, those which represent common nouns are intuitively most informative about a theory's ontology. A proponent of the Relational Approach could simply claim that since virtually all common nouns in ordinary empirical assertions are represented by relational predicates, such assertions are not explicit about their ontology, except perhaps in trivial cases in which they contain a predicate like 'is a physical object'. The *sorts* of physical objects presupposed by ordinary asserions about change, on this view, would not be determinable on the basis of formal representations of those assertions.

Now it is no objection to a theory to say that it is not explicit about its ontology. Set theory in its usual formulations is not. But in evaluating the Relational Approach, it will be important to understand what ontological consequences it regards as implicit in ordinary discourse. The only predicates which the Approach can ultimately exempt from its temporal relativization strategy are those like 'is a physical object' whose generality prevents their applying to an object during only a stage of its history, and either those like 'is an elementary particle' that apply to objects which never coincide with other objects, or those like 'is a space-time thread of maximal duration' (or 'is a maximal world line') that apply to objects always underlying but never undergoing change.[6]

In its acknowledgement of very few sortal predicates, the Relational Approach bears a distant kinship to a long line of reductionist ontologies (from the pre-Socraties and Democritus to Sellars) which have held that only atoms in the void, or only matter, is fundamentally real and that the objects of ordinary experience are either 'mere appearance' or should be explained as modifications of the more basic entities. The Relational Approach differs from its elders in resting its case on an analysis of non-technical empirical descriptions rather than on an interpretation of sophisticated scientific theory. But it shares with them a certain aura of revisionism. Ordinary language-users do not tend to think of molecules, engines, or trees as phases of something more basic. According to the Relational Approach, however, a general analysis of ordinary discourse shows that that is what language-users have committed themselves to.

The ordinary phaseal-nonphaseal distinction is on this viewpoint a product of temporal near-sightedness. The reason why the phaseal character of most count nouns is overlooked is that when one uses a count noun, one typically intends to apply it to some object which is phenomenologically, structurally, or functionally similar to other objects of recurrent human interest. Suppose that some wood constitutes a table at a given time. The general term 'table', on this account, applies truly to both the wood and the table at that time. When the wood is broken up and used for some other purpose, the table ceases to exist; and one's interest in the table distracts one from tracing the continuing history of the wood. If in numerous such uses of 'table' one were more interested in the table than in its relatively protean constituents, it would be easy to conclude that if 'table' is true of an object at any given time, it is true of that object throughout its existence. Thus, according to the Relational viewpoint, arises the illusion that 'table' will substitute truthfully in (NP).

The anti-essentialist character of the Relational viewpoint should be clear. What is once a dog, or table, or molecule is not always a dog, table, or molecule – much less necessarily one. The intuition that 'table' applies more essentially to tables than to wood, however, need not be counted *entirely* groundless by the Relational Approach. It has both unitemporal and transtemporal significance. 'Table' is true of all tables but only some quantities of wood relative to a given time. 'Table' is true of a given table at every time during which it exists, whereas the term tends to be more fickle with respect to a given portion of wood. By using these points, it is

possible to define an unrelativized predicate 'Table' in terms of the relativized one:

(UR) $\text{Table}(x) =_{df} (t)(x \text{ exists at } t \rightarrow \text{Table}(x,t)) \& (\exists t)(\text{Table}(x,t)).$[7]

(UR) utilizes the intuition behind (NP) to define phases of 'something more basic' which can play many of the roles of the ordinary objects of experience. (The phases are plausibly temporal stages of space-time threads or successions of time-slices of elementary-particle aggregates.) The relational predicate in the definiens is still fundamental for the Relational Approach because, given that 'is' in (1) and (4) is construed merely as the tensed copula, the one-place predicate is useless in representing contexts like these. But the defined predicate does fairly well in representing many other natural language sentences. And this partial adequacy, according to this approach, contributes further to the misconception that most physical-object count nouns substitute in (NP).

Remarks analogous to those made in the previous paragraph can be directed at predicates derived from mass terms. Definitions like (UR) are constructable for them as well. On the Relational Approach both concrete count nouns and mass terms are fundamentally time-relative – and for mirror-image reasons.

I should note that even definitions like (UR), which give us some one-place predicates to apply to approximations of the ordinary objects of experience, do not take the edge off the anti-essentialism of the Relational Approach. To be a Table (with capital 'T') one must be a space-time thread (an occupied space-time region) that is a table throughout its existence. But that space-time thread could have been 'filled' with matter, other than the wooden matter, that would have been unsuitable for use as a table. If time-slices of elementary particle aggregates are taken as basic, an analogous point may be made.

Traditional replies to the reductionisms kin to the Relational Approach have often resorted to vague denigrations of the ontological status of stuffs. Feeling that the objects which we ordinarily refer to with count nouns are 'basic', philosophers have fixed upon mass terms as the source of their uneasiness. (Cf. (5).) I shall not detail here why these moves seem to me misguided. In brief, reflection on sentences like (4) suggests that individuation of quantities of stuff is an integral element in our descriptions of the world. Stuffs do tend to have different sorts of individ-

uation and reidentification conditions than ordinary things have. But this difference does not give ground for calling stuffs less real, less actual, or less physical than things.[8]

The C-Approach need not ally itself with these replies to reductionist ontologies. In fact, by treating ordinary count nouns and mass terms as primitive one-place predicates, it clearly commits itself to quantifying over both stuffs and things.

2. MATTER AND FORM AT A TIME

So far we have centered our attention on sentences dealing with changes in the matter or form of a specified object. I wish now to consider a class of true sentences in which singular terms denote objects which differ but which are spatially indistinguishable during a period in their histories. These sentences introduce the problem of how to give formal representation to our individuation of stuffs and things. As an example of the sentences I have in mind, consider

(7)   The gold which was once a ball is now the statue which stands on yon pedestal.

which for our purposes can be shortened to

(7')   The gold is the pedestaled statue.

The problem of representing (7') is an acute one for the Relational Approach as we have so far developed it. The most immediately attractive way of handling the sentence would be to treat it as involving an identity sign flanked by two singular terms. One might call on one-place predicates 'Gold' and 'Statue' defined in the manner of (UR), thus:

(a)   (that x) Gold (x) = (that z) (Statue (z) & Pedestaled (z)).

Since we assume that in asserting (7) the language-user is demonstrating an object (the relevant gold) which pre-existed the statue, that object is not identical with the statue. So (a) is false, whereas (7') is, by hypotheses, true.

The Relational Approach might deny that a singular term occurs on the right side of (7) and continue to treat 'is' as merely the tensed copula. But experimentation with this claim will indicate that it is prohibitively

complicated in its effect on the analysis of sentences other than (7). For example, imagine accounting for the inference from (7) and 'The statue which stands on yon pedestal is identical with Cellini's finest piece of sculpture' to 'The gold which was once a ball is now Cellini's finest piece of sculpture'.

The upshot is that the Relational Approach is forced to introduce a non-logical primitive. There are two plausible choices for the Relational Approach. One is to introduce the relational predicate 'is a temporal stage of', abbreviated 'T'. The resulting analysis of (7′) would be

(8) $(\text{that } x)\,(T(x, (\text{that } y)\,\text{Gold}\,(y))) =$
        $(\text{that } z)\,(T(z, (\text{that } w)\,(\text{Statue}\,(w)\;\&\;\text{Pedestaled}\,(w)))).$

(There is, of course, a certain indefiniteness as to *which* temporal stage is meant. But this might be said to be derivative from the indefiniteness of the 'now' in (7).) A second choice open to Relational Approach is to attribute to the 'is' in (7′) a sense other than that of identity or the copula. This choice is, I think, best implemented by borrowing the primitive of the C-Approach and representing (7′) as

(9) $C((\text{that } z)\,(\text{Statue}\,(z)\;\&\;\text{Pedestaled}(z)), (\text{that } x)\,\text{Gold}\,(x), \text{now})$

For future reference I shall assume that the Relational Approach chooses (9). The C-Approach agrees in representing (7′) as (9), except that its one-place predicates 'Gold' and 'Statue' are primitive rather than defined.

3. The problem of Heraclitus

The problem of Heraclitus arises from the following argument:

(10)   All rivers are water

(11)   Heraclitus bathed in some river yesterday and bathed in the same river today

∴(12)   Heraclitus bathed in some water yesterday and bathed in the same water today.

One might imagine situations in which (10) and (11) are true, but (12) is false. So in natural language the argument fails. But in its most natural

formalization, the argument sails through:

(13) (x) (River (x) → Water (x))

(14) $(\exists y)$ (River (y) & Bathed-in $(h, y,$ yesterday) & Bathed-in $(h, y,$ today))

∴(15) $(\exists z)$ (Water (z) & Bathed-in $(h, z,$ yesterday) & Bathed-in $(h, z,$ today)).

On one possible reading of them, (12) and

(16)   There is some water which Heraclitus bathed in yesterday and which he bathed in again today

are true whenever (10) and (11) are. The aggregate of all currently existing water molecules is certainly some water. If Heraclitus takes water-baths on successive days, he bathes on both occasions in (within) that portion of the world's water that exists during both bathings. Many, however, will refuse to count (12) or (16) true under these circumstances. In some cases such refusal stems from denial that all the water in the world is some water. A more reasonable ground for resistance is the view that 'bathed in' is true of some water only if that water more or less immediately surrounds a bather.[9]

What is important for our purposes is that even if one regards (12) and (16) true whenever (10) and (11) are, that is not enough to establish the validity of (10)–(11)–(12) and thence the correctness of (13)–(14)–(15) as a representation. For the world's water could have been less durable than it is (perhaps if the process of reversible ionization occurred at a much faster rate). Suppose that after Heraclitus' first bath, all the world's water dwindles into oblivion and continuously synthesized water takes its place, the process of replacement being complete in time for the second bath. In such circumstances (10) and (11) would be true and (12) false.

Very roughly speaking, the C-Approach has pursued the strategy of introducing a non-logical primitive to represent 'is' whenever that word links mass terms and count nouns. Hence for it (10) will be the center of attention. In this light, (10) will be read not as (13), but as

(17) $(x)(t)$ (River (x) & Exists (x, t) → $(\exists y)$ (Water (y) & $C(x, y, t)$)).

('Every river is constituted of (coincides with) some water at every time during which it exists.') The reading shortcircuits the Heraclitean argument regardless of which of the construals of (12) is chosen.

The Relational Approach sees the problem differently. (13) is left unaltered as a reading of (10), with the provision that 'River' and 'Water' are defined in the manner of (UR). Alternatively, (10) could be read as '$(x)(t)$ (River $(x, t) \rightarrow$ Water (x, t))'. Either treatment follows the general plan of taking all occurrences of 'is' which attach directly to count nouns or mass terms as occurrences of the tensed copula. Whereas the C-Approach attributed the mistake in (13)–(14)–(15) to its representation in (13) of 'are water' as it occurs in (10), the Relational Approach naturally focuses on (15)'s construal of 'same water' as it occurs in (12). From the Relational viewpoint, (15) must be read: 'There exists something that throughout its existence is water and that Heraclitus bathed in yesterday and today'. (Recall that 'Water' in (15) is defined by the Relational Approach in a way illustrated by (UR).) The problem is that the something quantified over in (15) could as well be the river as a quantity of water. For given (13), both satisfy the defined predicate 'Water'; both are water (are 'in the water relation') throughout their existence. So if our man bathed in the river on successive days, (15) would be true even if (12) were false. This problem seems to force the Relational Approach into finding some way of expressing a distinction between an object's being water throughout its existence and being some water. Definitions of the form of (UR) can now be seen to be inadequate as expressions of the latter notion.

Tinkering with various alternatives will, I think, lead the reader to the view that no use of the resources that we have so far allotted the Relational Approach will produce an analysis that is both equivalent to (12) and syntactically plausible. What is needed for a relatively simple representation is the introduction of a predicate which distinguishes the sort of entity that the relevant water is from the sort of entity that the river is. The need seems filled by the following:

(18) $(\exists x)$ (Quantity (x) & Water (x) & Bathed-in $(h, x,$ yesterday) & Bathed-in $(h, x,$ today)).

In words, 'There exists a quantity which throughout its existence is water; and h bathed in that quantity yesterday and today.'

To explicate the general notion of quantity (or stuff) here would side-track us too far. But in the present instance, the idea is roughly that a quantity of water is a concrete aggregate of water molecules. Quantities of water are the same just in case they have at all times, respectively, the same water molecules as parts. Given this construal of 'Quantity', (18) distinguishes 'same water' from 'same river' and gives the wherewithal to block the Heraclitean argument.

The grammatical lesson of that argument has been that one cannot always take phrases of the form 'is MT' and 'is the same MT as' (where a mass term subs for 'MT') into the analyses traditionally given to general terms – '$M(x)$' and '$M(x)$ & $x=y$' respectively. The C-Approach alters the analysis of 'is MT'. The Relational Approach reconstrues 'is the same MT as'.

The Heraclitean argument suggests a more important lesson. We have seen that the temporal relativization of predicates representing mass terms and count nouns and the reliance on definitions like (UR) left the Relational Approach with insufficient means to individuate some water in such a way as to distinguish it from a river. But the Approach's weakness in individuating runs deeper. Definitions like (UR) are *always* too weak to provide unique correlates of the objects we intuitively associate with common nouns.

To see this, imagine the following sentence to be true:

(19)   Exactly one river extends through Heraclitus' home town.

To represent (19) the Relational Approach must invoke its one-place predicate 'River' defined in the manner of (UR). The resulting representation will imply that exactly one object which extends through Heraclitus' home town 'is' throughout its existence a river. But innumerable temporal stages of the (full-length) river 'are' a river throughout their existence and extend through the relevant town: 'River (x)' as defined by (UR) is true not only of rivers but also of all river-stages. The difficulty applies to all definitions of oneplace, physical-object count-noun predicates in the manner of (UR) and to all attempts to individuate quantities of stuff by supplementing (UR)-type definitions by the notion of quantity.

What recourses are open to the Relational Approach? One is to deny that river-stages satisfy '$(\exists t)$ (River (x, t))', claiming that only rivers and quantities of water satisfy it. Taken by itself, the positive claim virtually

begs the question. For the claim occurs in a semantical metalanguage that uses the very words ('river', 'water') whose formal representation we have been discussing. If those words are not to be construed as the C-Approach construes them, they must themselves be understood in terms of relational predicates; but then the same question arises for these predicates as arose with respect to 'River (x, t)' in the analysis of (19). The problem is that it is questionable whether the Relational Approach construes 'river' in such a way as to distinguish its application from 'river-stage'.

To defend the view that river-stages do not satisfy '$(\exists t)$ (River (x, t))', one must either deny their existence or explain why they do not satisfy it. (Similar points will apply to relational stuff predicates.) The former alternative is, I think, extravagant and implausible. The latter is unpromising. The Relational Approach is based on allowing entities that are not rivers, such as quantities of water, to satisfy 'River (x, t)' relative to certain times. Presumably they do so because they have the appearance, constitution, and form of a river at a certain time. But river-stages meet these very requirements. So there seems to be no cogent reason for denying that they satisfy '$(\exists t)$ (River (x, t))'. In fact, they seem to be paradigmatic satisfiers. Attributing the presupposition that river-stages do not exist or that they do not satisfy '$(\exists t)$ (River (x, t))' to ordinary assertions would be attributing unnecessary irrationality to the asserters.

Another artifice available to the Relational Approach is to hold that there is no reason to try to find a unique correlate of the ordinary notion of river: a multiplicity of river stages (of various temporal durations) will do. It is a remarkable fact that for the purposes of representing many natural-language sentences, such a multiplicity will 'do'. In (2), (5'), and (9), the relevant stage (engine-stage, quantity-of-gold-stage, statue-stage) could be regarded as vaguely determined in the context by demonstrative reference. As for (13), (14), and (18), the interpretation of 'River (x)' as river-stage (and 'Quantity (x) & Water (x)' as quantity-of-water stage) will in no way upset the material equivalences between the representations and the sentences they represent. Despite all this, the rationale is implausible. Applied generally, it would amount to giving up (or failing to account for) the practice of counting ordinary physical objects. For the number of temporal stages of any given sort would always be the same: non-denumerably many. Since we do not count with mass terms, this difficulty

would attach only to count nouns. But another difficulty would attach to both. The proposed view would require giving up generalizations about the age of things and of quantities of stuff of a given kind. (Consider 'All the gold on earth is over one-half billion years old'.) These problems make this strategy unattractive from both metaphysical and linguistic points of view. Counting and dating are the weak spots in the Relational Approach.

In a sense the dating problem – or more generally, the problem of failing to represent fully our reidentifications over time – is the more fundamental of the two. Although, as we have noted, reidentification is a difficulty apart from counting, the converse does not clearly hold. This can be seen by considering an attempt to solve the counting problem while ignoring the problem of reidentification. One might represent (19) as saying that there is one spatial volume such that all river-stages that now extend through Heraclitus' home town fully and congruently occupy it (and some do). But the analysis depends for whatever plausibility it has on the present tense of (19) and on a peculiar characteristic of rivers, their relative immobility as wholes. No such analysis would be even mildly plausible for

(20)   During the last year there were exactly twelve balls on the billiard table.

The reason is that the balls might have moved around on the table during the year: there would be more than twelve spatial volumes fully occupied by the various ball-stages. Unless we provide it with some means of tracing a line of stages in a way that parallels our apparent reidentification of objects, the Relational Approach will be unable to deal convincingly with such sentences.

The only remaining defense of the Approach would seem to consist in trying to strengthen definitions like (UR). One thinks immediately of introducing some relation of spatio-temporal continuity which would count a thing of a given sort as a maximal line of spatio-temporally continuous stages, all characterized by the relevant temporally relative predicate. But the prospects of rigorous definitions for each intuitive kind of stuff and thing are not very bright. Not only are there a number of well-known difficult cases (cf., for example, note 2), but it is hard to see generally how to make continuity principles both precise and consonant with facts about the micro-structure of the objects of ordinary experience.

One might shift from continuity principles to causal principles – or to some combination of the two. But the task of specifying the relevant causal chains in a way sufficiently rigorous to facilitate the needed reductive *definitions* is hardly promising.[10]

Our methods of reidentifying physical objects over time are developed only as far as our immediate practical and theoretical needs require. Such needs do not include an understanding of general principles which are necessary and sufficient for reidentification. Nor is there any reason to think that in the general case there *are* principles tacitly guiding our usage which are comprehensive enough to cover all possible (or even imaginable, or even, sometimes, actual) cases. Confidence in applying common nouns to physical objects derives from ostensive teaching, from illustrative statements larded with demonstrative references, from inculcated rules of thumb, and from our innate learning capacities. In short, counting and dating physical objects of a given kind presuppose not a general criterion of identity or criterion of reidentification, but an ability that rests on an exposure to paradigm cases (not necessarily of the given kind) and on a congery of inclinations, prejudices and truisms which help focus the exposures and project them.

Thus to represent sentences like (19) and (20) with defined one-place predicates, the Relational Approach would not merely have to formulate principles that are inexplicit and highly complicated. It would have to lay down principles of reidentification that in the ordinary use of common nouns are fundamentally undetermined. The advantage of using primitive one-place predicates, instead of relational predicates that apply to temporal stages, is that we may thereby presuppose an ability to reidentify objects instead of having to state a principle of reidentification. There are, I think, theoretical reasons why we do not lay down and adhere to such principles. But exploring the vagueness in the reidentification conditions of common nouns would take us beyond our present venture.

The difficulty that counting and dating present to the Relational Approach suggests that these activities are fundamental to one-place predication as applied to physical objects. Demonstrative reference and the activity of locating objects are no doubt our most familiar and pragmatically important means of discriminating members of a physical-object natural kind. But counting and dating, or reidentifying, are equally central to ordinary usage. For these latter activities seem to be our basis

for distinguishing physical objects of a given kind from mere modes or
stages of an underlying substratum.

4. POST MORTEM

The Relational Approach's difficulty with sentences like (19) and (20)
provides the best ground for preferring the C-Approach as a representa-
tion of natural discourse. But other grounds are worth articulating
briefly.

The real lure of the Relational Approach, as a linguistic theory as well
as a metaphysical one, is the simplified ontology it appears to promise. But
it is not committed to fewer entities than the C-Approach. Syntactically
plausible representations of (11) and (12) demand definitions like (UR).
And specifying the relata of the relational predicates in these definitions
requires postulating phases of the basic objects which are at least as
numerous as the physical objects postulated by the C-Approach. Whether
the Relational Approach is committed to fewer *kinds* of entities is a ques-
tion in need of a way of counting the kinds a theory recognizes. Clear ways
are not easy to come by. But one might suspect that if the Approach were
to explicate the conditions under which each common noun marks out a
stage of a maximal space-time thread, it would thereby make distinctions
which would demarcate 'kinds' of threads that correspond one-one to
the kinds recognized by the C-Approach. In brief, the ontological advan-
tages of the Relational Approach are dubious.

Whereas the Relational Approach provides no clear ontological simpli-
fication, it complicates an account of syntax pretty drastically. To obtain
reasonably simple representations of sentences like (11), (12), (19), and
(20), the Approach would have to formulate a definition like (UR) for
each mass term and physical-object count noun in the vocabulary. The
Approach also requires a significantly more complicated primitive pred-
icate basis,[11] a multitude of irreplaceable two-place predicates. The same
number of monadic predicates are utilized by the C-Approach to do more
work: they make possible a plausible formal representation of our activi-
ties of counting and reidentifying physical objects – which the Relational
Approach has so far failed to do.

From the point of view of the ordinary use of natural language, neither
all stuffs nor all things are relations on, properties of, or segments of

something more basic. Paradigmatic examples of stuffs and things are fully concrete elemental members of our physical ontology.[12] From the point of view of a reconstruction of scientific knowledge, however, our anti-essentialist Relational Approach may remain an instructive if methodologically exacting option.

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NOTES

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[1] Good informal discussion of aspects of the Aristotelian problem may be found in David Wiggins, *Identity and Spatio-Temporal Continuity* (Basil Blackwell, Oxford, 1967). On the Heraclitean problem, see W. V. Quine, 'Identity, Ostension, and Hypostasis', *From a Logical Point of View* (Harvard U. P., Cambridge, Mass., 1953), pp. 65-70; *Word and Object* (MIT Press; Cambridge, Mass., 1960), pp. 116, 171; Helen Morris Cartwright, 'Heraclitus and the Bath Water', *Philosophical Review* **74** (1965), 466–485; John Perry, 'The Same *F*', *Philosophical Review* **79** (1970), 181–200. In what follows I shall use 'physical object' to apply to anything which (from some assumed point of view) may be an object of reference, which is physical, and which is not an event. On our favored account, the terms 'stuff' and 'thing' will be construed as having *roughly* disjoint extensions each of which is included in that of 'physical object'.

[2] There are cases in which gradual change of parts seems to involve change in identity. Imagine that smugglers gradually dismantle a valuable, historic steel engine, replace its parts one by one with aluminum ones (to fool the authorities), and ship the original parts across the border where they are reassembled. I shall assume that such examples do not show that in all cases of complete part replacement, the identity of the whole is altered.

[3] This handling of mass terms is perhaps suggested by Aristotle's paraphrase of them into adjectives, *Metaphysics* **IX**, 7. The Relational Approach may be fairly characterized as treating substantivals on the model of adjectives.

[4] A position between our approaches is that of D. Gabbay and J. M. Moravcsik, 'Sameness and Individuation', *The Journal of Philosophy* **70** (1973), 513–526. The position treats mass terms and count nouns as one-place predicates true of functions from times to a substratum. Thus, portions of gold, tables, animals, and mountains are taken to be abstract objects. The excuse for this view is the unelaborated claim that it helps explain the sense in which physical objects are 'constructions'. But it is left unclear why such explanation requires identifying physical objects with functions rather then merely holding that for each physical object there is a function from times to some substratum that mirrors the object in the appropriate way.

[5] The schema is an offspring of Aristotle's so-called logical criterion for substance. Cf. *Categories* **4a**, 10–11.

[6] I use 'thread' instead of 'worm' because stuff can be spatially scattered (unraveled). I do not intend 'thread' to rule out even temporal discontinuity, but metaphors that make such a possibility four-dimensionally picturesque are scarce.

[7] I shall not argue for my representation of tense since it has no very deep bearing on the main issues of the paper. (For the argument see my 'Demonstrative Constructions, Reference, and Truth' *The Journal of Philosophy* **71** (1974), 205–223.) If we had used a tense-logic to represent English sentences, the same issues could have been developed by focusing on the metalanguage. I am willing to take 'Exists at t' as primitive, although as applied to physical objects it could be defined as 'occupies some place at time t'.

[8] Cf. note 3. Richard Rorty in 'Genus as Matter' in *Exegesis and Argument: Essays in Greek Philosophy Presented to Gregory Vlastos*, Edward Lee *et. al.* (eds.), Van Gorcum, Assen, The Netherlands, speculates that Aristotle's physical criterion for substance and his treatment of stuffs as 'mere potencies' were partly motivated by a desire to block reductionist ontologies which result from pushing the logical criterion for substance (essentially (NP)) to the point of counting only ultimate substratum as substance, cf. *Metaphysics* VII, 16. For criticism of more recent moves analogous to Aristotle's, see Helen Morris Cartwright, 'Quantities', *Philosophical Review* **79** (1970), 25–42; Henry Laycock, 'Some Questions of Ontology', *Philosophical Review* **81** (1972), 3–42; and my 'Truth and Mass Terms', *Journal of Philosophy* **69** (1972), 263–282, esp. sections II-IV.

[9] Quine occupies this ground in Review of Geach's *Reference and Generality*, *Philosophical Review* **73** (1964) 102. I assume that everyone would agree that water which does not exist while Heraclitus bathes is irrelevant to determining what water he bathed *in*.

[10] This is equally a difficulty for attempts to reconstruct our practice of counting by appeal to some sort of equivalence relation among the relevant stages. The problem is to state the equivalence relation without relying on the monadic 'kind' predicate.

[11] Reasons for this claim stem from Nelson Goodman's work on simplicity. See *The Structure of Appearance* (Bobbs-Merrill, New York, 1951), 2nd edition, pp. 63–123.

[12] This paper has dealt only with account-types. A closer examination of stuffs suggests that some of them are plausibly construed on the model of phases of more basic stuffs. Cf. 'A Theory of Aggregates', forthcoming in *Noûs*.