SORTALS, NATURAL KINDS AND RE-IDENTIFICATION*

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Investigations into the logical structure underlying ordinary language and our common sense framework have tended to support the hypothesis that there are different stages of conceptual involvement and that while the structures elaborated at a later stage are in general not explicitly definable or reducible to those at the earlier they nevertheless presuppose them as conceptually prior bases for their own construction and elaboration—even when these conceptually prior structures are somehow eliminated or completely reconstructed at the later stages. This applies, moreover, not just to the conceptual structures underlying our common sense framework but to those underlying the development of logic, mathematics and the different sciences as well.

Jean Piaget, for example, as a result of his investigations into genetic epistemology has found that our knowledge of logico-mathematical structures is obtained through a process of «constructive» or «reflective» abstraction which proceeds through a hierarchy of successive stages in which the structures acquired at a previous stage are reconstructed before they are integrated into the new structures elaborated at later stages (cp. [10], p. 159). But as Piaget has also shown it is not just in logic and mathematics that cognitive activity develops through successive stages of progressive structuration; for the development of intelligence and knowledge in general, whether as represented in our common sense or our scientific framework, proceeds in essentially the same way. Indeed, the construction of our scientific framework on the basis of our common sense framework is itself a prime example not only of how conceptual structures acquired at a previous stage are completely

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reconstructed before they are integrated into those elaborated at the later stage but also of how the later structures though built upon the earlier cannot be reduced to or defined in terms of them (cf. Sellars [11]).

Now there are different ways in which we might investigate and represent these successive stages of progressive structuration in our conceptual frameworks. E.g., because of his «fundamental hypothesis» that «there is a parallelism between the progress made in the logical and rational organization of knowledge and the corresponding formative psychological processes» ([9], p. 13), Piaget's approach has been a general inquiry into our formative psychological processes. The first principle of genetic epistemology, according to Piaget, is «to take psychology seriously» (*ibid.*, p. 9).

There is an alternative for philosophical logicians, however. For while it is not within our expertise to inquire into our formative psychological processes, we can nevertheless contribute to the study and representation of «the logical and rational organization of knowledge» through the construction of theories of logical form that are characteristic of at least some of the more important stages in the development of our common sense and scientific frameworks. One thing in particular which the construction of such a theory would help explain is the sense in which the operations and co-ordinations of concepts that characterize a given stage of conceptual involvement constitute a self-sufficient structured whole which purports to have limits beyond which there is nothing for thought. And it would also help explain how the formalization of these operations and the clarification of their limits can be the basis for new and more elaborate operations whose structuration transcends those same limits and leads to a new stage of conceptual involvement.

It is this methodology that we shall adopt in what follows where our primary concern will be the logical structure of our referential devices for quantifying, identifying and classifying things. We shall particularly be concerned with how this structure is to bear upon the problem of cross-world and re-identification.

1. *Sortal Concepts:*

Despite the differences in their grammatical roles, common nouns, adjectives and intransitive verbs are all represented as monadic predicates in standard logical theory. That is, they are all interpreted as having the same logical form or conceptual structure.

There have been some objections to this interpretation, however. E.g., P.F. Strawson has associated *sortal universals* with common nouns and *characterizing universals* with adjectives and verbs. A sortal universal, according to Strawson, «supplies a principle for distinguishing and counting individual particulars which it collects. It presupposes no antecedent principle, or method, of individuating the particulars it collects. Characterizing universals, on the other hand, whilst they supply principles of grouping, even of counting, particulars, supply such principles only for particulars already distinguished, or distinguishable, in accordance with some antecedent principle or method» ([16], p. 168).

P. Geach, following Aquinas, has made a similar point in distinguishing between *substantival* and *adjectival general terms*, where countability is a sufficient condition for a term's being substantival ([5], p. 39). And W. Sellars also has insisted on the difference in linguistic roles of common nouns and adjectives (cf. [13]).

We shall follow these philosophers and assume the distinction in question, particularly as described by Strawson. Instead of sortal universals, however, we shall speak of sortal concepts in the sense of socio-genetically developed cognitive abilities or capacities to distinguish, count and collect or classify things. We should add, however, that the concept of a thing in general is not itself a sortal concept, even though 'thing' is a common noun. This is because we do not distinguish, count and classify things *simpliciter* but only *sorts* of things; and in fact the common noun 'thing' has come to have a use only because of the conceptually prior use of count nouns as sortal terms (cf. Sellars [13], p. 253f). Thus, not all common nouns are sortal terms but only those that are count nouns.

Our initial claim then is that the conceptual structures underlying our use of sortal concepts, as opposed to those underlying our use of adjectives and verbs, has a primary and distinctive role to play in the logical and rational organization of knowledge. Accordingly, given our present methodological approach, we are in agreement with the position taken by John Wallace that «attempts to reflect in a pattern of canonical notation the logical role of sortal predicates ought to be taken seriously» ([17], p. 11).

Following Geach, Wallace notes that sortal terms are grammatically substantival; that is, «they admit the definite article, the plural ending, the pronouns 'same', 'other', 'another', and quantity words: 'all', 'every', 'no', 'some', 'a', 'many', 'most', 'few', 'one', 'two', 'three', ...» (*ibid.*, p. 10). It is particularly with respect to quantity words or quantifiers, according to Wallace, that there is a difference between standard predicate logic and a theory of logical form respecting the distinctive role of sortal terms. «In English, sortal predicates follow on the heels of quantifier words to give the subject matter of our sentences. Classical quantification theory obliterates this logical feature of sortals; the new theory is supposed to respect it» (*ibid.*, p. 12).

Utilizing the letters 'S', 'T' (with or without numerical subscrpits) for sortal terms, sortal quantifiers can be symbolized as '$(\forall xS)$', '$(\forall yT)$', '$(\exists zS)$', '$(\exists xT)$', etc., where 'x', 'y', 'z' are individual variables. E.g., where 'S' represents the sortal term 'man' and 'F' is a monadic predicate for 'is mortal', the sentence 'All men are mortal' (or 'Every man is mortal') is to be symbolized as: $(\forall xS)\ F(x)$.

Sortal predication is also to be distinguished, according to Wallace, from «standard» predication. Notationally, this distinction can be made by the convention that «a sortal predicate stands behind its variable, while a plain predicate's variable stands behind it» (*ibid.*). E.g., 'xS' is to be read 'x is a(n)S', while 'F(x)' is read 'x is F'. Thus where 'S', 'T' represent the sortal terms 'horse' and 'animal', the sentence 'Every horse is an animal' is symbolized as: $(\forall xS)xT$.

2. *Absolute vs. Sortal Quantifiers:*

The introduction of sortal quantifiers merely as a form of restricted quantification within the framework of standard predicate logic may not seem to be particularly illuminating. However, to the contrary, the analysis of sortal quantifiers from the perspective of standard predicate logic is just one of those reconstructions of a prior conceptual structure presupposed in the construction of the standard quantiφiers. After all, when interpreted model-set-theoretically the standard quantifiers are themselves relativized to particular *domains of discourse* which are none other than the extensions of sortal concepts.

Of course standard quantifiers might be taken in an absolute sense instead, i.e., as referring to *everything* independently of any and all relativizations to different domains of discourse. G. Frege, e.g., viewed the quantifiers of his *Begriffschrift* in this way (cp [19). But then Frege had really presupposed that the notion oφ an *object* was itself an ultimate sortal to which every other (first level) concept was subordinate; and this in effect is the same assumption as that 'thing' is a sortal term—an assumption we have already rejected.

But having rejected this assumption does not mean that we also reject the idea that we can refer to absolutely everything in some derivative sense. For while we do assume that each thing is such that reference to it is possible at all only through its falling under some sortal concept, we can nevertheless capture the full intent of quantifying over absolutely everything insofar as 'everything' refers to *everything of whatever sort*. Accordingly, once second order quantifiers regarding positions for sortal terms are allowed we can contextually define the absolute quantifiers as follows (cp. [15], p. 205):

$$(\forall x)\varphi \quad =_{df} \quad (\forall S)\,(\forall xS)\varphi$$
$$(\exists x)\varphi \quad =_{df} \quad (\exists S)\,(\exists xS)\varphi$$

We shall in what follows allow for second order quantifiers binding sortal terms. We note in this regard, however, that the adequacy of the above definitions requires that we construe these quantifiers as referring not just to those sortal concepts which we have already constructed and learned to use in our common sense and scientific frameworks but to those which we can in principle construct and learn to use as well. That is, our second order reference to sortal concepts must be understood to be implicitly counter-factual.

We should also note that on the basis of the above definitions our original guiding assumption that each thing falls under some sortal concept is now a trivial conceptual truth since '$(\forall x)\ (\exists T)xT$' now reduces to '$(\forall S)\ (\forall xS)\ (\exists F)xT$)'. We note this here since it might be objected that the original or pretheoretical assumption was not to be understood in this way but that it implicitly presupposes an independent development of our understanding of absolute quantifiers.

3. *Sortal Identity:*

Perhaps one explanation of the supposed difference in the pretheoretical content of this guiding assumption lies in the difference between individuation and identification at least as regards things belonging to a natural kind, i.e., things whose individuation does not depend on our conceptual framework. For as cognitive capacities to distinguish, count and collect or classify things, sortal concepts are therefore abilities by which things are identified. That is, sortal terms provide us with identity criteria; and in this regard, our above guiding assumption is really the claim that each thing is identifiable and can be referred to at all only through criteria provided by some sortal concept under which it falls. This claim, however, should in no way be confused with the different (and false !) claim that each thing is individuated in accordance with some (or any) sortal concept by means of which it is identified.

Our rejection of an independent as well as a conceptually prior development of our understanding of absolute quantifiers is matched by a similar claim regarding absolute identity. E.g., according to Geach, «it makes no sense to judge whether x and y are 'the same', or whether x remains 'the same', unless we add or understand some [substantival] general term» (*op. cit.*, p. 39), as in 'the same S'. Absolute identity, in other words, is neither conceptually prior to this form of relative identity nor an independent logical development.

Symbolizing 'x is the same S as y' as '$x \underset{S}{=} y$', the natural approach to absolute identity parallels that for the absolute quantifiers (cp. [15], p. 205):

$$(x = y) \quad =_{df} \quad (\exists S)\,(x \underset{S}{=} y)$$

Of course, just as the sortal quantifiers can be reconstructed as restricted absolute quantifiers, sortal identity can be reconstructed as absolute identity conjoined with a sortal predication, i.e., 'x is the same S as y' can be reinterpreted as 'x = y and x is an S'. But, again, to ignore the issue of conceptual priority and later reconstruction may lead to an inverted or distorted understanding of the logical and rational organization of knowledge. We do indeed have a notion of unrestricted or absolute identity, but it is one which has been constructed from the conceptually prior notion of identity relative to a sortal concept, i.e., identity relative to identity criteria provided by a sortal concept.

We should perhaps note in this context that Geach finds absolute identity even in this derived form unacceptabe since he believes it is possible that x is the same S as y but not the same T as y (*op. cit.*, p. 157). And of course this means he rejects Leibniz' principle of the indiscernibility of identicals not only for absolute identity as defined above but for relative identity as well.

David Wiggins, however, has argued against this aspect of Geach's approach, claiming that Leibniz' principle «marks off what is peculiar to identity and differentiates it in a way in which transitivity, symmetry and reflexivity (all shared by *congruence, consanquinity*, etc.) do not» ([18], p. 5). And Leslie Stevenson has convincingly argued that while the criteria Geach cites in his examples for the possibility that x is the same S but not the same T as y do define equivalence relations, they nevertheless fall short of full identity even when relativized to a sortal concept (cp. [14]). And in [15] Stevenson has constructed a consistent formal theory of sortal quantification for extensional contexts which takes Leibniz' principle as an axiom schema for all identities relative to a sortal concept.

We shall adopt the Wiggins-Stevenson view in what follows. That is, we accept the claim that Leibniz' law is a necessary feature of any adequate theory of identity and that therefore it is necessary for sortal identity as well. We shall not restrict ourselves to extensional contexts, however, as Stevenson does in his formal theory; and for this reason the question of the intuitive validity or invalidity of certain theses regarding sortal re-identification in non-extensional contexts will be our principal concern. Our investigations in this regard, moreover, will lead us to reject or at least seriously restrict, both of Stevenson's two basic assumptions for sortals (which he adopts from Wiggins). These are the assumptions (1) that every sortal is subordinate to some ultimate sortal and (2) that if two sortals intersect then there is a sortal to which both are subordinate (cf. [15], p. 187 and [18], p. 33).

4. *Sortal Predication:*

The novelties of logical form introduced so far are sortal quantifiers, sortal identity and sortal predication. The latter, however, is redundant and therefore eliminable as a primitive form of our logical grammar.

This elimination of sortal predication as a primitive form is not a matter of a later reconstruction, moreover, but amounts in effect to *the identity theory of the copula* which was so popular with 14th century logicians. The idea is that 'x is an S' means 'x = an S', where the latter is to be symbolized as '$(\exists yS)(x = y)$', or equivalently as '$(\exists y)(x \underset{S}{=} y)$', or finally and most explicitly as '$(\exists yS)(x \underset{S}{=} y)$'.

$$xS \quad =df \quad (\exists yS)(x \underset{S}{=} y)$$

As a formulation of the identity theory of the copula, the above definition also brings out the sense in which sortal terms or count nouns can be said to be *common names*. And in this regard it might be appropriate to avoid speaking of sortal terms as predicates in any sense. For of course we are not claiming here that predicates are names or that every predication pattern reduces to an identity. That, after all, would be to conflate adjectives and verbs, transitive as well as intransitive, with common nouns expressing a sortal concept. And of course, conversely, the interpretation of sortal terms as common names is not to be confused with construing them as a kind of adjective or verb. Sortal terms, in other words, even when occurring in sortal predications, are not to be taken as predicates at all.

5. *Sortal Quantification and Modal Logic:*

One of the more difficult and controversial problems in contemporary logical semantics is that of trans-world identification, i.e., the problem of identifying the same individual in the different possible worlds which our different modal notions lead us to consider. Clearly, since sortal concepts provide identity criteria, it is appropriate that we approach this problem within a framework respecting sortal quantifiers and sortal identity.

We must be cautious, however, in how we deal with the notions of a possible world and of a possible object identifiable as such in different possible worlds. For these notions occur at an advanced and rather involuted stage of reflective abstraction far beyond, e.g., our more basic conceptual involvement of identifying existing things in space and time. In particular, the metaphysical use of the notion of a *logically* possible world and the related modal notions of *logical* possibility and *logical* necessity should be most suspect of all.

This is perhaps especially so in our present context since the paradigm framework for these notions is logical atomism where there can be no question of an identity criterion for what are there taken to be ontologically simple objects. And, indeed, even the sense data of Bertrand Russell's epistemological variant of logical atomism have their own «perfect identity» for which the question of an identity criterion cannot arise.

Now we do agree that as a metaphysical framework, logical atomism (and probably only logical atomism) can provide a coherent account of a logically possible world and thereby of logical possibility and necessity. For because it assumes a fixed, absolute totality of simple objects (whose possible existence is the same as their actual existence) and a fixed, absolute totality of atomic configurations with these objects as constituents, logical atomism determines in a coherent and nonarbitrary manner a fixed, absolute totality of possible worlds. And by means of such a totality, logical atomism is able to provide a semantical account of logical possibility and logical necessity as purely formal concepts with no material content (cf. [2] and [3]). In other words, in logical atomism all *de re* modalities (regarding logical essences) are reducible to *de dicto* modalities.

But in the end, and notwithstanding the clarity of sense it gives to the logical modalities, logical atomism is too austere a framework to make sense of even the most basic conceptual structures with which we operate in our common sense and scientific frameworks. The myth of the simple upon which it is built yields at best an idealized abstract structure which philosophers can thematically employ in logical semantics and the theory of logical form. It is an extreme to which the philosopher resorts in his search for the meaning of necessity.

Having plumbed the depths of this extreme elsewhere (cp. [2]), we shall move on to a more realistic view where objects are not simple nor identity perfect and where what modalities there are, as opposed to propositional attitudes, have to do with the temporal and causal structure of the world.

6. *Sortal Quantifiers in Tense Logic:*

It is well-known that one of our earliest and more fundamental stages of conceptual involvement is concerned primarily with the problem of (re-)identifying things in space and time. It is a stage, moreover, where the conceptual structures corresponding to sortal quantification over *moments, durations,* or *intervals of time* have not yet been constructed or fully articulated. Indeed, the deeper or more basic structures we find our temporal references manifesting at this stage have more of a topological than a quantitative or metrical form; and in fact these structures are rather appropriately characterized by tense operators.

Accordingly, given our present methodology and the deeply embedded role of sortal concepts to provide identity criteria, we shall attempt to characterize the stage in question and in consequence deal with the problem of re-identification by a theory of logical form in which we apply sortal quantifiers and sortal identity to tense-logical contexts. We shall utilize for this purpose the sense operators '*P*' for 'it was the case that', '*F*' for 'it will be the case that' and '*N*' for 'it is now the case that'. The now-operator, as Hans Kamp has shown (cf. [7]), is not reducible to the simple present tense (which we assume incorporated in each atomic formula).

We understand temporal possibility and necessity at the stage in question in the Aristotelian manner, i.e., as what either was, is, or will be the case and as what always was, is, and always will be the case:

$$\Diamond^t\varphi \quad =_{df} \quad P\varphi \vee \varphi \vee F\varphi$$
$$\Box^t\varphi \quad =_{df} \quad \sim P \sim \varphi \,\&\, \varphi \,\&\, \sim F \sim \varphi$$

We might note, incidentally, that the construction of the later stages where sortals for events and moments, durations or intervals of time are first articulated is based initially on the emergence through reflective abstraction of certain logico-grammatical operations for nominalizing propositional forms. Events are then first taken as the «things» corresponding to true propositions so nominalized, and temporal predicates such as that for the earlier-than relation (of local time) are introduced corresponding to different combinations of the tense operators occurring in such nominalizations. Of course, after a series of constructive abstractions leading to the later stages where sortals for events and moments are fully articulated the conceptual structures represented by these nominalizing operations become completely reconstructed and are either eliminated or absorbed into the constructed logic of events and the similarly constructed geometric logic of the space-time manifold (cf. Sellars [12]).

Accordingly, while it is our view that there is no stage of conceptual involvement at which things are identified independently of a temporal framework, it is also our view that our (re-)identification of things in space and time does not ordinarily presuppose the prior or simultaneous identification of a moment or interval of time. Indeed, the general sort of tense-logical structure we are constructing as a theory of logical form for the stage in question represents just such a temporal framework within which such prior or simultaneous identifications are not presupposed. The fact that a logical reconstruction of the semantics for this framework may involve such presuppositions from its own later and derivative perspective, particularly if it is one based on the logic of events and the space-time maniφold, should not be taken as imposing these presuppositions on the framework itself. For to do so would be to invert and distort the logical and rational organization of knowledge.

In turning then to the use of sortal quantifiers in the sort of tense logic we have in mind for the stage in question let us first consider the problem of referring directly to past or future things. The question is whether such reference is basic to the stage of conceptual involvement with which we are here concerned or whether it can be constructed on the basis of sortal quantifiers that refer directly only to things that exist at the time in question.

Elsewhere (in [1]), I myself had argued that an adequate tense logical analysis of certain English sentences requires the use of quantifiers referring directly to past or future persons. E.g., where 'S' is a sortal term for 'person', the respective contents of:

(1) There did exist someone who is an ancestor of everyone now existing.
(2) There will exist someone who will have everyone now existing as an ancestor.

are not correctly represented by:

(1') $P\ (\exists x S)\ (\forall y S)$ Ancestor (x, y)
(2') $F\ (\exists x S)\ (\forall y S)$ Ancestor (y, x)

where the existential quantifiers refer not directly but indirectly, i.e., within the scope of a past or future tense operator, to a past or future person, respectively. For what (1') and (2') represent are the different English sentences:

(3) There did exist someone who was an ancestor of everyone *then* existing.
(4) There will exist someone who will have everyone *then* existing as an ancestor.

On the other hand, if we already have sortal quantifiers that refer directly to past or future persons, then the approriate tense-logical forms are easily formulable. E.g., where 'Past-' and 'Future-' are *sortal term modifiers* (derived somehow from the past and future tense operators) corresponding to attributive as opposed to predicate adjectives, we can formulate appropriate tense-logical counterparts to (1) and (2) as follows:

(1'') $(\exists x$ Past-S$)\ (\forall y S)$ Ancestor (x, y)
(2'') $(\exists x$ Future-S$)\ (\forall y S)\ F$ Ancestor (y, x)

where of course 'Past-S' and 'Future-S' are assumed in our present context to be (complex) sortal terms which provide identity criteria for past or future persons who might not exist at the time of assertion.

Now while we may in principle be able to articulate conditions for identifying past persons who no longer exist and, though perhaps more dubious, also future persons who have yet to be born, it is clear that to whatever extent such articulation is possible it must be based upon our identity criteria for persons *simpliciter*, i.e., to be somewhat redundant here, it must be based upon our identity criteria for *existing* persons. And of course the same observation applies to things of whatever other sort as well. The question, however, is whether the presumed conceptual priority of referring directly only to existing things occurs at a coherent stage of conceptual involvement, i.e., one at which the conceptual operations involved constitute a self-sufficient structured whole, or whether the purported difficulty of representing sentences like (1) - (2) indicates a structural flaw which must be emended, e.g., by constructing sortals which provide identity criteria for past or future things, before such structured self-sufficiency or wholeness can be achieved.

My own view in [1], as already noted, was that something like sortals for past or future things were necessary for the representation of sentences like (1) - (2). However, the tense-logical contexts considered at that time did not include the now—operator which I had then assumed to be reducible to the simple present tense (which was taken as being incorporated in each atomic formula). Once Hans Kamp had clearly distinguished the logic of this operator and showed it not to be reducible to the simple present tense (in quantificational contexts), we discover that (1) - (2) can be formulated without resorting to sortal quantifiers that refer directly to past or future persons after all:

(1*) $P\ (\exists xS)\ N\ (\forall yS)$ Ancestor (x, y)
(2*) $F\ (\exists xS)\ N\ (\forall yS)\ F$ Ancestor (y, x)

Generalizing upon this last result we see that we can contextually define the quantificational use of such sortals as 'Past-S'' and ''Future-S' as follows (1):

$$(\forall x \text{ Past-S})\, \varphi \quad =_{df} \quad \sim P \sim (\forall xS)\; N\varphi$$
$$(\forall x \text{ Future-S})\, \varphi \quad =_{df} \quad \sim F \sim (\forall xS)\; N\varphi$$

We shall assume accordingly that a tense logic such as we are now contemplating where sortal quantifiers refer directly only to existing things corresponds to a coherent stage of conceptual involvement, i.e., one whose conceptual operations constitute a self-sufficient structured whole. It is assumed to constitute, moreover, the conceptually prior basis upon which the conceptual structures requisite for direct quantification over realia, i.e., things that exist at some time or other, are to be constructed.

We shall also assume that singular terms (including free individual variables) in the theory of logical form characterizing this stage need not refer at any given time to a thing existing at that time. That is, at this stage *to be* is not to be the (purported) value of a variable. Instead, *to be* is *to be identifiable by means of some sortal concept:*

$$E!(x) \quad =_{df} \quad (\exists S)\,(\exists yS)\,(x = y)$$

Naturally, this formulation of the existence predicate must be completely reconstructed once sortal concepts which provide identity criteria for realia in general—and perhaps even for physical possibilia—become fully articulated.

7. *Re-Identification*

Since sortal concepts at the stage in question provide identity criteria only for things that exist whenever they are

(1) Even aside from being sortal relative, our treatment of quantifiers here differs from Kamp's in [7]. Kamp's quantifiers, like those in [1], refer directly not only to realia, i.e., past, present and future things, but possibilia as well.

identifiable by means of such concepts, the problem of re-identification is at this stage the problem of identifying the same thing at different times at which it exists. Actually, however, in our present context it is even more narrow a problem than that; for the problem and any thesis proposed as its solution must be formulable within the type of tense logical frame-work which we are concerned with here.

In this regard, we must remember that any direct quantificational reference to things in general (in the sense of the absolute quantifier defined earlier) can only be to things identifiable (and therefore existing) at the time of assertion. Moreover, since we cannot station ourselves in time outside of the present any more than we can station ourselves outside of the world, we take the present, i.e., now, to be the time of assertion when stating theses.

Our problem then, more narrowly confined, concerns the conditions under which things to which we can now refer can be re-identified at any other time at which they exist. And having stated the problem in this way we discover immediately at least a minimal thesis which we find intuitively valid: for there can be no question of being able to re-identify something to which we can now refer as being the same thing at another time at which it exists except by means of some sortal concept under which it falls then as well as now.

Thus, e.g., the boy you saw then is the man you see now: it is *the same person*. Or, the ring John gave Mary is the pendant Mary is now giving George: it is *the same bit of gold*. Here of course it is clear that while 'boy', 'man', 'ring' and 'pendant' are each sortals in their own right, the (re-)identifications in question are not based on identity criteria provided by these sortals but by those provided by 'person' and 'bit of gold'.

These examples might be misleading, however, insofar as the sortals by which the re-identifications are made are such that the things in question, i.e., a person and a bit of gold, are identifiable under these sortals at all times at which they exist. Our minimal thesis does not require this strong a condition but only that each thing to which we can now refer is in principle identifiable at any other time at which it exists by means of some sortal under which it is now identifiable as well:

(A) $(\forall x)\ \Box^{t}\ [E\,!\,(x) \rightarrow (\exists S)\ (xS\ \&\ N\,xS)]$

The occurrence of the now-operator within the scope of the other tense operators is essential here in thesis (A). Its elimination is possible only by turning to something like the stronger thesis that for each thing to which we can now refer there is some sortal under which the thing is identifiable not only now but *at all times at which it exists as well:*

(B) $(\forall x)\ (\exists S)\ [xS\ \&\ \Box^{t}\ (E\,!\,(x) \rightarrow xS)]$

It is clear of course that while (B) implies (A), they are not equivalent theses.[2] That is, (B) is signiφicantly stronger than (A), and in consequence we cannot give assent to it here without further inquiry into whatever plausibility it might be thought to have.

8. *Sortals and Natural Kinds:*

One explanation why (B) has been commonly assumed derives from its application to «natural things», i.e., things that belong to a natural kind. For natural kinds are both associated with sortals and are essential to the things belonging to them, i.e., anything belonging to a natural kind cannot but be of that kind throughout the entirety of its existence. Accordingly, if everything (of whatever sort) belonged to a natural kind and

[2] That (A) follows from (B) is an elementary consequence of the following valid schema:

$$(xS \rightarrow \Box^{t}\ N\,xS)$$

We realize that (B) is equivalent to the simpler formulation:

$$(\forall x)\ (\exists S)\ \Box^{t}\ (E\,!(x) \rightarrow xS)$$

but we prefer the original because of its emphasis on the present.

each natural kind can be associated with a sortal concept, then (B)'s plausibility would seem to be assured.

Now we do agree that within our common sense framework natural kinds are taken to be natural powers or capacities which things have to act, behave, function, etc., in certain specific determinate ways: to be in fact the causal basis for the natural laws upon which our scientific theories are constructed. And things belonging to a natural kind, moreover, are indeed taken to be such as to be essentially of that kind throughout the entirety of their existence.

Nevertheless, it is quite inappropriate to assume either that everything (of whatever sort) is of a natural kind or that each natural kind can be associated with a sortal concept whereby things of that kind can be identified. In particular, most artifacts do not belong to a natural kind; for unlike the ring or pendant which is a bit of gold, the materials out of which most artifacts are made are so mixed and varied as to render the artifact as a whole as not being of a natural kind. And of course sortals for artifacts are as deeply based within our common sense framework as are sortals for such natural kinds, e.g., as the different species of animals or plants.

Moreover, as causal structures with a potential to be realized in the appropriate environment, natural kinds may so far outstrip our conceptual abilities as to nullify any attempt to associate a distinct sortal concept with each natural kind. There may, in other words, be more natural kinds in nature as physically realizable causal structures than there are possible concepts as socio-genetically or psychologically realizable cognitive capacities.

Still, despite its shortcomings, there is an important methodological connection between thesis (B) and the theory of natural kinds. Consider, e.g., the logic of natural kinds developed in [4] where natural kinds are projected as the values of monadic predicate variables bound by special predicate quantifiers '$\exists^k$' and '$\forall^k$'. A fundamental axiom of this logic is:

(K1) $$(\forall x)(\forall^k F)(\Diamond^c F(x) \rightarrow \Box^c[E!(x) \rightarrow F(x)])$$

which stipulates that an individual *can* belong to a natural kind only if being of that kind is essential to it, i.e., only if it *must* belong to that kind whenever it exists. Here of course we are concerned not with any putative logical modalities but with some form of physical or causal possibility and necessity instead. The possible worlds over which these modalities range are worlds in which the same laws of nature hold as hold here. Such worlds may in particular be none other than the physically accessible world-lines of the one cosmic system of world-lines to which our world-line(s) belong(s).

In any case, adapting this logic of natural kinds to our present context [3], we can formulate the condition under which a sortal concept can be said to provide identity criteria for things belonging to a natural kind as follows

$$NK(S) \quad =_{df} \quad (\exists^k F)\, \Box^c\, (\forall x)\, [F(x) \leftrightarrow xS]$$

It should perhaps be noted that the above definiens specifies a factual and not a logical condition. That is, whether or not there is in nature a natural kind the members of which are identified by means of a given sortal concept is something to be discovered by scientific inquiry and not by purely logical or semantical means alone.

Now by (K1) and the above definition, anything which can be identified by means of a sortal to which there corresponds a natural kind is re-identifiable by means of that same sortal not only at all times (of our world-line) at which it exists but at all times at which it exists in any causally accessible world (or world-line) as well. That is, we have the following:

[3] The (absolute) quantifiers in [4] range over realia and even physical possibilia. It is still our view that such quantifiers are necessary for the full development of the theory of natural kinds. However, for our present purposes we can easily understand the theses of (4) to be restricted to the absolute quantifiers of this earlier stage of conceptual involvement.

$$\text{(C)} \qquad NK(S) \rightarrow (\forall xS)\, \Box^c\, (E!\,(x) \rightarrow xS)$$

as a valid thesis. Of course (C) has as its antecedent the hypothesis that there is a natural kind the members of which can be identified under the sortal in question and this hypothesis may require just the re-identifications involved in the consequent of (C) for its confirmation; in which case (C), despite its validity, can hardly be said to specify a condition under which such re-identifications can be made in the first place .

Nevertheless, conditions that render scientific inquiry intelligible would appear to validate at least as a methodological principle the thesis that anything belonging to a natural kind can in principle be identified by means of some sortal to which there corresponds a natural kind (and to which therefore the thing belongs):

(MT1) $(\forall x)\ [(\exists^k F)\ F(x) \rightarrow (\exists S)\ (NK(S)\ \&\ xS)]$

It is not assumed in (MT1) that the natural kind corresponding to a sortal by means of which a natural thing can be identified need be an *infima species.* That may in fact be the ideal we strive for in scientific research and it too may be methodologically warranted. But as regards the justification of thesis (B) when applied to natural things, it is an additional assumption we do not need to make here in our present context. For by (C), which is valid on purely conceptual grounds, and by the weaker methodological assumption (MT1), thesis (B), when restricted to natural things, follows. That is, we take:

(B^k) $(\forall x)\ [(\exists^k F)\ F(x) \rightarrow (\exists S)\ (xS\ \&\ \Box^c\ [E!\,(x) \rightarrow xS])]$

to be methodologically warranted even if not valid on purely conceptual grounds. And of course the same claim can be made for thesis (B) in the strictly temporal contexts as well, since what is causally necessary is temporally necessary.

Finally, as regards validity simpliciter, we should note that not only do we still have thesis (A) as a valid condition for re-identification, but even as a condition for cross-world identification in causal contexts the immediacy of (A)'s intuitive validity remains. Accordingly, we take the stronger thesis:

(A^c) $(\forall x) \Box^c [E!(x) \rightarrow (\exists S)(xS \,\&\, N\, xS)]$

to be valid in our combined tense-logical framework of sortals and natural kinds.

9. *Sortal Proper Names:*

Another explanation regarding thesis (B) derives from the use of proper names to uniquely identify (at most) a single thing. The novel insight here is that proper names can be assimilated with common names so as to constitute a special type of sortal term.

This assimilation is justified in part because of the way in which both proper names and common names provide identity criteria, even if the former is to a point of uniqueness. E.g., according to Geach «any given successful use of a proper name is tied to identification by some definite criterion of identity» ([6], p. 295). And Sellars makes a similar point claiming that where 'S' is a proper name, 'S exists (did exist, will exist)' has the sense of 'something satisfies (satisfied, will satisfy) the criteria for being called 'S', where the criteria include a uniqueness condition ([12], p. 562).

Now in regard to this uniqueness condition it should be clear that we are not suggesting that proper names are like common names in that both can be used to identify or refer to more than one thing. For of course proper names can be and are so used. But unlike the unambiguous use of a common name to identify or refer to many things, a proper name can be so used only ambiguously. That is, it is the unambiguous use of a proper name that we take to be a cognitive capacity to uniquely identify (at most) one thing. And it is only with this use that we are here concerned.

Construing proper names as sortal terms means more than that they provide identity criteria, however. In particular, it also means that their referential role is primarily quantificational. E.g., where 'S' is a (proper name) sortal for 'Pegasus' and 'T' is a sortal for 'winged horse', we can now see how on one interpretation 'Pegasus is a winged horse' would be true:

$$(\forall xS)xT$$

while on another it would be false:

$$(\exists xS)xT$$

Interpreted in the first way it is taken as asserting only that whatever is (uniquely) identifiable as Pegasus is a winged horse, while in the second it is taken as asserting the existence of something (uniquely) identifiable as Pegasus which is a winged horse. Thus, the so-called presupposition free use of a proper name such as 'Pegasus' is accounted for by the universal sortal quantifier '$(\forall xS)$', while the existential presuppositional use is accounted for by '$(\exists xS)$'.

Our assimilation explains, moreover, why issues of scope are relevant to proper names occurring in epistemic or doxastic contexts. E.g., where 'S' and 'T' are as above and '*B*' is a doxastic operator for 'John believes that', we have four ways of disambiguating 'John believes that Pegasus is a winged horse', each depending first on the question of the scope of 'Pegasus' as a quantified sortal term and, second, on whether 'Pegasus' is being used with or without existential presupposition:

$$B\,(\forall xS)xT$$
$$(\forall xS)\,BxT$$
$$B\,(\exists xS)xT$$
$$(\exists xS)\,BxT$$

Assuming then that we have made a reasonable case for the assimilation of proper names to sortal terms, let us turn to the supposed defense of thesis (B). We note first in this regard that proper names are used only ambiguously to identify different things not only at the same time but at different times as well. That is, proper names in the sense intended here are «rigid designators» with respect to temporal contexts. And what we take this to mean is that as used now a proper name sortal is projected as always refering to or identifying one and the same thing which in principle is always so identifiable whenever it exists. Accordingly, we take

$$(\forall xS)\,[\Box^{t}\,(\forall yS)\,(y = x)\ \&\ \Box^{t}\,(E\,!\,(x) \rightarrow xS)]$$

to be valid when 'S' is a proper name sortal. Moreover, for purposes more of notational convenience we shall assume not only that every proper name sortal satisfies the above condition but also that any sortal doing so amounts to a propre name sortal with respect to temporal contexts:

$$PN^{t}(S) \quad =_{df} \quad (\forall xS)\,[\Box^{t}\,(\forall yS)\,(y = x)\ \&\ \Box^{t}\,(E\,!\,(x) \rightarrow xS)]$$

Now the stronger claim that proper names are «rigid designators» in causal as well as temporal contexts has been made, e.g., by S. Kripke (cf. [8]). On this view there is somehow a causal connection established between a proper name and the thing it can be used to uniquely identify so that the name cannot be unambiguously used even in causal contexts to identify something else. In other words, on this view, which we shall also accept here, even

$$(\forall xS)\,[\Box^{c}\,(\forall yS)\,(y = x)\ \&\ \Box^{c}\,(E\,!\,(x) \rightarrow xS)]$$

is valid when 'S' is a proper name sortal. Accordingly, again more for notational convenience, we shall assume not only that every proper name sortal satisfies this condition but also that any sortal doing so amounts to a proper name sortal with respect to causal (as well as temporal) contexts:

$$PN^{c}(S) \quad =_{df} \quad (\forall xS)\,[\Box^{c}\,(\forall yS)\,(y = x)\ \&\ \Box^{c}\,(E\,!\,(x) \rightarrow xS)]$$

Finally, in regard to the defense of thesis (B) we can distinguish between the weeker claim that everything (of whatever sort) is in principle identifiable by means of a proper name sortal with respect to temporal contexts:

(D) $(\forall x)(\exists S)[PN^t(S) \& xS]$

from which thesis (B) follows, and the stronger similar claim for causal contexts:

(D^c) $(\forall x)(\exists S)[PN^c(S) \& xS]$

It is clear of course that (D) is but a more specialized form of (B), as well as that (D^c) is but a more specialized form of:

(B^c) $(\forall x)(\exists S)[xS \& \Box^c (E!(x) \rightarrow xS)]$

Consequently, our problem regarding whatever plausibility (B), and now (B^c) as well, might be thought to have has only shifted to the more stringent problem of justifying (D) and (D^c).

Theses (D) and (D^c) might perhaps seem and even be acceptable when applied to the things of our common sense framework, at least so long as we are clear that we are concerned here with what is in principle uniquely identifiable by means of a proper name sortal. But when applied to the theoretical entities of our scientific framework, on the other hand, their acceptability is quite another matter. For even if, as seems unlikely, we could in principle uniquely identify each atom or molecule upon which physical chemistry is based, the phenomena of quantum physics suggests that principle will have to go by the board in the case things in the sub-atomic microworld Indeed, even just fixing our quantificational reference to these things in terms of the identity criteria provided by theoretical, and therefore general, sortals is still something of a problem today and brings us to the very frontiers of our developing scientific framework. Consequently, at least as applied to the things in the micro-world if not also to the things of our common sense framework, we remain dubious of the acceptability of (D) and (D^c) as intuitively valid theses.

Finally, we should be wary of an attempt to justify (D) and (D^c) by reference to so-called *individual natures* or *essences* which somehow can in principle have proper name sortals correlated with them. For even if there are such natures in the world we must still distinguish them in their individuating function as an aspect of reality from the uniquely identifying and referential role of their associated proper names as an aspect of our conceptual framework. Moreover, since such individual natures or essences are at best attributable only to things belonging to a natural kind (including the natural kinds in the micro-world), any attempt to defend (D) and (D^c) along these lines must be restricted to natural things and can at best be proposed as a methodological thesis even more demanding than (MT1) restricted to sortals for infima species:

$$\text{(MT2)} \qquad (\forall x)\,[\exists^k F)\, F(x) \rightarrow (\exists S)\,(NK(S)\ \&\ PN^c(S)\ \&\ xS)]$$

10. *Re-Identification through Sortal Subordination:*

One implicit assumption of the view that individual natures or essences are necessary for cross-identification through causal as well as temporal contexts seems to be that such identification is possible only by a «narrowing» of identity criteria to a point of uniqueness corresponding to the real or causal individuation of the thing in question. This in a way is the same assumption mentioned earlier that somehow there must be a perfect match if not second order sameness between the real individuation of a thing and its identity ([4]). And just as we rejected this version of the assumption, so too we reject the other. For even if there are individual natures or essences, the use of a proper name sortal does not presuppose that the identity criterion it provides must somehow correspond to the real individuation of the thing (if any) to which it refers. Nor of

([4]) Identity and individuation do co-incide when restricted to purely logical or conceptual things, however, E.g., the principle of individuation for classes is the same as their identity criterion: classes are the same iff they have the same members.

course does the use of a general sortal under which things belonging to a natural kind are identified presuppose that the identity criteria provided must somehow match the generic individuation of these things. (This may, however, be an ideal of science as regards theoretical sortals. But these, because of constraints regarding nomological form, will not be proper name sortals in any case).

Moreover, even aside from the question of individuation, cross-world and re-identification need not in general be based on a «narrowing» but might instead be based on a «widening» of identity criteria. For by widening our criteria from those provided by one sortal to those provided, e.g., by a superordinate sortal, we are able to cross- and re-identify things which because of changed conditions are not identifiable under the narrower or subordinate sortal. Thus, e.g., it is just such widening we resort to when we (re-)identify the boy you saw and the man you see as the same person.

Now as a general proposal we can again distinguish between a weaker and a stronger version of the claim in question. On the weaker version subordination is defined as sempiternal inclusion:

$$S \underset{t}{\leq} T \quad =_{df} \quad \Box^{t} (\forall xS)xT$$

while on the stronger it is taken as inclusion in all causally accessible situations as well:

$$S \underset{c}{\leq} T \quad =_{df} \quad \Box^{c} (\forall xS)xT$$

The weaker and stronger claims then are the theses that everything identifiable by means of a sortal S is identifiable in principle whenever it exists by means of some sortal to which S is temporally or causally subordinate, respectively:

$$\text{(E)} \qquad (\forall S)\,(\forall xS)\,\Box^{t}\,[E\,!\,(x) \rightarrow (\exists T)\,(S \underset{t}{\leq} T \,\&\, xT)]$$

(E^c) $$(\forall S)\,(\forall xS)\,\Box^c\,[E\,!\,(x) \rightarrow (\exists T)\,(S \underset{c}{\leq} T \;\&\; xT)]$$

These theses, we might note, imply (A) and (A^c), respectively, but do not imply (B) and (B^c). And in this latter regard we should distinguish (E) and (E^c) from the much stronger claims:

(F) $$(\forall S)\,(\exists T)\,(S \underset{t}{\leq} T \;\&\; (\forall xS)\,\Box^t\,[E\,!\,(x) \rightarrow xT])$$

(F^c) $$(\forall S)\,(\exists T)\,(S \underset{c}{\leq} T \;\&\; (\forall xS)\,\Box^c\,[E\,!\,(x) \rightarrow xT])$$

which while they imply (B) and (B^c), respectively, are clearly to be rejected in as much as they fail when applied to sortals for artifacts.

But then thesis (E^c) fails for essentially the same reason; and if '$\underset{t}{\leq}$' in (E) were replaced by '$<$' where

$$S \underset{t}{<} T \quad =_{df} \quad S \underset{t}{\leq} T \;\&\; \sim (T \underset{t}{\leq} S)$$

than perhaps even (E) as well would have to be rejected. However, since a sortal is temporally subordinate to itself, it is not clear that (E) is to be rejected at all.

We are not claiming here, on the other hand, that (E) should be accepted as intuitively valid. Like (B) it is a thesis which both yields (A) and which does not require the now-operator for its formulation. But also like (B) it is significantly stronger than (A) and not acceptable as intuitively valid without further inquiry into the grounds for whatever plausibility it might be thought to have.

11. *Ultimate Sortals:*

We should in particular be cautious of the attempt to defend (E) in terms of ultimate sortals. For while (E) when restricted to sortals for natural kinds is indeed a consequence of a summum genus principle for such sortals, (E) itself, i.e., (E) when not so restricted, is independent of the more general assumption that every sortal is subordinate to some ultimate sortal.

Defining ultimate sortals relative to temporal or causal contexts, respectively, as:

$$\mathrm{Ult}^t(S) \quad =_{df} \quad \sim (\exists T)\ (S \underset{t}{<} T)$$

$$\mathrm{Ult}^c(S) \quad =_{df} \quad \sim (\exists T)\ (S \underset{c}{<} T)$$

we can formulate the weaker and stronger assumptions regarding ultimate sortals as follows:

$$(\mathrm{US}^t) \qquad (\forall S)\ (\exists T)\ [S \underset{t}{\leq} T \mathbin{\&} \mathrm{Ult}^t(T)]$$

$$(\mathrm{US}^c) \qquad (\forall S)\ (\exists T)\ [S \underset{c}{\leq} T \mathbin{\&} \mathrm{Ult}^c(T)]$$

Our initial claim then is that neither (US^t) nor (US^c) imply either (E) or (E^c), or for that matter any other thesis regarding conditions for cross-world or re-identification. In particular, where S is a sortal for things that do not in general belong to a natural kind, the fact that an S is a T, where T is an ultimate sortal to which S is (temporally or causally) subordinate, does not imply that the S question is always a T whenever it exists.

As also indicated, however, there is a connection between (E) when restricted to sortals for natural kinds and the parallel assumption regarding ultimate sortals for natural kinds. E.g., defining the latter notion as:

$$\mathrm{Ult}^k(S) \quad =_{df} \quad NK(S) \;\&\; \sim (\exists T)\,[S \underset{c}{<} T \;\&\; NK(T)]$$

we can formulate a summun genus principle for sortals to the effect that every sortal under which things belonging to a natural kind can be identified is (causally) subordinate to an ultimate sortal for natural kinds:

$$(US^k) \qquad (\forall S)\ (NK(S) \rightarrow (\exists T)\ [S \underset{c}{\leq} T \;\&\; \mathrm{Ult}^k(T)])$$

from which follows thesis (F^c) but restricted to sortals for natural kinds:

$$(F^k) \qquad (\forall S)\ (NK(S) \rightarrow (\exists t)\ (S \underset{c}{\leq} T \;\&\; (\forall S)\ \Box^c\ [E\,!\,(x) \rightarrow xT])]$$

And from (F^k) of course both (E) and (E^c) follow when restricted in the same way, i.e., (F^k) implies

$$(E^k) \qquad (\forall S)\ (NK(S) \rightarrow (\forall xS)\,\Box^c\ [E\,!\,(x) \rightarrow (\exists T)\ (S \underset{c}{\leq} T \;\&\; xT])]$$

Now while we do not believe that any of the theses (US^t), (US^c) or (US^k) can be validated on purely conceptual grounds, we do think that (US^k), and therefore (F^k) and (E^k) as well, might at least be methodologically warranted. E.g., if we assume as an ideal of science the methodological thesis that for each natural kind which is a summum genus there is a sortal under which things belonging to that kind are in principle identifiable:

$$(MT3) \qquad (\forall^k F)\ [\Diamond^c\ (\exists x)\ (F(x) \;\&\; (\forall^k G)\ [G(x) \rightarrow G \underset{c}{\leq} F]) \rightarrow (\exists S)\ \Box^c\ (\forall x)\ (F(x) \leftrightarrow xS)]$$

then (US^k) can be methodologically warranted (at least for non-vacuous sortals) on the basis of the ontological thesis that everything belonging to a natural kind belongs to a summum genus, i.e., a natural kind which has subordinate to it every natural kind to which the thing belongs:

$$\text{(K2)} \qquad (\forall x) [(\exists^k F)F(x) \rightarrow (\exists^k F) (F(x) \& (\forall^k G) [G(x) \rightarrow G \underset{c}{\leq} F])]$$

The underlying assumption here is that unless there are summum genera in nature as posited by (K2) there can be no real individuation of natural things. That is, it is assumed to be physically or causally impossible that things belonging to natural kinds should be individuated through an infinitely ascending chain of more and more generic causal structures; and, accordingly, there must be a most generic natural kind or causal structure determining the real individuation of any given natural thing.

This ontological assumption, which together with (MT3) yields (US^k), does not apply to the purely conceptual theses (US^t) and (US^c). And, indeed, when we consider sortals in general, and particularly those not identifying things belonging to a natural kind, there seems to be no reason in principle why each must be subordinate, whether temporally, causally, or even analytically, i.e., by meaning postulate, to some ultimate sortal. That there should be ultimate sortals based only on temporal and not also causal contexts can at best be sheer contingency. And that there should be sortals that are ultimate even through causal contexts but which are not analytically determined can only be a consequence of causal conditions such as (K2), in which case it is not (US^c) but (US^k) that is really at issue after all. Thus either (US^t) and (US^c) are valid because purely conceptual considerations lead us to recognize that all sortals are subordinate to analytically based ultimate sortals or they are not valid at all. And it is our view that it is the latter which is the case.

All sortals are of course subordinate to such common noun concepts as those for 'thing', 'object' or 'individual' (in the logical sense). These common nouns, however, are not sortal terms but rather presuppose or are defined (impredicatively) in terms of sortals. Even 'natural thing' is not a sortal term in this regard, being (impredicatively) defined as 'thing belonging to a natural kind'. And then even 'artifact' is not a sortal term to which all sortals for different kinds of artifacts are subordinate, as has become clear from the contemporary problem of providing identity criteria for artifacts on space probe missions to alien planets.

Restricted to sortals then it is not clear what purely conceptual considerations would lead us to claim that either (US^t) or (US^c) should be valid. There are after all an indefinite number of ways that we might add to, alter, and even generalize whatever identity criteria we presently possess so that ever new and more general sortals might in principle be formulated and become an articulated part of our conceptual framework. And if this is really so then the structure of sortals, particularly those for artifacts and things whose identity depends on «individuating standards» set by us, is open-ended as far as the possibility of the introduction and articulation of more and more general sortals is concerned.

12. *A Restricted Intersection thesis for Sortals:*

Having rejected the first of Stevenson's two basic assumptions for sortals, at least as extended to apply to our present temporal and/or causal contexts, let us briefly consider his second basic assumption. This is the thesis that if two sortals intersect then there is a sortal to which both are subordinate:

$$(IT^c) \qquad (\exists xS_1)xS_2 \vee (\exists xS_2)xS_1 \rightarrow (\exists T)\,(S_1 \underset{c}{\leq} T \;\&\; S_2 \underset{c}{\leq} T)$$

We avoid also formulating the weaker version (IT^t) where subordination amounts only to sempiternal inclusion since, as with the comparison of (US^t) with (US^c), we find the idea that such an assumption should be valid only with respect to temporal and not also causal contexts to be unacceptable. But then we also find no reason why (IT^c) should be valid on purely conceptual grounds as well. That is, on our view, any plausible defense of (IT^c) will be based on causal considerations; and in that case (IT^c) will be restricted to sortals for natural kinds.

There is in fact just such a defense that can be given for (IT^c) so restricted. Indeed, on this defense we can validate not only (IT^c) restricted to sortals for natural kinds but even the stronger thesis that if two such sortals *can* intersect then one is (causally) subordinate to the other:

$$(IT^k) \qquad NK(S) \mathbin{\&} NK(T) \rightarrow [\Diamond^c(\exists xS)xT \vee \Diamond^c(\exists xT)xS \rightarrow S \leq_c T \vee T \leq_c C]$$

Now the defense of (IT^k) requires no methodological assumptions and is based directly on the ontological thesis that if two natural kinds can intersect then one must be subordinate to the other:

$$(K3) \qquad (\forall^k F)(\forall^k G)(\Diamond^c(\exists x)[F(x) \mathbin{\&} G(x)] \rightarrow F \leq_{\mathbf{c}} G \vee G \leq_{\mathbf{c}} F)$$

The underlying assumption here is that the family of natural kinds to which a natural thing belongs is characterized by a chain of causal subordination of these kinds one to another so that the thing or its real individuation is determined essentially by a hierarchy of causal structures operating one within another in accordance with natural laws. Given (K2), the summum genus principle, this hierarchy has an initial or maximal causal structure, a master template as it were, within which all the others fall as more and more specific template structures terminating finally either in an individual nature or an infima species.

This assumption as well as that for (K2) was of course first formulated by Aristotle and both have persisted as deeply embedded posits of our common sense framework. That is, we believe both (K2) and (K3) to be intuitively valid ontological theses with respect to our common sense framework. Consequently, (IT^k) can also be taken as intuitively valid and (US^k), given (MT3), can be taken as valid at least on methodological grounds. We do not find, on the other hand, any of the more general theses (IT^c) and (US^c) or (IT^t) and (US^t) to be valid at all.

13. *Concluding Remarks:*

We have found then only theses (A) and (A^c) to be intuitively valid on purely conceptual grounds with respect to the stage of conceptual involvement in question. Both specify for their respective contexts the minimal conditions that can be given for cross-world and re-identification.

Theses stronger than (A) and (A^c) can of course be formulated and, in fact, in such a way as to supersede any essential use of the now-operator. But these theses we find can be validated, first, only when restricted to natural things and, second, only on methodological grounds. The first restriction involves ontological assumptions regarding the theory of natural kinds while the second concerns our ability to provide identity criteria by which things belonging to a natural kind can be identified.

It is moreover, this same confrontation between ontology in the form of a theory of natural kinds and our present referential and identifying operations which we have found to be the proper field of application for Stevenson's and Wiggin's two basic assumptions regarding sortals. And from our perspective and methodological approach what this suggests is that a study and formal representation of the nature of this confrontation, particularly as regards the logical role of differentia and the species-genus relation, is an appropriate next step in clarifying the stage of conceptual involvement in question as well perhaps as certain features of the subsequent stages in the development of our common sense and scientific frameworks.

APPENDIX

So as to avoid any question of ambiguity arising in the text, we briefly describe a fragment of our intended formal grammar and a corresponding set theoretic semantics.

We shall use $\sim$, $\rightarrow$, $=$, $\forall$, F, P, N as primitive logical constants. We assume denumerably many individual variables, sortal term variables and, for each positive integer n, n-place predicate variables. Atomic wffs are then either of the form of a relative identity $\alpha \underset{\sigma}{=} \beta$, where α, β are individual variables and σ is a sortal term variable, or of the form $\pi(\alpha_1, \ldots, \alpha_n)$, where π is an n-place predicate variable and $\alpha_1, \ldots, \alpha_n$ are individual variables. The wffs are then the members of the smallest class containing the atomic wffs and such that $\sim\varphi$, $F\varphi$, $P\varphi$, $N\varphi$, $(\varphi \rightarrow \psi)$, $(\forall \alpha\sigma)\varphi$, $(\forall \sigma)\varphi$, are in the class whenever φ, ψ are in the class, α is an individual variable, and σ is a sortal term variable. (We omit quantifiers for predicate variables in our present fragment).

By a *sortal frame* we understand a structure $\langle D, I, R, S \rangle$ such that (1) D is a domain of discourse, empty or otherwise, (2) $R \subseteq I \times I$, (3) $S \subseteq (\mathscr{P}D)^I$, and for $i, j \in I$, $\bigcup_{s \in S} s_i \cap \bigcup_{s \in S} s_j \subseteq \bigcup_{s \in S} (s_i \cap s_j)$.

By an *assignment* (of values to variables) in a sortal frame $\langle D, I, R, S \rangle$ we understand a function A with the set of variables (of all types) as domain and such that (1) $A(\alpha) \in D$, for each individual variable α, (2) $A(\sigma) \in S$, for each sortal term variable σ, and (3) for each positive integer n and n-place predicate variable π, $A(\pi) \in (\mathscr{P}D^n)^I$.

We understand a *sortal model* to be a triple $\mathfrak{A} = \langle \langle D, I, R, S \rangle, A, t_0 \rangle$, where (1) $\langle D, I, R, S \rangle$ is a sortal frame, (2) A is an assignment in $\langle D, I, R, S \rangle$, and (3) $t_0 \in I$. (We take t_0 to be the present moment, i.e., *now*).

Where $\mathfrak{A}$ is a sortal model such as above, $i \in I$ and φ is a arbitrary wff we recursively define *the truth-value of* φ *in* $\mathfrak{A}$ *at* i *when part of an utterance at* t_0, in symbols Val $(\varphi, \mathfrak{A}, i)$, as follows: (1) Val $(\alpha \underset{\sigma}{=} \beta, \mathfrak{A}, i) = 1$ iff $A(\alpha) = A(\beta)$ and $A(\alpha) \in A(\sigma)$; (2) Val $(\pi(\alpha_1, \ldots, \alpha_n), \mathfrak{A}, i) = 1$ iff $\langle A(\alpha_1), \ldots, A(\alpha_n) \rangle \in A(\pi)_i$; (3) Val $(\sim \varphi, \mathfrak{A}, i) = 1$ iff Val $(\varphi, \mathfrak{A}, i) = 0$; (4) Val $(\varphi \rightarrow \psi), \mathfrak{A}, i) = 1$ iff Val $(\varphi, \mathfrak{A}, i) = 0$ or Val $(\psi, \mathfrak{A}, i) = 1$; (5) Val $(P\varphi, \mathfrak{A}, i) = 1$ iff for some $j \in I$, jRi and Val $(\varphi, \mathfrak{A}, j) = 1$; (6) Val $(F\varphi, \mathfrak{A}, i) = 1$ iff for some $j \in I$, iRj and Val $(\varphi, \mathfrak{A}, j) = 1$; (7) Val $(N\varphi, \mathfrak{A}, i) = 1$ iff Val $(\varphi, \mathfrak{A}, t_o) = 1$; (8) Val $(\forall \alpha\sigma)\, \varphi, \mathfrak{A}, i) = 1$ iff for all $x \in A(\sigma)_i$, Val $(\varphi, \mathfrak{A}(x/\alpha), i) = 1$; (9) Val $((\forall \sigma)\varphi, \mathfrak{A}, i) = 1$ iff for all $s \in S$, Val $(\varphi, \mathfrak{A}\,(s/\sigma), i) = 1$.

Finally, a wff φ is said to be *valid* iff φ is true at the now-moment of any sortal model, i.e., iff for all sortal models $\mathfrak{A} = \langle\langle D, I, R, S\rangle, A, t_o\rangle$, Val $(\varphi, \mathfrak{A}, t_o) = 1$.

We note that by clause (3) of the definition of a sortal frame every wff which is an instance of thesis (A) is valid. If we wish to validate any of the other theses we need only add the appropriate clause to the same definition:

(1) for thesis (B) add: for all $x \in \bigcup_{i \in I} \bigcup_{s \in S} s_i$ there is a $t \in S$ such that for all $j \in I$, if $x \in \bigcup_{s \in S} s_j$, then $x \in t_j$.

(2) for thesis (D): for all $x \in \bigcup_{i \in I} \bigcup_{s \in S} s_i$ there is a $t \in S$ such that (a) for all $i \in I$, $t_i \subseteq \{x\}$ and (b) for all $j \in I$, if $x \in \bigcup_{s \in S} s_j$ then $t_j = \{x\}$.

(3) for thesis (E): for all $s \in S$, all $i, j \in I$ and all $x \in s_i$, if $x \in \bigcup_{s \in S} s_j$ then for some $t \in S$, $x \in t_j$ and for all $k \in I$, $s_k \subseteq t_k$.

(4) for thesis (US^t): for all $s \in S$ there is a $t \in S$ such that (a) for all $i \in I$, $s_i \subseteq t_i$ and (b) for all $u \in S$, if for all $i \in I$, $t_i \subseteq u_i$ then $t = u$.

(5) for thesis (IT^t): for $s, t \in S$ if for some $i \in I$, $s_i \cap t_i$ is not empty, then there is a $u \in S$ such that for all $j \in I$, $s_j \subseteq u_j$ and $t_j \subseteq u_j$.

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