Abstracts: Symposium and Invited Papers

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Gassendi, in his role as scientific theorist, formulated various materialist hypotheses to explain the observed natural phenomena, but he also realized the limited nature of these hypotheses. Strategy (2) was thus superseded in his theorizing about body by what I have called the "strategy of the Renaissance translator." His formulation of strategy (3) enabled him to develop his own dualist framework for defining concepts of mind and body. Essential to this strategy was his practice of modeling the interpretation of a philosophical text on the procedure he employed in translating a text from one natural language to another. In reading the ancient philosophers, he had noticed that certain terms—for instance, *principium materiale* and *substantia incorporea*—not only facilitated the translation of a given text from Greek to Latin, but they also made possible the interpretation of the *contents* of a given text in comparison with the contents of other texts. Thus he adopted, as a guide to the interpretation of these texts, a dualist framework consisting of the concepts of the material principle and incorporeal substance. Within such a framework, the general concept of the material principle supplied the common terms in which to compare a variety of rival principles, ranging from Aristotle's prime matter to Epicurus's material atoms.

Gassendi's strategy (3) for justifying his choice of Epicurean atoms as the one true material principle conflicted with that of another notable translator of Greek texts, Hobbes. Hobbes's defense of his materialist concept of body relied on a radically different procedure for interpreting philosophical texts and arriving at definitions of theoretical terms. His difference with Gassendi grew out of his account of how words such as "body" acquire their meaning. "Body," on Hobbes's view, was defined independently of past usage. For Gassendi, however, the term "body" comes to us from the study of the texts of previous philosophers, and we must decide what is the best account advanced in those texts.

The divergent philosophical strategies of Gassendi, Descartes, and Hobbes show that they did not become dualists or monists simply by affirming or denying the claims of the same dualist or monist theory. Rather their attempts to articulate concepts of body involved them in irresolvable differences arising from incommensurable notions of rationality, the likes of which may still constrain our own contemporary debates about dualism and monism.

INDIVIDUAL CONCEPTS: THEIR LOGIC, PHILOSOPHY, AND SOME OF THEIR USES

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Here I present some results, partially circulated in 1976 but never published, regarding quantification over individual concepts, and some ideas, mostly much more recent, about their philosophical bases and their uses.

Following Carnap, individual concepts (i.c.'s) are functions from worlds to individuals. Here we assume a quantificational frame with an accessibility relation (not needed for S5) and a domain function, in the sense of my own model theory. It is technically convenient, though philosophically perhaps less appropriate, to require i.c.'s to be defined on all worlds and domains of worlds to be nonempty. (I believe that mathematically the general case reduces to the special case.)

Modal logicians often seem to think of the "individuals" of first order modal logic as concrete particulars. There is no reason not to take the viewpoint prevalent in extensional first order logic, where first order quantifiers can range over *any* nonempty domain. Henceforth, we use the term "individual" without any presupposition as to the range of our variables. From this point of view, the logic of "individual concepts" is simply the general logic of *intensions* (identifying intensions coinciding on all worlds; a more structured theory closer to Frege's original ideas is also possible). If "worlds" are instants of time, i.c.'s are "time worms" of entities playing the role of "stages" (but these could be anything). The Fregean "intensional logic" background of i.c.'s leads some philosophers to think that i.c.'s are dubious philosophers' inventions. Hence I should emphasize that i.c.'s (yes, intensions!) with measure-theoretic restrictions are prominent in contemporary probability theory (and hence, in physics) under the name of *random variables*. (Martin-Lof told me he also noticed this; I haven't seen it elsewhere.)

Following Carnap (see also Thomason), quantifiers range over *all* i.c.'s on a frame, and atomic predicates are interpreted for i.c.'s by relations induced by corresponding relations among individuals. For example, '=' is the relation of *coincidence* between i.c.'s, induced by identity among individuals. (One can also consider cases where quantifiers range over an arbitrary nonempty family of i.c.'s, or where atomic predicates among i.c.'s can be "intensional"; these are not our primary concern. I proved completeness for quantification over a family already in the late 1950's; now I prefer a proof reducing it to quantification over individuals.)

Many favored these systems because the models, being invariant under local isomorphism, conformed to "anti-Haecceitism", though this is not a necessary motivation. (On the approach above, a philosopher's view of the matter may depend on the domain; none who do modal logic will be "anti-Haecceitist" about *all* domains.) There has been some confusion about the interpretation of these systems, some even treating them as quantifying over individuals, and "=" as identity between individuals. Largely I think this confused, but the following partial justification is possible: if one extends what Dummett and Evans have called the Fregean interpretation of quantification, equivalent in the classical case to the usual one over individuals, to modal logic in a way natural especially from the "anti-Haecceitist" point of view, the result is equivalent to i.c. quantification.

A related issue is *Carnapian doublethink*. Carnap favored a double interpretation of his variables, while Quine argued that they simply ranged over i.c.'s. Technically, Quine was surely right; but after consideration I have come to increased sympathy with Carnap's viewpoint. When a sentence has no "quantifying in", the i.c. interpretation of the variables is equivalent to the individual interpretation, and it is a matter of indifference which way we look at it. To a certain extent, this viewpoint can be maintained even if there are free variables (even within modal operators). Paradoxically, the viewpoint is especially natural given Quine's later views about quantification and identity (which are not mine). Notice that the sentences free of quantifying in (over individuals) are precisely those acceptable to the "anti-

Haecceitist". My impression is that probabilists use some Carnapian doublethink when they think intuitively about random variables.

Consider the two-sorted modal language with quantification over propositions (arbitrary sets of worlds) and over individuals, but with no quantifying in over individuals (so that for sentences the individual and i.c. interpretations are equivalent). The main technical result is this: for normal modal propositional logics, every sentence of the extension with full quantification over i.c.'s is equivalent to a sentence of the two-sorted language just specified. Thus the language of i.c.'s *could* be interpreted as a disguised anti-Haecceitist fragment of the language of *individuals* with propositional quantification. A reverse translation of the two-sorted language into the language with i.c.'s does not quite hold, but it obtains for frames with necessarily at least two individuals (for the general case there is a slightly weaker result).

A corollary is that the degree of unsolvability of the valid formulae of the language with i.c.'s is $d\mathrm{U}0'$, where d is the degree of the valid formulae of the language with propositional quantification only. The determination of d in turn reduces to that of the monadic second order theory of one binary relation corresponding to the modal propositional logic. (Generalizations to tense logics, more than one modal operator, relaxation of the normality condition, etc., are of course possible.) When $d=0$, the valid formulae for i.c.'s are recursively enumerable. More typically, however, (e.g., if the underlying propositional logic is contained in S4 or B) $d=d\mathrm{U}0'=$ the degree of full second order logic.

A salient case where $d=0$ is S5. In this case, adequate axioms are given by the axioms for quantified S5 in my 1959 *JSL* paper, thus including the Barcan formula and its converse, and the following:

(1) $(x)\,(x=x)$

(2) $(x)\,(y)\,(A(x) \wedge x=y. \supset . A(y))$

(3) $\Box(\exists x)A(x) \supset (\exists x)\Box A(x)$

(4) $(x)\,(\exists y)\,(x=y \wedge (z)\,(x=z. \supset . \Box(x=y \supset x=z))$

Obvious restrictions on substitution are observed, and in (2) and (3), $A(x)$ contains no modal operators. Modus ponens, necessitation, and universal generalization are the rules. The completeness proof reduces the case to that of quantification over a family of i.c.'s. Compactness holds. A satisfiable formula is always satisfiable in a frame with *finitely* many worlds, and finitely or denumerably many individuals. In contrast to the case for individuals, the monadic fragment is decidable. A simple axiomatization can also be given for pure quantification theory without coincidence.

In this case (S5) propositional quantifiers could be replaced by modal operators saying that a formula holds in at least n worlds. Even without additional operators, there is also an extension of the system where every sentence is equivalent to one without quantifying in (and no propositional quantifiers). Thus this extension *could* be interpreted as one quantifying over individuals alone. (See my remarks on this system, *JSL*, Dec. 1985, pp. 1088-9, in a review of papers of Kit Fine.)

The basic ideas are those of Feferman and Vaught in the study of direct products, although the techniques can be carried out directly in the modal language. The completeness proof for S5 is best carried out by a reduction to the case of quantification over a family of i.c.'s.

If atomic formulae are allowed to be "intensional", even for S5 we get the degree of full second order logic.

Montague suggested that i.c.'s were important in the interpretation of natural language. Certain examples support this suggestion, in contexts suggesting Carnapian doublethink and related to the present systems.

Kit Fine has argued in favor of "arbitrary objects". Much of what he proposes to treat with his arbitrary objects (especially the application to the formalism of elementary calculus and analysis) *could* be done quite naturally with i.c.'s (where Carnapian doublethink and at least an intensional predicate for rigidity are helpful). Indeed, mathematically arbitrary objects are simply i.c.'s of a special kind (where literally to carry out Fine's theory one must use structured partial i.c.'s). However, especially for the application to elementary analysis unstructured i.c.'s have some definite advantages. (A remark of John Burgess was helpful in inspiring this application.)

THOMAS HOBBES'S MECHANISM AND CALVINISM

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The topic of this paper is the relationship between Hobbes's mechanism and some of his theological views in the mid-1640's. Hobbes denied being an atheist and denied that mechanism entailed atheism. There are good reasons for believing that he was a sincere Christian of the Calvinist persuasion. Some of his Calvinist beliefs were consonant with his mechanism and facilitated a drift towards deism although that was not what he intended to be the result of his views. Elsewhere I have argued that one of Hobbes's goals in *Leviathan* was to show that orthodox Christian doctrine was compatible with modern science. In this article, I focus on that project as expressed in his critique of Thomas White's book *De Mundo*.

For Hobbes all change was change of place, and because he wants to explain every change as local motion, he was quite happy to accept the Aristotelian principle: whatever is moved is moved by another (*omne quod movetur ab alio movetur*). This principle is ambiguous. On one interpretation, it contains an indeterminacy and means "Everything that is moved. . . is moved by another." Let's call this the "Passive Principle."

This indeterminate form of the Principle of Motion is compatible with two possibilities: (1) that something x is moved by something y and y is not itself in motion; (2) that something is in motion and not caused by anything to be in motion. Concerning (1), Aristotelians, including White, think that there are many unmoved movers. A hamburger that attracts a dog to eat it is an unmoved mover. The soul