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OLD FOUNDATIONS FOR A LOGIC OF PERCEPTION*

Perception is a species of judgment. So far as logic goes, there is nothing very special about perception. Of course, there is plenty that is intriguing about perception, and puzzling. But so far as logic goes perception is just a kind of knowing and believing. And the logic which governs our ascriptions of knowledge and belief to things is pretty much a matter of bookkeeping. It is mainly a matter of keeping the references and concepts of those of us who are scribes, recording the occurrences of psychical happenings, distinct from those of the agents to whom we ascribe mental events. It is of course part of the bookkeeping to recognize that scribes are also agents, and, often enough, conversely as well.

Current fashion construes the logic of propositional knowledge and belief as a modal logic.[1] It is a logic of modalities which are relativized to agents and certain occasions, expressing what the agents on certain occasions then believe or know. If perception is a species of judgment, then the logic of perception is but a species of this more general modal logic of knowledge and belief. We say that a psychical agent indeed sees, or, other times, perhaps merely thinks he sees, that his surroundings are thus and so. For perception, thus, we ascribe knowledge or belief to the agent in a suitably qualified way; e.g., he knows, sees, that this. Or he believes, thinks he hears, that that. We ascribe knowledge or belief in a suitably qualified way, as sensuous knowledge or belief. Perceptions are visual or tactual, auditory or olfactory, instances of propositional knowledge or belief. Accordingly, perceptual knowledge or belief is but a certain kind of knowledge or belief, qualified by reference to the manner in which it is attained.

The logic of perception (meaning always, the logic of the statements in which we ascribe propositional perceptual occurrences to agents) is thus but a qualified version of the generic logic of knowledge and belief. Perceptual knowledge and belief do not literally have an interesting, special logic. It is not necessary so far as the logic of perception goes to introduce special syntactical resources, doubling our quantifiers as do

Hintikka and Thomason.[2] It is not necessary to make special semantical assumptions, enlarging our domains of interpretation with pathological phenomenal objects as do sense datists, or with aspects of things as do some phenomenologists. Standard modal resources, suitably qualified, suffice to capture the logical features of perception as we shall try to show below.

The fact that the logic of perception is logically trivial, being as it is a species of the generic logic of knowledge and belief, and the fact that this generic logic is mainly a matter of bookkeeping, these facts do not mean that the characteristic features and assumptions of the logic of perception are obvious or that the required bookkeeping is uncomplicated. Moreover, the issues which give this generic logic its interest, the problems of 'quantifying into' psychical contexts and of our pronomial references within them, these issues carry over directly to the logic of perception as well.

In what follows, I want first to comment on the (essentially trivial) logic of perception developing enough of it to see it as a suitably modified version of the generic modal logic of knowledge and belief, and offering a version of how the bookkeeping should go. Doing this, we thereby give an account of 'quantifying into' psychical contexts. We shall then consider certain specimen formulae. Some of these are theorems in systems familiar from the literature, but not here, and some emerge as theorems here but not in the familiar systems.

After this, motivated by our way of casting the bookkeeping, we discuss certain central epistemological issues of perception. We sketch a version of naive realism as an ontologically economical way of dealing with these issues.

1. BOOKKEEPING

To every declarative sentence P in the indicative mood there is another of the form $^2M^1P$ which can be used to express the fact that an agent on a given occasion knows, believes, hopes, fears, ..., that P.

'$^2M^1$' is a syntactical variable ranging over psychical modal operators of degree two and with one argument place. This is, these are unary operators which, prefixed to a sentence, yield a sentence. Since the operators are themselves of degree two, they contain slots for singular terms and may of course themselves be quantified into quite as much as may the sentences they operate on. A sample instantiation might be written:

$(x) (\exists o) B^{(x,o)} R(x, o)$. We read: everyone thinks on some occasion that he is then right. 'B' here is the psychical modal operator '...thinks on occasion... that...'. 'R' is the predicate '... is right on ...'. Since we are here interested in perception as a kind of knowing or believing, we restrict 'M' to range over just doxastic or epistemic operators; in particular, we restrict these to just 'K' (knows) and 'B' (believes, or judges.)

To every sentence of the form $^2M^1P$, where M is a doxastic or epistemic psychical modality, there is another sentence of the form SMP. These sentences can be used to express the fact that an agent on a given occasion perceives or sensuously judges that P. (We suppress henceforth the temporal indices on M. In particular, although important issues concerning the notions of deliberation and planning turn on cross-temporal references,[3] we abstract in the present discussion from references to the occasions of the occurrences of the psychical acts we characterize.)

'S' is a syntactical variable ranging over 0-degree unary modifiers of psychical modal operators. These are expressions which, prefixed to such operators, yield an operator. Instantiations of S are thus adverbial qualifiers of the epistemic or doxastic modalities. To perceive is to sensuously know, and when we report someone else as thinking he perceives that P, we here understand that a sensous belief has been ascribed to him. Agent, we say, sensuously believes that P.

For example, we may write: VK^aP and TB^aP. And we then read: Agent visually knows (i.e., sees) that P; Agent tactually believes (believes he feels) that P.

It is our present thesis that all that is formally unique about perception is captured by the introduction of these sensuous modifiers of the doxastic and epistemic modalities, together with the laws governing the relation between sensuous knowledge and belief and knowledge and belief generally. No further syntactical resources, unique to perception, are required.

This is not to say that no further resources are required at all. There remain ambiguities to be resolved. These indeed require further syntactical resources than we have so far gathered. But these ambiguities are not unique to ascriptions of perceptual acts to agents. The resources needed to resolve them are required anyway by a fully developed general logic of the psychical modalities.

As philosophers, we are at first tempted to suppose that a true ascription of a mental act to a psychical agent should be followed by a proposi-

tional clause which expresses just what is 'before the agent's mind' on the indicated occasion. We soon come however to realize that things are neither so simple nor so hard as this.

Things are not so simple as we can see in cases of pronominal self- and other-reference.[4] E.g., John perhaps thinks that he is right and I am wrong about the logic of perception. I correctly so report his belief. But the propositional text before his mind presumably is quite the reverse. John for example gives voice to his thought, saying instead, '*I* am right and *he* is wrong.'

Nor are things so hard. We often, quite acceptably, settle for less than what is literally before our agent's mind. You report, perhaps, what brutes or infants think or perceive on an occasion. You do so without philosophical qualms over the supposed disparity between their intellectual resources and yours. Again, we make explicit the references which are usually tacitly understood in a given case as an agent's or ours. We may say in a guarded way, 'John believes that Giscard, (as the press calls him and we know him) will revalue France's gold reserves.' Or we may say this suppressing the parenthetical qualifier. We may say this even though the propositional text expressing John's belief could not be correctly so stated. John does not know the French President's name.

Pronominal ambiguities and considerations of scope would anyway have required supplementary resources for an adequate formal characterization of knowledge, belief and perception. Consider: John thinks that Harry believes that he succeeded in blackballing him; John sees that Harry sees that he will reach the intersection ahead of him.

In practice, we guard against such ambiguity, inserting perhaps the explicit reference: ... that he, John, succeeded ....

We require, like common sense, formal devices to make clear our pronominal references. We require the means to keep track of the occurrence of references, Agent's, or recording Scribe's, within modal contexts. It is not, despite the examples, to be supposed that these pronominal occurrences are simply cases of pronouns of laziness, occurrences of which are replaceable anywhere by the antecedent singular references to which they are linked. 'The girl John is watching thinks she is unseen.' It can hardly be true that the girl John is watching thinks literally and without qualification that the girl John is watching is unseen. She may be imprudent but not inconsistent.

The upshot is this. We think of the logic of perception as a qualified version of some standard system of the logic of knowledge and belief, Hintikka says.[5] The logic further requires operator modifiers to express perception as in particular sensuous knowledge or belief. In addition, the standard version itself requires supplementation if we wish to catch more completely the various occurrences of pronomial references in ordinary ascriptions of mental acts to psychical agents. So, as a species of this more generic logic, the logic of perception requires also this supplementation.

We add thus to some standard modal logic for knowledge and belief a set $\mathscr{S}$ of operator modifiers, S, such that if MP is a well-formed doxastic or epistemic sentence, so too is SMP.

Further, in mimic of Russell's theory of description, to each individual constant, i, without syntactical parts, we associate a scope-indicator, $[i]$.[6] The position of an occurrence of $[i]$ displays the scope of its associated individual constant, i, relative to occurrences of other operators in the context of its occurrence. The scope of an occurrence of an individual constant, i, is the smallest wff. containing that occurrence of i to which $[i]$ is prefixed. ($[i]P$ is just P, if i has no free occurrence in P.) In general, scope considerations for proper names, (syntactically simple individual constants,) are straightforward. It is not worth developing here the detail of scope relationships across truth-functional and extensional contexts, with the possible exception of contexts governed by negation. For negation, we ignore subtleties and lay down that $[i] \sim Pi \leftrightarrow \sim [i] Pi$. It is rather the relation of occurrences of proper names to those of psychical modal operators which is of present interest. This relation will have to be reflected in the underlying semantics. Intuitively, we distinguish $[i] BPi$ from $B[i] Pi$. The former approximates: 'Agent believes that i, as we know him, is P'; the latter, 'Agent believes that i, as he calls him, is P.'

Finally, we introduce an operator, *[7], which converts a singular term, i, into a personal (not demonstrative) pronoun $i*$.

$(i*)*$ is just $i*$, and an occurrence $i*$ is undefined unless it occurs in a wff of the form $[i] P$ in which i antecedently occurs unstarred. We say that an instance of $i*$ is *bound by* the scope-index of the antecedent occurrence of the term starred, and that it lies within that scope. We do not further characterize the *-operator here.[8]

If we believe, for example, that it is a psychical law that $(x) (K^x P \to \to K^x K^x P)$, then we shall need some device like*. For we shall need to

distinguish instantiations of the law like $[i]K^iP \rightarrow [i]K^i[i]K^iP$ from the
more natural instantiations of the form $[i]K^iP \rightarrow [i]K^iK^{i*}P$. These instan-
tiations need not coincide in truth-value, pending other assumptions to be
made. For an instance of the former might read: If John known that P,
then John knows that John knows that P; but the latter then reads, more
naturally: If John knows that P, then John knows that he knows that P.
The latter could be true when the former is not. John may not know himself
as the referent of that name.[9]

We can now formalize the import of sentences like 'John saw that Harry
saw that he would reach the intersection before him'. Depending on what is
intended, we write perhaps $[j]VK^j[h]VK^hI(j^*, h^*)$, '$I$' expressing the
relational concept 'reaches the intersection before'. And we read: John
sees (visually knows) that Harry sees that he, John, will reach the inter-
section before him, (Harry.) Or, we write: $[j]VK^j[h]VK^hI(h^*, j^*)$.
And read: John sees that Harry sees that he, Harry, will reach the intersec-
tion before him.

Since scribes, who record occurrences of mental acts can themselves be
the objects of such ascriptions in turn, and since the primitive form of
such modal ascriptions is (for each of us) that in which we as scribes assert
these psychical occurrences, we have one special individual constant, 'I'.
First-person self-knowledge is reflected in special principles governing this
constant but, again, we do not develop these here.

Our logic of perception is thus a standard doxastic and epistemic modal
logic supplemented by the occurrence of special (sensuous) modifiers, a
scope-indicator for singular terms, an operator for converting singular
terms, an operator for converting singular terms into pronouns, and a
special, first-person constant.

Given these resources, we formalize ordinary assertions ascribing knowl-
edge, belief, and the various sensory forms of perception to sentient beings
as modal sentences of this enhanced doxastic-epistemic logic. We think of
the formalizations as mundane sentences, true or false of the actual
world.

To each mundane modal formalization we next characterize a unique
transcription which contains no modal operators, and no operator modi-
fiers, but which is simply an expression of an extended first-order logic.
This extension is simply an applied first-order logic supplemented with
some specific predicates and constants and supplemented with some spec-

ific assumptions governing these. Mundane logical truths are those which have transcriptions which are theorems in this extended first-order logic.[10]

'World-theory' transcriptions of mundane modal sentences are familiar enough these days. What may be of interest here are the particular transcriptions adopted and the particular assumptions laid down. The consequences of these do not wholly coincide with those familiar from recent literature.

The motivation for the transcriptions and assumptions which will follow is roughly this, that in ascribing thoughts and perceptions to others we are, very nearly, saying meta-linguistic things. But not quite. We want to say sometimes that an agent (who may we recall be a child or beast) on some given occasion has a given thought or perception. Agent thinks of, or sees, something. He takes or sees this to be thus-or-so. We say this without knowing or reproducing exactly Agent's references or concepts. There is something, perhaps, which we know as a, whom Agent sees or in some way thinks of, and of whom Agent thinks thus-or-so, nearly enough. Agent of course need have no idea of this identity of a and his object of reference.

It is as though we used substitutional quantifiers, restricting the expressions substitutable for variables of quantification occurring within the scope of modal ascriptions to members of a set of expressions belonging to the Agent's vocabulary. We attempt then to say that there is a word, w, of Agent's vocabulary whose reference is (the object we know as) a, and the Agent 'mentally asserts': 'thus-or-so' concatenated with 'w'.

But of course this won't do. Subtleties aside, the central fact is simply that where there are no expressions there is no substitutional quantification for them. And Agent (you, I, infant or beast) need command on a given psychical occasion no literal, conventional language at all.

We can, however, recover our quasi-metalinguistic motivation for the characterization of the psychical modalities closely enough. We do so by exploiting instead world-theory transcriptions. We turn to these now.

2. WORLD-THEORY TRANSCRIPTIONS

The transcriptions utilize special predicates which have the effect of making explicit the way in which the content of mundane modal ascriptions are relativized to the agents to whom they are ascribed. 'T' is a

relational predicate used to relativize truth to a world. 'TwP' says that the proposition P is true in (the world) w. 'B' is a relational predicate expressing the presence of an individual in a world. 'Bwi' says that the individual i belongs to w. There is a set of predicates, '$\mathscr{R}$', members of which express relations of accessibility across worlds. Depending on the index, k, '$R^k aww'$' says that, for the agent, a, (the world) w' is a doxastic, or epistemic, or sensuous alternative of (the world) w. A visual alternative, say, relative to an agent, a, is a world all the truths of which are compatible with all the agent, a, sees on the given occasion. (Temporal references, we recall, are suppressed here.)

The transcription of a mundane modal assertion, MP, proceeds in two steps. (We assume that mundane formulae with free variables are universally quantified.) First, the mundane assertion is relativized to the world in which, presumably, it obtains; in the simplest case, for us as scribes, this would be the actual world, o. We then have $ToMP$.

The truth-in-a-world predicate is next confined to atomic sentential occurrences as follows:

$$ToM^i P \quad \text{to} \quad (w)\,(R^k iow \to TwP),$$

where the index 'k' is 'e' or 'd' as 'M' is 'knows' or 'judges' (i.e., as 'M' is an epistemic or doxastic operator).

Generalizing, we confine

$$TwM^i P \quad \text{to} \quad (w')\,(R^k iww' \to Tw'P),$$

with 'k' as above.

Similarly, for perceptual assertions, we have

$$TwSM^i P \quad \text{to} \quad (w')\,({}^s R^k iww' \to Tw'P).$$

Here, the index 's' on 'R' will vary as the instantiation of the sensuous modifier, S, on the mundane M, varies across the distinct sense modalities.

We confine T across truth-functional operators and the quantifiers, as follows:

$$Tw(P \,\#\, Q) \quad \text{to} \quad (TwP) \,\#\, (TwQ),$$

for any binary, truth-functional connective, $\#$, and

$$Tw \sim P \quad \text{to} \quad -(TwP)$$

for negation.

$$Tw(\exists x)\,P \quad \text{to} \quad (\exists x)\,(Bwx\;\&\;TwPx),$$
$$Tw(x)\,P \quad \text{to} \quad (x)\,(Bwx \rightarrow TwPx),$$

for the quantifiers.

For singular expressions, T is confined across the scope-index thus:

$$Tw[i]\,P \quad \text{to} \quad Bwi\;\&\;TwP;$$

and within modal contexts:

$$TwM^{i}Pj \quad \text{to} \quad (w')\,(R^{k}iww' \rightarrow (\exists y)\,(Bw'y\;\&\;Tw(\,j\,=y)$$
$$\&\;Tw'Py)).$$

Here, 'j' may be either a free variable of quantification, a singular constant whose scope-index does not lie within the scope of the indicated modality, M, or a pronoun, 'h^{*}', the scope-index of whose antecedent, 'h', does not lie within the scope of M. (We need not here attempt to preserve finer differences among these singular expressions.)

Note, as the confinement principles make explicit, the modal index, i, does not occur within the scope of the operator whose index it is.

The confinement of the truth-in-a-world operator, T, across psychical modalities in whose scope lie unbound singular expressions reflects the radical subjectivity of mental acts.[11] An agent need not share a scribe's concepts or references not in general share his mental resources. We need not assume that the agent has a developed human intellect, a command of language, or even conceptual capacities of any special sophistication. The agent may be an infant or a beast. We as scribes say then that there is something, in some way the object of his attention, which is the same as our indicated reference even though it may be compatible with all the agent judges that this is not so. The agent, infant or beast perhaps, need not know this identity of referents, his and ours.

This relativity of reference and judgment to the agents to which they are ascribed requires a restricted concept of identity. The rule of Interchange of Identities reads thus:

One may interchange any occurrences of a and b in TwP provided that Bwa, Bwb and $Tw(a=b)$.

The matching relativized axiom of the reflexivity of identity reads thus:

$$(w)\,(x)\,(Bwx \rightarrow Tw\,(x=x)).$$

3. Some consequences

Montague,[12] once remarked that "the principle of universal instantiation does not always hold." It does not hold in general for psychical contexts. Montague held that, given psychical modalities, a system should be 'purely referential' in the sense that

$$(x)\,(y)\,((x=y) \to (MPx \leftrightarrow MPy))$$

is derivable, although

$$(a=b) \to (MPa \leftrightarrow MPb)$$

is not.

Relative to our present discussion, of course, the second of these formula cannot be derivable. It is not, here, well-formed lacking as it does scope-indicators for the individual variables occurring in it. These might have largest scope, e.g.,

$$[a]\,[b]\,((a=b) \to (MPa \leftrightarrow MPb)),$$

or most restricted scope,

$$[a]\,[b]\,(a=b) \to (M\,[a]\,Pa \leftrightarrow M\,[b]\,Pb).$$

Clearly, relative to our present discussion, it is this last which Montague meant to proscribe. From the fact that 'two things' are identical it should not follow that an arbitrary agent knows, believes, or perceives that what is true of the one is also true of the other.

Our present account coincides with Montague's intentions:

$$\vdash (x)\,(y)\,((x=y) \to (MPx \leftrightarrow MPy))$$

is derivable while the last formula, the instantiation of this with individual expressions of most restricted scope, is not.

That is to say that the world-theory transcription of the former,

$$(x)\,(Box \to (y)\,(Boy \to (To(x=y) \to ((w)\,(Row \to (\exists z)\,(Bwz$$
$$\&\ To\,(z=x)\ \&\ TwPz)) \leftrightarrow (w)\,(Row \to (\exists z)\,(Bwz\ \&\ To\,(z=y)$$
$$\&\ TwPz)))))).$$

is (exploiting our rule of Interchange of Identities) a theorem of first-order

logic. By contrast, the transcription of the latter, i.e.,

$$(Boa \ \& \ Bob \ \& \ To(a = b)) \to ((w) \ (Row \to (Bwa \ \& \ TwPa)) \leftrightarrow$$
$$\leftrightarrow (w) \ (Row \to (Bwb \ \& \ TwPb)).$$

is not a theorem of first-order logic. (The alternative formula with individual expressions whose scope is not confined to the modalities,

$$[a] \ [b] \ (a = b \to ([a] \ MPa \leftrightarrow [b] \ MPb)$$

is, as we should have expected, derivable.)

Thus, Universal Instantiation cannot be taken with natural piety relative to psychical contexts. Nor, as we know of course, can Existential Generalization or Substitution for identities. The question then is, what sorts of qualified versions of these are acceptable? What are the implications following from the qualified versions which are accepted?

Everyone agrees what is required to make Substitution go in psychical contexts. It is not that the objects of the agents' reference must be identical, but that the agent takes them to be so.·

$$M \ [a] \ Pa, \ [a] \ [b] \ (a = b) \ \text{so} \ M \ [b] \ Pb$$

is not the form of a valid inference. But

$$M \ [a] \ Pa, \ M \ [a] \ [b] \ (a = b) \vdash M \ [b] \ Pb$$

is so. Its matching transcription in first-order logic makes this evident.

Not everyone agrees however as to what is required for Existential Generalization over individual expressions of restricted scope. Clearly,

$$M \ [a] \ Pa, \ \text{so} \ (\exists x) \ MPx$$

is not a valid inference form. Symmetry with Substitution, now qualified for psychical contexts, suggests perhaps the addition of a certain supporting premise:

$$M \ [a] \ Pa, \ (\exists x) \ M \ [a] \ (x = a) \ \text{so} \ (\exists x) \ MPx.$$

However, this is, it seems to me, unnecessarily strong. Certainly it seems unacceptably strong for perception. Agent sees, at the periphery of his vision perhaps, an object, he knows not what, move. The object indeed exists. It follows, clearly I think, that there is something which Agent sees move. But while the object is perceptually individuated for the Agent it is

not identified; there is nothing with which the Agent (perhaps a child or beast after all) identifies it. A weaker premise should then suffice. It is not necessary that an agent knows what the object of his demonstrative, perceptual reference is. What is crucial is that the object exists.

The following inference form, bolstered with its premise of existence, is valid on the present account as its world-theory transcription would verify:

$$M\,[a]\,Pa,\,(\exists x)\,[a]\,(x{=}a) \vdash (\exists x)\,MPx.$$

It is not surprising, given the transcription of mundane quantifications into psychical contexts and given the altered version of Existential Generalization adopted here, that various interesting formulae diverge in their formal status here from that they enjoy in received systems familiar from the current literature. We consider now certain such interesting formulae. We contrast the formal status of some of these as theorems or not in the present system with results in the literature.[13]

Since on the present account perception is a kind of judging, it ought to be that what one sensuously believes (or knows), he thereby believes (or knows). That is to say, the following should be a theorem:

$$\vdash [i]\,SM^iP \to [i]\,M^iP.$$

It is, on the assumption that

$$(w)\,(w')\,(R^kiww' \to {}^sR^kiww').$$

(Here, 'k' is 'e' or 'd' as M is 'knows' or 'believes', and 's' ranges over expressions for the various sense modalities of sight, touch,... etc.) The corresponding conditional with antecedent assumption and transcribed mundane modal formula is a theorem of first-order logic. The following is derivable:

$$\vdash (w)\,(w')\,(R^kiww' \to {}^sR^kiww') \to [(Boi\ \&\ (w)\,({}^sR^kiow \to$$
$$\to TwP)) \to (Boi\ \&\ (w)\,(R^kiow \to TwP))].$$

The antecedent assumption is a reasonable one. It says that if w' is an alternative of w, truths there being compatible with all i knows or believes, then it is a sensuous alternative as well, compatible with all i sensuously knows or believes.

We remarked earlier that, supposing as many do, that knowledge iterates and one knows that he knows what he knows, there is a certain

difficulty about applying the law. For, given general problems with the free application of Universal Instantiation, (as we have witnessed from Montague earlier,) and given pronomial occurrences in modal indices, there are difficulties about the instantiation of the law.

We wish, presumably, to have the law itself as a theorem. We want

$$\vdash (x)\,(K^x P \to K^x(K^x P)).$$

If so, we surely wish to instantiate it. We wish to say that if John, for instance, knows (or perceives) that P, then John knows he knows (or perceives) it. (Suppressing qualifications for perception,) we want this:

$$\vdash [i]\,K^i P \to [i]\,K^i(K^{i*}P).$$

It is stronger, and not generally desirable however that

$$[i]\,K^i P \to [i]\,K^i([i]\,K^i P).$$

John may know that P, and know he knows it. But John may not know that John knows that P. We do not want this to follow from the (putative) law alone.

None of the three formulae above is a theorem without further assumptions. For one thing, each requires an assumption of the transitivity of R to support the iteration of K. For another thing, we require some assumption to support the repeated occurrences of 'i' in indices of the iterated modal operators. Names, occurring in modal indices are not themselves within the scope of the modal operator they index, as their scope-indicators display. Accordingly, they are not relativised to the agent's own corpus of knowledge and belief as are the references occurring within the proposition which is governed by the indexed modal operator.

Given the transitivity of R, it suffices to assume the following 'Population Principle' for agents to establish the law:

$$(x)\,(w)\,(w')\,((Bwx\ \&\ R^k xww') \to Bw'x).$$

This suffices, and has a certain plausibility given the quasi-referential occurrence of names in modal indices. But it is too strong. For all three theorems are now derivable. We fail to discriminate, as we desire to discriminate, between the extent of the agent's self-knowledge as expressed in the latter two formulae.

We can derive the general law and divide the latter two formulae if we assume instead that

$$(x)\,(w)\,(w')\,((Bwx\ \&\ R^k xww') \to (\exists y)\,(Tw\,(x=y)\ \&\ Bw'y))$$

together with the referential transparency of R.[14] On these assumptions the first and the second, but not the third, of the three formulae are derivable.

More generally, statements of the form, 'Agent knows that he is P' do not presuppose that Agent knows he is that object of our reference or supports that referring expression. Formally, '$[a]\,K^a Pa^*$' goes by our transcription principles into '$Boa\ \&\ (w)\,(R^k aow \to (\exists y)\,(Bwy\ \&\ To(a=y)\ \&\ TwPp))$' of our extended, first-order logic. I.e., although a belongs to the actual world, o, we can say only that relative to the worlds compatible with all Agent believes there is an individual, actually identical with Agent, who is P. Agent knowing this may not know that he himself is Agent.

Given results above it follows that what one sensuously knows (or believes,) he then knows (or believes) that he knows (or believes) it. We have earlier that

$$\vdash [i]\,SM^i P \to [i]\,M^i P$$

and now, on the required assumptions, that

$$\vdash [i]\,M^i P \to [i]\,M^i(M^{i*}P).$$

Thus,

$$\vdash [i]\,SM^i P \to [i]\,M^i(M^{i*}P).$$

It is perhaps worth pausing, given the special features of the transcription and confinement principles, to defend our account from certain objections.

It is not for instance true that from the fact that John knows (trivially) that the one spy from Monaco is a spy, (assuming there is one,) it follows that there is someone whom John knows to be a spy. This, despite our modified principle of Existential Generalization. What does follow however, (given that Harry exists,) is that if John knows Harry is self-identical, then there is indeed someone whom he knows to be self-identical. But, this is, I believe we would all agree, quite as it should be.

More important, perhaps, is the fact that we are not committed on the present view of things to what might be thought an evident *reductio ad absurdum* of the view. It might be thought that all agents are, on the present account, possibly inconsistent agents. Surely that need not be so, at least as a matter of logic. If this were indeed a consequence of the account, then the account would indeed be unacceptable. To develop the *reductio*, suppose that *b* exists and in fact is identical with *c*. Suppose that an arbitrary psychical agent, *a* perhaps, believes that *b* is *P* but does not believe *Pc*. Thus, it may seem, there is an object such that our agent both believes and yet also does not believe that it is *P*. And such an agent surely seems irrational. Yet so far as the characterization goes, this might be any agent at all. Is then the following which formalizes the putative *reductio* derivable on the present account?

$$[[a] \ M^a([b] \ Pb) \ \& \ ([a] \ M^a([c] \ Pc)) \ \& \ [b] \ [c] \ (b = c) \ \&$$
$$(\exists x) \ [b] \ (x = b)] \rightarrow (\exists x) \ ([a] \ M^a Px \ \& \sim ([a] \ M^a Px)).$$

This is not derivable on the present account. Our transcription and confinement principles safeguard the system from inferences like these without further qualifications or conditions on names and variables. Intuitively, the common individual, *b*, i.e., *c*, of the actual world splits in the worlds compatible with all the agent believes. There is not some one individual in those worlds of whom the agent has made inconsistent ascriptions.

Perception, we have claimed, is a special case of cognition. It is a sensuous kind of knowing or believing which is intrinsically tied to the occasions of its occurrences. Although it is a special case of cognition it is particularly interesting for the light it throws on the characterization of knowledge and belief generally. For we do not require – as Hintikka for instance has required[15] – that the value of variables and singular expressions in the scope of psychical operators must be known to, or identified by, the agent to whom the mental act is ascribed. We do not require that the values of such variables "must be referred to by a constant *b* such that $(\exists x) \ K^a(x = b)$ holds."[16]

Evidently, for perception, a requirement like this is too strong. Agent may for instance see or hear that I am rapidly approaching from his right rear. He may do so having no idea who or what I, who loom rapidly on his sensory horizon, may be. Primitive Agent presumably was particularly sensitive, at pain of survival, to movement in his surroundings. Primitive

Agent presumably on occasion discriminated and individuated without identifying sources of sight, sound or smell in a hostile environment sensuously available to his scrutiny.

There is, I believe, in all perception a demonstrative element. It is this element which ties in the necessary way the perceptual act to the occasion of its occurrence. This feature distinguishes perception thereby from occurrences of non-sensuous thought which may wander freely across the boundaries of the psychical act. The other striking feature of perception, the other main contrast it bears with judgment generally, is its sensuous character. This too is intimately linked with its demonstrative aspect. For the simplest form of perception, the basic perceptual act, consists in the ascription of a sense quality, one of the Aristotelian proper- or common-sensibles, to what lies in one's sensorily available surroundings. We feel, hear, smell or see how something is. 'This, before me is red. That, which I touch, is sticky.' These basic perceptual acts, with the demonstrative references implicit in their occurrences and their qualitative, sensuous ascriptions are also logically minimal acts. They presuppose discrimination, but not classification. They involve qualitative attribution, but not identification. They are simple cognitive acts of no formal complexity, involving the most primitive form of reference, demonstration, and the most primitive form of attribution, qualitative awareness. Sense impressions of the qualitative character of what is 'before us' are logically the simplest form of judgment. An impression of a proper sensible has no constituent, internal complexity and is a direct awareness of the thing which is perceived or sensibly qualified in the given way.

Ordinarily, of course, everyday perceptions outrun these simple impressions of sense qualities. We see, for example, not only the color and shape of what is before us, but often what the thing before us is, and of what it is made, and what it is doing or will do. Seeing a small, blue car parked nearby, I have an impression not only of the relative size and color of what is there, visually before me, but perceive as well the kind of thing it is and its current disposition. We have for example no simple *impression* of the kind, *car*, as we do of its color and shape. How these richer, more complex, but everyday perceptions are related to our primitive impressions of sense is a basic issue for any theory of perception. But it is not essentially a formal issue. We shall conclude later on with some brief remarks on this basic issue, but for now the central point is

rather this. The existence of these basic acts of perception, of minimal formal complexity, however related to ordinary perception, provide a species of judgment the formal characterization of which cannot correctly presuppose our richer everyday judgments and perceptions. We must not require that an agent to whom an act is ascribed knows always the values of the singular terms occurring in the expression of the propositional content ascribed him. This is a point of formal relevance. Characterizations of 'quantifying into' psychical contexts, and of pronomial references within them, require instead some weaker condition. No identificatory knowledge, no 'vivid names,' indeed no names at all, are to be a precondition of the correct ascription of perceptual acts generally.

It is perhaps pertinent, then, further to contrast the consequences of the applications of the weaker condition actually imposed by the confinement principles adopted above with those of other, stronger conditions extant in the literature.

The formula,

$$\vdash (x) \, [i] \, K^i P x \rightarrow (x) \, P x,$$

for instance, is provable on the present account. It says that if, of each thing there is, an agent knows it to be P, then everything is indeed P. And surely this is reasonable. What is known to be the case must, after all, be the case. The proof of the transcription of the formula requires only the (usual) assumption that the relation R^e is reflexive, securing thereby the link of knowledge to truth, together with the application of our relativized identity conditions on Interchange.

This formula, intuitively desirable as it is, is not provable however in the systems of Hintikka's *Knowledge and Belief*,[17] the original treatise which has been the main influence on subsequent contemporary discussions of knowledge and belief and which first construed these concepts as psychical modalities.

By contrast, we cannot prove the following formula on the present way of transcribing modals:

$$(x) \, (y) \, ((x = y) \rightarrow M \, (x = y)).$$

And, again, this is I think as it should be. For the formula appears to assert that things are identical only if they are known (believed or perceived) to be so. That surely is false. So the failure to yield this formula is

a highly desirable failure. The formula has however been vigorously up-
held. John Tienson in the course of an examination of Hintikka's
conditions on the values of variables in psychical contexts points out
that Hintikka has defended the formula as tantamount to defending his
restrictions on quantification into contexts governed by psychical modal
operators.[18] Without special ways of construing the quantifiers and occur-
rences of their associated variables, it is untoward that a system should
deliver this formula as a theorem. And it is of course our present point
that special ways with the quantifiers need not be invoked. Our interpreta-
tions and formalizations of mundane modal psychical ascriptions proceed
with quite standard formal resources construed in quite familiar ways.

The Barcan-like formula,

$$\vdash (\exists x)\, MPx \rightarrow M\,(\exists x)\, Px,$$

emerges here as a theorem without further assumptions. (The transcrip-
tion principles are of course different for the mundane psychical modalities
and the mundane alethic modalities. One effect of the difference is that for
the latter, special population assumptions on B are required to deliver the
formula as a theorem when M is interpreted alethically.) For psychical
instantiations of M however the formula is a plausible one. If there is
someone whom Agent knows (believes or perceives) to P, then Agent
surely knows (believes, or perceives) that someone is P. The converse, of
course, is not forthcoming.

Finally, as Chisholm long ago somewhere pointed out, it does not
follow from the fact that of each thing there is, Agent knows it to be P,
that Agent knows that Pb. This does not follow even though b is one of
the things there is. For Agent may not, after all, know that b is one of the
things there is. Accordingly, the following ought not to be a theorem of
our system, and it is not:

$$((x)\, MPx\, \&\, (\exists x)\, [b]\, (x = b)) \rightarrow M\, [b]\, Pb.$$

4. Some Reflections

So far, our account has been mainly negative. We have urged that standard
modal resources ought to suffice for our ascriptions of perceptual acts to
sentient agents. We have tried to characterize these modalities sufficiently

to show that this is indeed plausible. None of this has touched very directly or at all deeply on the nature of perception itself, although the character of basic perceptual acts has motivated the development of our transcription principles for the psychical modalities in general.

We need now to conclude with some brief remarks on more substantive features of perception itself and not just of the logic of perceptual ascriptions. For one thing, it is surely not a consequence of the logic of perception itself that there are, or for that matter are not, phenomenal entities. The facts of perceptual life, of perspective and illusions and hallucinations, together with the theories we bring to organize and explain these facts should determine our need to posit such special objects of awareness. But our logic itself is neutral across such theories. It is wrong, I believe, to attempt to wring metaphysical conclusions from the formal characterization of perceptual ascriptions. What is special about perception, as the species of judgment it is, resides rather in the characterization of the modal operators and their modifiers than in enhanced syntactical resources or special ways of construing the quantifiers.

There are of course genuine questions over the nature and status of the objects of our perceptions. There are genuine and puzzling issues concerning the relation of seeing to inferring, or concerning the relation between seeing how things are and what they are. There are very real difficulties in determining a standard by which we can say how much is seen on a given occasion. But these questions and puzzles are epistemological or psychological questions and puzzles. They are not formal ones.[19]

If this is so, then current concerns to bring perceptually individuated entities into single sharp focus as physically identified ones are themselves concerns in perceptual, but not logical, theorizing. We seek to bring what we perceive, or seem to perceive, into coincidence with accepted, background, physical fact. We wake to a thump in the night and speculate over the cause. What, and where is that sounding body? What are the steps from perceptual impression to physical identification? You, alert and familiar with the surroundings, hear perhaps a loose shutter in the wind. I, groggy and unknowing, record no more than a thump in the night.

Perceptual occurrences range from detection, discrimination and individuation, to identification and judgment. The relations among these no doubt are difficult to isolate and make clear. But quite general and interesting theoretical issues at least become evident in the course of attempting

to sort out and relate these perceptual occurrences. These are issues in the epistemology of perception. How much is perceived, directly perceived, across the range of such occurrences, and how much is inferred, perceiving what we do? And if, in standard cases, both perception and inference figure, how do we tell which is which and how much of each goes on?

It is tempting to suppose that perception, true, pristine perception unsullied by inference, is a matter always of our sense impressions of things. True perception it might be thought is always, at most, a matter of what we called earlier basic perceptions. (Perhaps not even all of these are inferentially untainted.) The rest is a matter inference or is mixed with non-sensuous judgment or more. When we see, say, what is before us, and of what it is made, and what it is doing, we see the look and sense qualities of the thing but do much more as well. We do not have sense impressions of the kind, nature, character and tendencies of what we see, so these it is thought must be inferred from the impressions we do have. The conclusions are projected from these sensuous premises by our background knowledge of perspective and of lawful correlations of the standard appearances of familiar physical kinds of things. We infer classifications from perceptual impressions.

It is possible of course, but not necessary and so not to be concluded, that this view takes what is perceived always to be phenomenal entities, entities every quality of which is manifest in our direct, momentary, and non-inferential awareness of them. This is possible. But it is not required by this way of dividing occurrences of perceptions from inferential judgments based on them. It is consistent with this division to view sense impressions not as themselves phenomenal objects of direct awareness, indeed as not objects at all. They are, rather, simply our qualitative impressions of what is directly seen, the physical objects and happenings in our sensorily available surroundings. What is perceived are physical things. What we perceive is the qualitative attributes of these; their color, shape and feel; their characteristic looks. What, given the impression we have, is inferred is what we ordinarily say we perceive. We infer what is before us, and of what it is made, from the qualitative appearance by which we are impressed. Seeing the size, shape and look of what's at the curb, I judge a car is parked there. My conclusion is premised on these sense impressions. Hearing the thump, you but not I, conclude the shutter

is loose. We share the impression but not the linking generalization, tying impression to shutter. I lack your knowledge.

It is possible then to divide perception and inference in this radical way, familiar from the empirical tradition. Moreover, it is possible to do so without a concomitant commitment to either a phenomenalist or to a realist epistemology so far as the division goes.

But even so, the view seems implausible positing as it does multitudes of unconscious inferential acts for what common sensically seem the most direct perceptual occurrences. Am I never directly and non-inferentially aware of what is before me? Do I really infer that, say, this is a pen I hold?

It is possible, I think to mitigate the implausibility of the view.[20] We do not pause now to do so, however, for there is an alternative, less familiar, view which divides perception, identification, and inference at the other extreme. It is with this alternative that we conclude our discussion.

The empiricist way with perception, whether phenomenalist or realist, seemed implausible converting as its does so much of everyday perception to inference. An alternative account instead makes all perception non-inferential and direct.[21] The epistemologically important fact about it is this, the set of such perceptions includes not only the qualitative ascriptions of sense impressions, but it includes as well perceptions of the kinds and natures and matter of what we see. Common sense is an accurate record of the division between perception and inference on this view. We correctly say now that I see a *car*, or you hear a shutter in the wind. We literally do so, if the view is correct. We say correctly and literally that I see the car, and not merely impressions of its characteristic appearance from which we infer its presence.

Since perceiving is a kind of judging, all perception is conceptual. Minimal perceptions, mere sense impressions of my surroundings, are formally primitive judgments. As primitive sensuous judgments, they are ascriptions of sense qualities or relations to objects demonstratively indicated by the very occurrence of the impressions themselves.

This is not to say that everyone placed alike in the same physical ambience will have the same impression. What sense quality is ascribed on a given occasion will be a function not only of the perspective, stimulation, and physiological equipment of the agent. It will be a function of what he knows, his experience and attention, and no doubt other things

as well. You, for example, seeing a standing coin from the side, see that it is round. You corroborate your impression, perhaps, by facing it head on. Infant child and chimp, perhaps, placed as you are placed, may not have as you have a correct impression of the shape of the coin. No doubt all this is something to be learned and a function of maturation as well. Though the impression will vary in similar circumstances, being a complex function of a number of factors affecting agent as well as his environment, the relevant present point is that, on this view, each impression is an ascription of some sense quality. Each is a perceiving of how something is. Though the having of impressions is thus a conceptual matter, and though the impression had in a given case will vary with experience, learning and knowledge, the having of impressions is the seeing, not inferring, of how things are.

Equally, on the present view, my perceptions of the kinds of objects in my sensory environment and their natures is, in standard cases, direct, non-inferential and not projected on the basis of experiencing other, intermediary or phenomenal objects. I see, directly see and do not infer, that it is a pen I hold.

Again, the classifications and identifications I perceptually make are complex conceptual matters. Like sense impressions, what (kind) I perceive will be a function not only of how I am placed in my surroundings but of what I know and how I come to the perceptual context. Here, as with sense impressions, the fact that my perceptual classifications are complex functions of learning and other factors does not mean that I infer what kind of thing is before me. I see, and do not infer, that this is a pen. Child or chimp perhaps, placed as I am placed, would not. But the important point is that I have perceived, and not inferred, what kind of thing I hold. My perception is the identification, the classification of the physical object as the kind of thing it is.

But if, in such cases, my richer perception is a direct, non-inferential, classification of what is before me, what, in such cases, functions as the sensuous classificatory concept I apply? I have no sense impressions of *pen*, *car*, or *shutter* as I do of the color or feel of things. If I have no simple sense impressions of the classificatory status of things, and if my perceptual classification is (by hypothesis now) direct and non-inferential, then it must be that sequences of occurrences of sense impressions function in these richer perceptions as do single, minimal sense impressions in our

primitive awarenesses of our surroundings. It is sequences of sense impressions which are, which literally constitute, a sensuous classificatory concept.

The view is not implausible. For one thing, it relates the simpler impressions of sense qualities to our classifications of physical kinds in a simple and attractive way. We see, for example, what a thing is through sequences of seeing how it is. The characteristic look of a given kind of thing will typically involve patterns of impressions of its qualities. Seeing a thing as a certain *kind* of physical thing will require often ordered sets of such characteristic appearances as we alter position slightly, moving eyes or head. Seeing that kind of thing as a *physical* thing, means that these ordered sets will obey certain laws. Reversing eyes and head to their origin, we should retrieve sets of impressions congruent with the original ones. If not, what is before us lacks the stability of appearance which we associate with enduring physical things. That these laws obtain is a matter of fact. Their determination presumably is a matter of the psychology of perception. What is of interest here, concerns the relation which obtains between these richer, but everyday, perceptual identifications and classifications and our simpler basic impressions of things.

It is by literally incorporating these simpler qualitative ascriptions that our perceptual classifications are tied, as all perceptions are tied, to the sensory context of their occurrence. There is in all perception a demonstrative element. The constituent sense impressions link our classification to the object classified. We see that *that* by the curb, with its characteristic appearance, is a car. Our sets of impressions are impressions of the qualitative display manifest there before us.

It is by incorporating as constituents these simpler qualitative members of the sequences the occurrences of which are literally an activation and application of a classificatory concept that seeing what something is always presupposes awareness of how it is. (The converse of course is not generally true.) Perceptual classification entails, because it incorporates, the occurrence of sense impressions.

Evidently, various questions flow from this version of radical direct realism. We shall wish to know what conditions govern these sets of sequences of sense impressions. Can these member sequences be permuted? Are different sets ever the activation of the same classificatory concepts; or the same sets, of different concepts in different circumstances,

or across various agents? Some of these questions are empirical; some are conceptual. Are there never, after all, cases where, seeing what we do, we literally infer what is there? And if there are, how do we in principle distinguish such cases from direct perceptual identification? Are the applications of concepts ever literally extended through time, as the applications of perceptual classifications must, on this theory, be?

We cannot investigate such questions here. What is pertinent however, to the modest, negative thesis of this paper is this: we can perceive how something before us is without perceiving or inferring what or who it is. And perceptual knowledge of the latter sort in any case presupposes perceptual knowledge of the former sort. An adequate characterization of the logic of perception cannot, then, be based upon richer resources than required in the characterization of these simpler perceptual impressions of how things are. These resources are the resources adequate for the old foundations for doxastic logic generally.

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NOTES

[1] The fashion is due to Professor Jaakko Hintikka and his seminal work, *Knowledge and Belief*, Cornell, Ithaca, New York, 1962.
[2] See Hintikka, J., 'On the Logic of Perception', in *Perception and Personal Identity* (ed. by N. Care and R. Grimm), Case Western, Cleveland, 1969; and Thomason, R. H., 'Perception and Individuation', in *Logic and Ontology* (ed. by M. K. Munitz) N.Y. 1973.
[3] Professor Robert Binkley has developed modal characterizations of these, drawing on the implications of their temporal dimensions.
[4] Professor H. N. Castaneda has first drawn attention to these cases and developed resources for systematically sorting out these kinds of reference. See his '"He": A Study in the Logic of Self-Consciousness', *Ratio* 8 (1966), 130–157; 'On the Logic of Attributions of Self-Knowledge to Others', *The Journal of Philosophy* 65 (1968), 439–456; 'Indicators and Quasi-Indicators', *The American Philosophical Quarterly* 4 (1967), 85–100. John Tienson has stressed the problems with instantiating iterated psychical modal operators indexed to the same agent.
[5] *Knowledge and Belief*, see note 1.
[6] Professor Ausonio Marras, exploring the existential presuppositions of the occurrence of names, first exploited the device of tagging names with an indication of their scope relative to the other formal operators.
[7] See H. N. Castaneda, note 4, for developed systems of such pronominal reference.

[8] But there are various interesting side effects. If, e.g., to say that an object a, say, is self-identical is to say something of the form $[a]$ $(a=a^*)$, then the necessity of the fact does not tempt us to suppose that b, if identical to a, is necessarily so. Merely that b too is self-identical.

[9] Again, see note 4 and H. N. Castaneda, but especially appropriate is the reference there to Prof. John Tienson.

[10] The transcriptions in effect lay down truth-conditions for mundane modal assertions, and we can exploit proof algorithms for 1st-order logics to turn up the resulting theorems.

[11] This is the central point of the paper, and determines the results which are at odds with received views familiar in the literature.

[12] Montague, R., 'Pragmatics and Intensional Logic' in *Semantics of Natural Language* (ed. by D. Davidson and G. Harman).

[13] The present paper is essentially an enlargement of one part of a discussion to appear in the proceedings of a conference on Perception at Ohio State University, 1974. The formulae to be considered here are ones cited there, now sometimes complicated with the presence of the scope indices or operators. Castañeda and Hintikka have written a number of papers on these matters, including 1st-person cases. See, e.g., Castañeda, H-N., 'On Knowing (or Believing) that One Knows (or Believes)', *Synthese* **21** (1970), 187–203, and Hintikka, J., '"Knowing Oneself" and Other Problems in Epistemic Logic', *Theoria* **32** (1966), 1–13; Hintikka, J., '"Knowing that One Knows" Reviewed', *Synthese* **21** (1970), 141–162.

[14] We need to make the (reasonable) assumption that identities can be interchanged freely within R. In particular,

$$(x)\,(y)\,[To\,(x=y)\rightarrow(w')\,(w'')\,((Bw'x\,\&\,Rxw'w'')\rightarrow(Ryw'w''))].$$

[15] Hintikka, J., 'Individuals, Possible Worlds, and Epistemic Logic,' *Noûs* **1** (1967), 33–62, see esp. p. 37.

[16] Hintikka, as above. See, too, Tienson, J. 'Hintikka's Argument for the "Basic Restriction"', *Philosophical Studies* **28** (1975), 33–40.

[17] See note 1.

[18] See notes 15 and 16.

[19] I attempted to address some of these epistemological puzzles in 'Considerations for a Logic for Naive Realism,' forthcoming in the volume cited in note 13.

[20] Which I attempted to do in the paper referred to immediately above, note 19.

[21] This view, I thought, was implicit in the writings of psychology Professor J. J. Gibson. After discussion with him, I am not clear as to the extent of his realism. His writings are in any case pertinent. See, e.g., Gibson, J. J., 'Constancy and Invariance in Perception', in *The Nature and Art of Motion* (ed. by G. Kepes), George Braziller, N.Y., 1965. And see my discussion, cited in note 19 above.