

University of Massachusetts Occasional Papers in Linguistics

Volume 9 *University of Massachusetts
Occasional Papers in Linguistics Volume 8*

Article 8

1983

Hob, Nob, Bob, Cob and Situation Semantics

Raymond Turner

Follow this and additional works at: <https://scholarworks.umass.edu/umop>



Part of the [Linguistics Commons](#)

Recommended Citation

Turner, Raymond (1983) "Hob, Nob, Bob, Cob and Situation Semantics," *University of Massachusetts Occasional Papers in Linguistics*: Vol. 9 , Article 8.

Available at: <https://scholarworks.umass.edu/umop/vol9/iss2/8>

This Article is brought to you for free and open access by ScholarWorks@UMass Amherst. It has been accepted for inclusion in University of Massachusetts Occasional Papers in Linguistics by an authorized editor of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.

HOB, NOB, BOB, COB and SITUATION SEMANTICS

Raymond Turner

Geach describes the problem of intentional identity by reference to the following sentence:

Hob thinks that a witch has blighted
 (1) Bob's mare and Nob believes that she
 (the same witch) killed Cob's sow.

We are to imagine that a reporter is describing an outbreak of witch mania in Gotham village. Hob has been overcome by this mania, indeed, it was in his mind that the mania first started. It was he who started to speak about witches and it was he who infected Nob with this religion. He has convinced Nob of the existence of some particular (from the perspective of their thoughts and beliefs) witch. Our reporter, on the other hand, does not believe in the existence of witches (poor fool) nor indeed that there is any actual individual at the focus of this mania. Apparently then, Hob and Nob have attitudes which have a common focus even though there may not actually be anything at that focus. This is the kernel of the problem of intentional identity.

What is the "logical form" of this sentence? Suppose we permit ourselves the apparatus of first-order logic together with the intensional operators T_H (Hob thinks that) and B_N (Nob believes that) can we capture the intended reading of (1)?

Our first stab at formalizing the intended reading might be the following:

(2) $T_H(\exists x)(x \text{ is a witch \& } x \text{ has blighted Bob's mare})$
 &
 $B_N(\exists y)(y \text{ is a witch \& } y \text{ killed Cob's sow})$

This interpretation has the merit that the two attitudes are not directed at any actual individual. On the other hand, it fails to capture the intended reading since there is no guarantee that Hob and Nob have attitudes towards a common focus.

We can certainly obtain such a common focus with the following reading:

(3) $(\exists x)(T_H(x \text{ is a witch \& } x \text{ has blighted Bob's mare})$
 &
 $B_N(x \text{ is a witch \& } x \text{ killed Cob's sow})$
).

But this will not suffice. Reading (3) implies that there is some actual individual at the focus of their belief. Such an implication is not part of the intended reading.

So we might try to retain the best of (2) and (3) as follows:

- (4) $T_H(\exists x)(x \text{ is a witch \& } x \text{ has blighted Bob's mare})$
 $B_N(x \text{ is a witch \& } x \text{ killed Cob's sow})$
).

Although the focus of the two attitudes is the same, and this reading does not imply the existence of some actual individual at the focus, this is still inadequate. According to (4), the belief of Nob is part of the thoughts of Hob, and this is certainly not implied by (1) on the intended reading.

As a final grope we might try to analyze the pronoun she in (1) as a substitute for a definite description. In which case the intended reading must be

- (5) $T_H(\exists x)(x \text{ is a witch \& } x \text{ has blighted Bob's mare})$
 $\&$
 $B_N((\lambda x)(x \text{ blighted Bob's mare}) \text{ killed Cob's sow})$
 or

- (6) $T_H(\exists x)(x \text{ is a witch \& } x \text{ has blighted Bob's mare})$
 $\&$
 $(\exists y)(y = (\lambda x)(x \text{ has blighted Bob's mare}) \&$
 $B_N(y \text{ killed Cob's sow}))$
)

- according to whether the definite description is to have narrow or wide scope. These can be easily dismissed. The reading (5) entails that Nob has access to Hob's beliefs. As Geach points out our reporter might be justified in asserting (1), if he heard Hob say, "The witch has blighted Bob's mare" and later heard Nob say, "She killed Cob's sow," even if Hob had not thought or said anything about Cob's sow nor Nob about Bob's mare. Of course, our reporter would somehow have to know that Hob and Nob have been overcome by witch mania and that their thoughts had settled on a particular (from the perspective of their thoughts and beliefs) witch. The wide scope reading (6) will not work either: it commits the reporter to the existence of some particular and actual witch.

We seem to have reached an impasse. It seems that the techniques of traditional philosophical logic cannot capture the intended reading of (1).

To emphasize that the problem of intentional identity is not limited to Geach's sentence, we list some examples taken from [12].

- (a) Ernie believes that he will find a proof for the theorem. He is sure it will not be an elegant one.
- (b) Ed believes that Larry kissed some girl last night. Ed is certain that she was good looking.
- (c) Joan believes that someone stole her car. She also believes he tried to break into her house.
- (d) Bill believes that the lady on the stairs knows him, but John knows she is only a wax figure.

In the next section we turn to an approach to the semantics of natural language which we believe throws new light on the problem of intentional identity.

2. SITUATION SEMANTICS

In this section we provide a basic introduction to situation semantics. This discussion will be very brief. For more philosophical and linguistic motivation we refer the reader to the writings (both published and unpublished) of Barwise and Perry. These papers contain a more detailed account of all issues mentioned here. Our interest is in the problem of intentional identity and, in the main, we shall discuss only those aspects of situation semantics which relate directly to this problem.

The basic assumption or claim of situation semantics can be put quite simply: simple declarative sentences describe situations (or, more generally, courses of events) whereas more complex sentences indicate properties of or relations between situations. According to the perspective adopted in situation semantics, the world consists not just of objects but of objects having properties and standing in relation one to another. These "parts" of the world are called situations.

2.1 Primitives of the Theory In attempting to develop a theory of linguistic meaning that concentrates on situations, Barwise and Perry recognize (as they say) the epistemological primacy of situations, but follow the lead of language and take objects, relations and locations as the primitives of their theory. Situations and courses of events are constructed from them. The primitives of the theory are:

- (a) a set A of objects or individuals a_1, a_2, a_3, \dots
- (b) a set $R = R_0 \cup R_1 \cup R_2 \dots$ of relations where R_n is the set of n -ary relations
- (c) a set L of (space-time) locations l_1, l_2, l_3, \dots

"Situations" are constructed from these basic objects as follows: a Situation s is a pair $\langle l, t \rangle$ where $l \in L$ and t is a Situation Type, where the set T , of situation types, is the set of partial functions $\bigcup_{n \geq 0} R_n \times A^n \rightarrow \{0,1\}$. So the set of situations is the set $S = TxL$. Situations are special cases of courses of events where a Course of Events (coe) e is a partial function from L into $T - e \in E = L \rightarrow T$. We shall write $e(l)$ as e_l . The actual course of events e^* is the one that obtains. A situation $s = \langle l, t \rangle$ is actual if $t \subseteq e^*(l)$. Propositions are set of coes, P , which are persistent: if $e \in P$ and $e \subseteq e'$ then $e' \in P$.

2.2 The Language SIT In order to give a semantic analysis for Geach's troublesome sentence we need to provide the syntax and semantics for the following constructions:

- (i) Sentences and sentence conjunction (S)
- (ii) Noun phrases (NP)
- (iii) Property phrases (PP)
- (iv) Pronouns
- (v) Attitude verbs

We shall do this in the rest of section 2. We shall provide the syntax and semantics for an artificial language or fragment SIT rich enough to express the Geach sentence. We begin with a simple language and gradually enrich it until it includes all of the above features.

Basic Symbols

Firstly, we introduce the basic symbols and their interpretation:

1. The n-ary relation symbols are r, s, \dots
2. The terms are
 - (a) a gap -
 - (b) thing variables $X = \{x_1, x_2, \dots\}$
 - (c) names $N = \{n_1, n_2, \dots\}$
 - (d) location variables $U = \{u_1, u_2, \dots, v_1, v_2\}$.
3. Logical operators \wedge, \vee .

To interpret the basic symbols we need to specify an interpretation function I which assigns elements of A to names and elements of R_n to n-ary relation symbols. We also require an element c of $c = X \cup U \rightarrow A \cup L$ the set of connections. These connections are partial functions such that $c(x_i) \in A$ and $c(u_i) \in L$. Such a connection represents the links between certain words and things in the world.

S-Rules

We first give the main rule for sentences.

- (SA) (i) If α is an NP and π is a PP (property phrase) then $[\alpha\pi]$ is an S.
 (ii) $c[[\alpha\pi]]e \Leftrightarrow$ there is an $a \in A$ such that $c[[\alpha]]e, a$ and $c[[\pi]]e, a$.

What does this tell us? The above semantic rule is to be read: (with connections c) $[\alpha\pi]$ describes e , iff (with connections c) π characterizes a (given e) and α designates a (given e).

The other S-rule involves sentence conjunction and disjunction.

- (SB) (i) If θ_1 and θ_2 are in S then $[\theta_1 \wedge \theta_2]$ are in S.
 (ii) $c[[\theta_1 \wedge \theta_2]]e \Leftrightarrow (\exists c' \supseteq c)(c'[[\theta_1]]e \text{ and } c'[[\theta_2]]e)$.
 $c[[\theta_1 \vee \theta_2]]e \Leftrightarrow (\exists c' \supseteq c)(c'[[\theta_1]]e \text{ or } c'[[\theta_2]]e)$.

We shall comment upon (SB) later. Notice that the semantic type of sentence is CxE.

NP-Rule

The semantic type of NP's is CxExA: given a coe (and connections) an NP designates an element of A.

- (NPA) (i) If α is a name, then α is an NP.
 (ii) $c[[\alpha]]e, a \Leftrightarrow a = I(\alpha)$
- (NPB) (i) If x is a thing variable, then x is an NP.
 (ii) $c[[x]]e, a \Leftrightarrow a = c(x)$

These rules are straightforward so we offer no comment.

PP-Rules

In order to specify the structure of PP's we need to describe several sub-categories. Basically PP's are "located" relations.

- (RP) (i) If r is an n-ary basic relation symbol, then r and $\sim r$ are n-ary relation phrases.
 (ii) $c[[r]]e, l, \underline{a} \Leftrightarrow e_1(I(r), \underline{a}) = 1$
 $c[[\sim r]]e, l, \underline{a} \Leftrightarrow e_1(I(r), \underline{a}) = 0$ where $\underline{a} = \langle a_1, \dots, a_n \rangle \in A^n$.

These relations have type CxE_lLxAⁿ: they characterize individuals at specified locations (given connections and coes).

- (LRP) (i) If γ is an n-ary RP and u a location variable then γ_u is an n-ary LRP.
 (ii) $c[\gamma_u]e, a \Leftrightarrow c[\gamma]e, c(u), a$

These expressions have semantic type $CxExA^n$. We can now give our main PP-rules.

- (PPA) (i) If γ is an n-ary LRP and t_1, \dots, t_n are thing terms with gap t_i , then $(t_1 \gamma t_2 \dots t_n)$ is a PP (iff t_i is a variable it is free in the resulting PP).
 (ii) $c[(t_1 \gamma t_2 \dots t_n)]e, a \Leftrightarrow c[\gamma]e, a$ where $a_j = a$ and for $i \neq j$ $c[t_i]e, a_i$.
- (PPB) (i) If π_1 and π_2 are PP's then $\pi_1 \wedge \pi_2$ is a PP.
 (ii) $c[\pi_1 \wedge \pi_2]e, a \Leftrightarrow (\exists c' \supseteq c)(c'[\pi_1]e, a \text{ and } c'[\pi_2]e, a)$

Rule (PPA) informs us that PP's characterize individuals -- the individual that "fits in the gap".

2.3 Antecedents To allow NP's to serve as antecedents, they are subscripted. The resulting NP's only designate objects when the connections ensure that the NP's and governed variables designate the same object. We add a new NP-rule:

- (NPC) (i) If α is an NP; (α_i) is an NP; (α_i) is the antecedent of x_i .
 (ii) $c[(\alpha_i)]e, a \Leftrightarrow c[\alpha]e, a$ and if $c(x_i)$ is defined $c(x_i) = a$.

By way of example consider the following sentence:

- (7) John has blighted Rosey and he has killed Lucy.

This would be represented in SIT by the expression

$(John_1)(- \text{ has blighted}_u \text{ Rosey}) \text{ and } x_1(- \text{ killed}_v \text{ Lucy})$

The NP's are $(John_1)$ and x_1 ; the PP's are $(- \text{ has blighted}_u \text{ Rosey})$ and $(- \text{ killed}_v \text{ Lucy})$. Rule NPC guarantees that John and x_1 will designate the same object. We urge the reader to work out the details for herself.

The rule NPC gives us a new way of "quantifying in":

- (PPC) (i) If (α_i) is an NP and π a PP, with x_i free, then $(\alpha_i \pi)$ is a PP (with x_i not free).
 (ii) $c[(\alpha_i \pi)]e, a \Leftrightarrow$ there is a $b \in A$ such that $c[(\alpha_i)]e, b$ and $c[\pi]e, a$ where $c' = c + \langle x_i, b \rangle$ and $c + \langle x_i, b \rangle = c \cup \langle x_i, b \rangle$ if the latter is a function; otherwise $c + \langle x_i, b \rangle$ is undefined.

We shall use this rule in obtaining one of the readings of the Geach sentence.

2.4 Singular Determiners We now extend our language by the addition of the singular determiners a and the. We introduce a new NP-rule:

- (NPD) (i) If \mathcal{D} is a singular determiner and π a PP then $(\mathcal{D}\pi)$ is an NP.
 (ii) $c[[a\pi]]e, a \iff a$ is some x such that $c[[\pi]]e, x$
 $c[[the\pi]]a, e \iff a$ is the unique x such that $c[[\pi]]e, x$.

Consider the sentence:

- (8) The witch was blighting and Hob disturbed her.

This is represented in SIT as

$$[(\text{The witch})_1](- \text{ was blighting}_u) \wedge [\text{Hob}(- \text{ disturbed}_v x_1)]$$

We want what Barwise and Perry call the attributive reading; for this reading we want different witches in different coes. This is the reason for the form of (SB)¹ and (PPB). Without the condition $(\exists c' \supseteq c)(\dots)$, the pronoun her (or more precisely the thing variable x_1) would fix what the The witch designates -- it would designate the same thing in all coes.

Sections 2.2, 2.3 and 2.4 are based on ALIAS [7].

2.5 Discourse Situations A discourse situation represents the situation in which the speaker and addressee find themselves. Suppose some witch says

- (9) I blighted Bob's mare.

This event occurs in the world. It involves the utterance of a certain token of a certain expression by a person, etc. This event is the discourse situation.

A discourse situation is any situation $d = \langle l_d, t_d \rangle$ with

- (i) A designated individual a_d such that $t_d(\text{speaks}, a_d) = 1$
 (ii) location of utterance l_d .

Discourse situations are involved in the interpretation of expressions (indexicals) such as I, now, here, this, yesterday, tomorrow.

We introduce a new NP-rule for indexicals.

- (NPE) (i) If $\alpha = I$ then, α is an NP
 (ii) $c, d[[I]]e, a \iff a$ is the unique x such that $t_d(\text{speaks}, x) = 1$.

Notice that NP's (and PP's) now have type $CxDxExA$ where $D(\subseteq S)$ is the set of discourse situations. The type of sentences is now $CxDxE$.

The analysis of indexicals and discourse situations is more fully discussed in [5] and [8].

2.6 Resource Situations Consider the sentence

(10) A witch_u has blighted_v Bob's mare.

Suppose that Hob has been telling us about some state of affairs; building up a coe. Hob is bewildered by witch mania and has mentioned several witches by name -- Janet, June, Janice, and Joyce. If Hob uttered (10) under such circumstances we would normally interpret his utterance as:

{e: (∃a)(I(Janet) = a or I(June) = a or I(Janice) = a or I(Joyce) = a and c,d[- has blighted_v Bob's mare]e,a)}

On the other hand, suppose that Hob has made no mention of witches or witchcraft. We now cannot "load" the description a witch. In this case we would naturally analyze (10) as:

{e: (∃a)(c,d[witch_u]e,a and c,d[- has blighted_v Bob's mare]e,a)}

In the former case the background discussion contributes Janet, June, Janice and Joyce to the coe.

How can we capture these differences formally? Barwise and Perry introduce the so-called RESOURCE coe; this can be exploited to load NP's and PP's. Sentences, NP and PP's now have type

C x D x E x E
 C x D x E x E x A
 C x D x E x E x A

respectively. These are to be interpreted as follows: C are the connections; D the discourse situations; E the resource coes and the second E the coes which forms the subject matter of the main sentence. We require an additional NP-rule:

- (i) If α is an NP then (α^R) is an NP.
- (ii) c,d[(α^R)]_{e^R,e} <=> c,d[α]_{e^R,e^R}

In other words, for a referential reading the NP utilizes the resource coe. For the referential reading of PP's we introduce:

- (i) If π is a PP then (π^R) is a PP.
- (ii) c,d[(π^R)]_{e^R,e} <=> c,d[π]_{e^R,e^R}.

All the other NP's, PP's and sentences have this additional component but otherwise remain unchanged (see appendix for details).

More details concerning the subject of resource situations (coes) can be found in [6].

2.7 Attitudes and Embedded Sentences In this section we introduce the attitudes. We shall not say anything about the lexical meaning of the various attitudes but refer the reader to [5] for a detailed discussion. Here we shall concentrate on the problems posed by embedded sentences. This section is based on the account given in [6].

We add the following rule to our syntax

(PPD) (i) If \emptyset is an S and θ an AV (attitude verb) then $(\theta\emptyset)$ is a PP where AV = {said that, believes that, thinks that}

Before we provide the semantic rule we need to look carefully at the possible readings of sentences involving embedded sentences. Consider

(11) Hob said that a witch has blighted Bob's mare.

Apart from the possibility of loading the indefinite description some witch from the resource coe there are now further alternatives. In uttering (11) the speaker is building up a coe with Hob in it. He might mean that the indefinite description is to designate some member of a group of witches. This would be true if, for example, Hob had pointed to a group of witches (or, if you insist, women taken by Hob to be witches) and said: "One of you blighted Bob's mare." On the other hand, Hob might have uttered: "A witch has blighted Bob's mare." We now interpret the indefinite description a witch from the coe of the embedded sentence. On this interpretation the speaker is not committed to the existence of witches. Can we get both these interpretations? In particular, can we get the first one? Tentatively, we put forward the following semantic rule for our new PP's:

$$c, d[(\theta\emptyset)]e^R, e, a \Leftrightarrow c, d[\theta]e^R, e, a, P$$

where $P = \{e': c, d[\emptyset]e^R, e'\}$

Attitudes are thus understood to express a relation between persons and propositions. But as it stands this rule will not give us the first reading. For the first reading of our chosen sentence we want the indefinite description of a witch to be loaded by the coe of the whole sentence -- namely e. But this is not possible since e is not accessible anymore. To get the above reading we need to pass the coe e, along with e' and e^R, to the embedded sentence \emptyset . To facilitate, this Barwise and Perry "stack" the coes as they are encountered. Sentence now have semantic type

C x D x M x E

University of Massachusetts Occasional Papers in Linguistics, Vol. 9 [1983], Art. 8
 where $m \in M = E^*$. These components are: the connections; discourse situation; the resource stack and the coe which forms the subject matter of the main sentence.

We need to replace the PP and NP rules introduced in the last section by the following two rules:

- (NPF) (i) If α is an NP, then (α^i) ($i > 0$) is an NP.
 (ii) $c, d[(\alpha^i)]_m, e, a \leftrightarrow c, d[\alpha]_m, m^+i, a$
 where m^+i is the i^{th} member (from the top) of the resource stack m .
- (PPE) (i) If π is a PP, then (π^i) ($i > 0$) is a PP.
 (ii) $c, d[(\pi^i)]_m, e, a \leftrightarrow c, d[\pi]_m, m^+i, a$.

With these rules understood we can state our PP-rule involving the attitudes.

- (PPD) (ii) $c, d[(\theta\theta)]_m, e, a \leftrightarrow c, d[\theta]_m, e, a, P$ where $P = \{e': c, d[\theta]_m^*e, e'\}$
 where m^*e is the stack formed from m by adding e to the top.

3. HOB, NOB, BOB AND COB

We now have all the semantic apparatus necessary to give our analysis of Geach's rebellious sentence. We represent the sentence in SIT by the following expression:

$$\emptyset = \begin{cases} \text{Hob thinks that } ((\text{a witch}_u)_1)(\text{-has blighted}_v \text{ Bob's mare}) \\ \text{and} \\ \text{Nob believes that } x_1 (\text{- has killed}_w \text{ Cob's sow}) \end{cases}$$

The description a witch_u is to form part of the subject matter of the embedded sentence "a witch has blighted Bob's mare"; it is not to be loaded by the coe which forms the subject matter of \emptyset . The latter would commit the reporter to the existence of witches and this is not implied by Geach's intended reading.

To investigate the consequences of the above representation we must work out the semantics of this sentence in some detail. By (SB), $d, c[\emptyset]_e^R, e$ reduces to²

$$\begin{aligned} & (\exists c' \supseteq c) [d, c' [\text{Hob}(\text{-thinks that } ((\text{a witch}_u)_1)(\text{-has blighted}_1 \\ & \quad \text{Bob's mare}))]_e^R, e \\ & \quad \text{and} \\ & \quad d, c' [\text{Nob}(\text{-believes that } x_1 (\text{-has killed}_w \text{ Cob's} \\ & \quad \text{sow}))]_e^R, e \\ &] . \end{aligned}$$

By NPA and PPD this is equivalent to

$$\begin{aligned}
 (\exists c' \supseteq c) [& \exists a_1 \in A(d, c' \llbracket \text{Hob} \rrbracket e^R, e, a_1 \text{ and } d, c' \llbracket \text{thinks that} \rrbracket e^R, e, a_1, P \\
 & \text{where } P = \{e': d, c' \llbracket ((a \text{ witch}_u)_1) \rrbracket (-\text{has blighted}_v \\
 & \text{Bob's mare}) \rrbracket e^{R*e}, e'\}) \\
 & \text{and} \\
 & \exists a_2 \in A(d, c' \llbracket \text{Nob} \rrbracket e^R, e, a_2 \text{ and } d, c' \llbracket \text{believes that} \rrbracket e^R, e, a_2, Q \\
 & \text{where } Q = \{e'': d, c' \llbracket x_1 \rrbracket (-\text{has killed}_w \text{ Cob's} \\
 & \text{sow}) \rrbracket e^{R*e}, e''\}) \\
 &].
 \end{aligned}$$

Now we examine P and Q in more detail. By (SA) these reduce to:

$$\begin{aligned}
 P &= \{e': \exists a \in A \text{ such that } d, c' \llbracket ((a \text{ witch}_u)_1) \rrbracket e^{R*e}, e', a \text{ and} \\
 & \quad d, c' \llbracket (-\text{has blighted}_v \text{ Bob's mare}) \rrbracket e^{R*e}, e', a\} \\
 Q &= \{e'': \exists b \in A \text{ such that } d, c' \llbracket x_1 \rrbracket e^{R*e}, e'', b \text{ and} \\
 & \quad d, c' \llbracket (-\text{has killed}_w \text{ Cob's sow}) \rrbracket e^{R*e}, e'', b\}.
 \end{aligned}$$

By NPC and NPB these are equivalent to:

$$\begin{aligned}
 P &= \{e': \exists a \in A \text{ such that } d, c' \llbracket (a \text{ witch}_u) \rrbracket e^{R*e}, e', a \\
 & \quad (\text{and if } c'(x_1) \text{ is defined it equals } a) \text{ and} \\
 & \quad d, c' \llbracket (-\text{has blighted}_v \text{ Bob's mare}) \rrbracket e^{R*e}, e', a\} \\
 Q &= \{e'': \exists b \in A \text{ such that } c'(x_1) = b \text{ and} \\
 & \quad d, c' \llbracket (-\text{has killed}_w \text{ Cob's sow}) \rrbracket e^{R*e}, e'', b\}.
 \end{aligned}$$

Finally, using NPD, PPa, LRP and RP we obtain:

$$\begin{aligned}
 P &= \{e': \exists a \in A \text{ such that } e'_{c'}(u)(I(\text{witch}), a) = 1 \\
 & \quad (\text{and if } c'(x_1) \text{ is defined it equals } a) \text{ and} \\
 & \quad d, c' \llbracket (-\text{has blighted}_v \text{ Bob's mare}) \rrbracket e^{R*e}, e', a\}
 \end{aligned}$$

Notice that the object b is determined by c' and so is fixed for all $e'' \in Q$. This is intuitively what we want; Nob's beliefs have some single focus. Moreover, since the constraints on c' demand that $a = b$, it is fixed for all $e' \in P$. In other words, Hob and Nob have attitudes directed towards the same individual. This is exactly what Geach's intended reading demands. On the other hand, the individual does not form part of the subject matter of the whole sentence -- there is no demand that an individual exists as part of the $\text{coe } e$. This is how it should be: the reporter is not to be committed to the existence of witches or anything else (except Hob, Nob, Bob, Cob, the sow and the mare).

We can state our solution more informally as follows:

There is an individual *a* who is part of every course of events *e* which forms part of the subject matter of Hob's thoughts and in each such *e*, *a* blighted Bob's mare. There is an individual *b* who is part of every course of events *e'* which forms the subject matter of Nob's beliefs and in each such *e'*, *b* killed Cob's sow. Moreover, *a* = *b*.

Individuals and relations enter into or constitute courses of events and such courses of events can form part of the beliefs and thoughts of individuals. As Barwise and Perry say in [4]:

"Once we move from an actual situation to its type, we realize that the facts might have been otherwise, that there are situation-types that don't fit the actual situation. Indeed these 'unactual' types are involved in our hopes, our fears, our intentions... Most of our mental life and hence the language we use to describe that mental life, involves situation types."

Can we obtain other readings of the Geach sentence -- those that Geach did not intend? Suppose the reporter is more enlightened and actually believes in the existence of witches. Suppose Hob points to a group of women (believed by the reporter, Hob and Nob to be witches) and says

One of you blighted Bob's mare.

Nob echoes the sentiment and yells

and you killed Cob's sow.

The witch would then form part of the subject matter of the whole sentence spoken by the reporter. To capture this reading the description a witch_u would have now to be loaded by the coe of the whole sentence. This reading can be obtained from the SIT expression:

$$\psi = \begin{cases} \text{Hob said that } (((a \text{ witch}_u)_1)^1) \text{(-has blighted}_v \text{ Bob's mare)} \\ \text{and} \\ \text{Nob said that } x_1 \text{ (-has killed}_w \text{ Cob's sow.)} \end{cases}$$

The only difference concerns the loading index on the description a witch_u. We assign to the reader the task of computing the coe's described by ψ .

Next suppose, Hob and Nob have been talking about witches (with the reporter present) and have mentioned several by name: Joyce, Janet, June and Janice. The reporter is skeptical about the existence of witches but believes that these women are the cause of Hob and Nob's mania. In this case the reading we want is given by:

$$\eta = \left\{ \begin{array}{l} \text{Hob}(((\text{an individual})_1)^1)(-\text{thinks that } x_1((-\text{is a witch}_u) \wedge \\ (-\text{blighted}_v \text{ Bob's mare})) \text{ and} \\ \text{Nob believes that } x_1 \text{ killed}_w \text{ Cob's sow.} \end{array} \right.$$

Here we have the "quantifying in" rule because we want the NP an individual to be loaded by the resource coe which has Joyce, Janet, June and Janice as its constituents.

4. INTENTIONAL IDENTITY AND POSSIBLE WORLDS

The most detailed analysis of the Geach sentence to date occurs in the writings of Saarinen. It will be instructive to compare the analysis offered here with the solution of Saarinen. Saarinen's account utilizes both possible-worlds and game-theoretic semantics. We shall not say anything about game-theoretic semantics; our main concern is to compare and contrast situation and possible world semantics with respect to the problem of intentional identity.

In order to provide an analysis of Geach's sentence Saarinen appeals to a distinction (due to Hintikka) between two different ways of identifying individuals across possible worlds. According to Hintikka, we cross-identify individuals between possible worlds in two essentially different ways. Hintikka has called these two ways of trans-world identification the physical and the perspectival methods. The purpose of the descriptive or the physical method of individuation is to pin down, from the different possible worlds we are considering, the same concrete physical individual. According to the perspectival or contextual individuation method, we cross-identify an individual by the role that individual plays in the attitudes of the agent. These two methods of identification induce two distinct methods of quantification. The first is based on the physical method, of individuation and commits one to the actual existence of individuals. The second has a different function: it is a device to state that in all the various possible worlds we may have to consider, we are to consider the same individual.

To complete his analysis Saarinen has to face one further problem. On the intended reading of the Geach sentence, the focus of the two attitudes (one of Hob's and one of Nob's) must be the same. But how can this be; how could two perspectivally cross-identified individuals be one and the same? On the face of it, it seems that the perspectival cross-identification method cannot be used to admit comparisons between worlds introduced by the attitudes of two different persons. Saarinen "solves" this problem by appeal to the authority of Hintikka. Apparently, we can cross-identify two perspectivally identified individuals provided that there is some causal relation between the two. Hob's thoughts and Nob's beliefs are part of the vocabulary of the actual world and therefore, Hob's thoughts and Nob's beliefs may interact with the course of the actual world in various ways. This is part of what is involved in the stipulation causal connection.

With all this accepted and understood, we can state Saarinen's solution:

There is a perspectively cross-identified individual *a* in Hob's think-alternatives such that in each of those worlds she is a witch and she has blighted Bob's mare. There is a perspectively cross-identified individual *b* in Nob's belief-alternatives such that in each of those worlds she is a witch and she killed Cob's sow. Moreover, *a* bears an appropriate causal relation to *b*.

This summary of Saarinen's solution does not do justice to the subtlety and length of Saarinen's exposition, but we hope that we have said enough for the reader to grasp the essence of the possible world approach.

Saarinen's solution seems to provide the intended reading but it seems committed to several recalcitrant and controversial notions. As Hintikka and Saarinen admit, the two ways of trans-world identification become very problematic as soon as one attempts anything like a detailed analysis. Moreover, the concept of a "causal connection" between two perspectively identified individuals is far from being a clear one.

Nevertheless, I believe that there are certain correct intuitions driving the Saarinen analysis. Certainly the notion of the role played by an individual in our thoughts and beliefs has something to recommend it. The individual (witch) in Geach's sentence is identified, by the reporter at least, according to the role it plays in the thoughts and beliefs of Hob and Nob. Unfortunately, the framework of possible worlds seems to be a hindrance to the task of giving a clear analysis of this notion. On the account given by situation semantics, the individual in question enters into the course of events which constitute the propositions believed by Hob and Nob. In these courses of events, the individual has certain properties and stands in certain relations to other individuals. These properties and relations are precisely what define the role of the individual in the thoughts and beliefs of Hob and Nob.

FOOTNOTES

¹This rule apparently causes some problems. Sentences of the form "John walks and she talks" get the interpretation: John walks and someone talks. One way out is to ban sentence conjunctions from SIT which have pronouns in the second conjunct with no antecedent in the first or some prior conjunct -- unless they are a variable of "quantifying in." The other way out is to deny that it gives the wrong reading.

²We have assumed the resource stack has a single member e^R .

APPENDIX

SYNTAX AND SEMANTICS OF SIT

(i) SyntaxBasic Symbols

- (a) n-ary relation symbols r, s, \dots
- (b) a gap -
- (c) Thing variables $X = \{x_1, x_2, \dots\}$
- (d) Names $N = \{n_1, n_2, \dots\}$
- (e) Location variables $U = \{u_1, u_2, \dots\}$
- (f) Logical operators \wedge, \vee
- (g) Singular determiners a, the
- (h) Attitude verbs AV = {believes that, thinks that, said that}

Sentence Rules (S-Rules)

- SA If α is an NP and π is a PP then $[\alpha\pi]$ is an S
- SB If θ_1 and θ_2 are in S then $[\theta_1 \wedge \theta_2]$ and $[\theta_1 \vee \theta_2]$ are in S.

Noun Phrase Rules (NP-Rules)

- NPA If α is a name, α is an NP
- NPB If x is a thing variable, x is an NP
- NPC If α is an NP then (α_i) is an NP; α_i is the antecedent of x_i
- NPD If ν is a determiner and π a PP then $(\nu\pi)$ is an NP
- NPE I is an NP
- NPF If α is an NP then (α^i) is an NP for $i > 0$.

Property Phrase Rules (PP-Rules)

- RP-Rule If r is an n-ary basic relation symbol, then r and $\sim r$ are n-ary relation phrases
- LRP-Rule If γ is an RP and u a location variable then γ_u is an n-ary located relation phrase.
- PPA If γ is an n-ary LRP and t_1, \dots, t_n are thing terms with gap t_j then $t_1 \gamma t_2, \dots, t_n$ is a PP (if t_j a free variable it is free in the resulting PP)
- PPB If π_1 and π_2 are PP's then $(\pi_1 \wedge \pi_2)$ is a PP.
- PPC If (α_i) is an NP and π is a PP (with x_i free), then $(\alpha_i \pi)$ is a PP (with x_i bound)
- PPD If $\theta \in AV$ and \emptyset is an S, then, $(\theta\emptyset)$ is a PP.
- PPE If π is a PP then, (π^i) is a PP for $i > 0$.

(ii) Semantic Domains

Basic Domains

- (a) $a \in A$ -individuals
- (b) $r \in R = R_0 \cup R_1 \cup R_2 \dots$ -relations
- (c) $l \in L$ -locations

Situations

- (a) $s \in S = L \times T$ -situations
- (b) $t \in T = \sum_{n \geq 0} R_n \times A^n + \{0,1\}$ -situation types
- (c) $e \in E = L \rightarrow T$ -courses of events
- (d) $m \in M = K^*$ -stacks of coes
- (e) $d \in D \subseteq S$ -discourse situations
- (f) $c \in C = x \cup U \rightarrow A \cup L(c(x) \in A; c(u) \in L)$ -connections

Semantic Types

- (a) $D \times C \times M \times E$ -sentences
- (b) $D \times C \times M \times E \times A$ -noun phrases
- (c) $D \times C \times M \times E \times A$ -property phrases
- (d) $D \times C \times M \times E \times P(E) \times A$ -attitude verbs
- (e) $D \times C \times M \times E \times L \times A^n$ -n-ary relation phrases
- (f) $D \times C \times M \times E \times A^n$ -n-ary located relation phrases

Interpretation Function

I assign to names elements of A and to n-ary relation symbols elements of R_n .

(iii) Semantic Clauses

S-Rules

- (a) $d, c[[\alpha]]_m, e \leftrightarrow (\exists e \in A)[d, c[[\alpha]]_m, e, a \ \& \ d, c[[\pi]]_m, e, a]$
- (b) $d, c[[\theta_1 \wedge \theta_2]]_m, e \leftrightarrow (\exists c' \supseteq c)[d, c'[[\theta_1]]_m, e \ \& \ d, c'[[\theta_2]]_m, e]$
 $d, c[[\theta_1 \vee \theta_2]]_m, e \leftrightarrow (\exists c' \supseteq c)[d, c'[[\theta_1]]_m, e \ \text{or} \ d, c'[[\theta_2]]_m, e]$

NP-Rules

- NPA $d, c[[n]]_m, e, a \leftrightarrow I(n) = a$
- NPB $d, c[[x]]_m, e, a \leftrightarrow c(x) = a$
- NPC $d, c[[\alpha_i]]_m, e, a \leftrightarrow d, c[[\alpha]]_m, e, a$ and if $c(x_i)$ is defined, $c(x_i) = a$
- NPD $d, c[[\text{the}\pi]]_m, e, a \leftrightarrow a$ is the unique x such that $d, c[[\pi]]_m, e, x$
- NPE $d, c[[\text{a}\pi]]_m, e, a \leftrightarrow a$ is some x such that $d, c[[\pi]]_m, e, x$
- NPF $d, c[[\alpha^i]]_m, e, a \leftrightarrow d, c[[\alpha]]_m, m^i, a$ where m^i is the i^{th} member of m .

PP-Rules

- RP $d, c[r]m, e, l, a \Leftrightarrow e_1(I(r), a) = 1$
 $d, c[\sim r]m, e, l, a \Leftrightarrow e_1(I(r), a) = 0$
- LRP $d, c[\gamma_u]m, e, a \Leftrightarrow d, c[\gamma]m, e, c(u), a$
- PPA $d, c[t_1 \gamma t_2 \dots t_n]m, e, a \Leftrightarrow d, c[\gamma]m, e, a$ where $a_j = a$ and for $i \neq j$,
 $d, c[t_i]m, e, a_i$
- PPB $d, c[(\pi_1 \wedge \pi_2)]m, e, a \Leftrightarrow (\exists c' \supseteq c)(d, c'[\pi_1]m, e, a \& d, c'[\pi_2]m, e, a)$
- PPC $d, c[(\alpha; \pi)]m, e, a \Leftrightarrow (\exists b)(d, c'[\alpha]m, e, a \& d, c[(a; \pi)]m, e, b$ where
 $c' = c + \langle \alpha_i, b \rangle$ and
 $c + \langle \alpha_i, b \rangle = c \cup \langle \alpha_i, b \rangle$ if the latter defined as a function.
- PPD $d, c[(\theta)]m, e, a \Leftrightarrow d, c[\theta]m, e, P, a$ where $P = \{e' : d, c[\theta]m^*e, e'\}$
 and m^*e is the stack created from m by adding e to the top.
- PFE $d, c[(\pi^i)]m, e, a \Leftrightarrow d, c[\pi]m, m+i, a.$

REFERENCES

Situation Semantics

1. Barwise, Jon (1981), "Scenes and Other Situations," Journal of Philosophy, vol. 78, no.7 (July), pp. 369-397.
2. _____ (ms), "Computational aspects of situation semantics".
3. _____ & John Perry (1980), "The Situation Underground," in Jon Barwise and Ivan Sag, eds., Stanford Working Papers in Semantics, Stanford.
4. _____ (1981a), "Semantic Innocence and Uncompromising Situations," in Midwest Studies in Philosophy VI, pp. 387-403
5. _____ (1981b), "Situations and Attitudes," Journal of Philosophy, vol. 78, no. 11 (November), pp. 668-691.
6. _____ (ms, no date), "Chapter III: Evaluation and Definite Descriptions" from an early draft of Situation Semantics, a book now to be split into two books; the chapter will not occur in this form in either one.
7. _____ (ms notes, 1982), "ALIAS: An Artificial Language to Illustrate Situation Semantics," Stanford. (Handout and notes for their seminar)
8. Perry, John (ms 1981), "Perception, Action, and the Structure of Believing," to appear in a Festschrift for Paul Grice edited by Richard Grandy and Richard Warner.

Intentional Identity

9. Cohen, L. Jonathan (1968), "Geach's Problem About Intentional Identity," Journal of Philosophy 65.
10. Dennett, D. C. (1968), "Geach on Intentional Identity," Journal of Philosophy 65.
11. Geach, Peter T. (1967), "Intentional Identity," Journal of Philosophy 74.
12. Saarinen, Esa (1977), "Intentional Identity Interpreted," Linguistics & Philosophy.