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# A PRAGMATIC ANALYSIS OF SPECIFICITY

## 0. INTRODUCTION

This paper is mainly concerned with the analysis of some aspects of the specific/non-specific contrast. It also contains some remarks on the *de dicto/ de re* ambiguity in belief contexts. The basic assumption underlying our analysis is that an adequate theory of meaning for a language should consist of (at least) a semantic theory and a pragmatic theory. A semantic theory we consider to be a theory of truth and a pragmatic theory a theory of correctness. One of the grounds for adopting this assumption is that there are aspects of the meaning of certain expressions and constructions which cannot be captured in terms of truth conditions, but which should be described in terms of the conditions under which these expressions and constructions can be used correctly.[1] An important and interesting part of these conditions are those which concern the information of language users. That part of a pragmatic theory which deals with these conditions we call 'epistemic pragmatics'.

In Section 1 we will argue that the specific/non-specific contrast, in contra-distinction to the *de dicto/de re* contrast which is of a semantic nature, is a distinction which should be accounted for in pragmatic terms, more specifically, in epistemic pragmatic terms.

Section 2 is concerned with a sketch of the outlines of a framework in which this view on the matter can be made a little more precise. In this section we develop for two very simple formal languages a framework in which the information of language users about the denotation of the expressions of these languages can be represented. The framework enables us to formulate certain correctness conditions, thus partly formalizing the main Gricean conversational maxims of Quality, Quantity and Relation and allowing for a formal derivation of certain so-called conversational implicatures.

In Section 3 it is shown how within such a theory of epistemic pragmatics a general definition of the specific use of terms can be given.

In Section 4 it is indicated how the framework representing the information of language users developed in Section 2 can also be used to solve a certain semantic problem, viz. the *de dicto/de re* contrast concerning objects of belief.



*F. Heny (ed.), Ambiguities in Intensional Contexts,* 153–190.

## 1. THE SPECIFIC/NON-SPECIFIC CONTRAST

The specific/non-specific contrast has been discussed quite often in the literature, but unfortunately does not always seem to be understood in exactly the same way.[2] The following example is intended to clarify what we mean by it.

(1) A picture is missing from the gallery.

There are two different kinds of circumstances in which this sentence can be used. The first kind of circumstances are those in which a speaker using this sentence with the term *a picture* refers to a specific piece of art, say Botticelli's 'Primavera'. The second kind of circumstances are those in which a speaker using this sentence with the term *a picture* does not refer to any specific picture at all. With Kasher & Gabbay (1976), one can imagine the gallery in question to be fitted with an alarm system which gives a signal in a control room whenever one of the pictures hanging in the gallery is taken from its place. A guard alarmed by such a signal could utter sentence (1) without having any idea about the identity of the picture which is missing. It is the latter kind of use which we call non-specific use, whereas the former kind of use we call specific.

As far as we know, all authors discuss the specific/non-specific contrast only in connection with indefinite terms like *a picture, a Swede, one of John's friends*. However, we think that the contrast in question can be applied to the use of other terms as well. Consider first terms with numerical quantifiers like *one picture, two Swedes* and *three of John's friends*. The two kinds of circumstances distinguished with respect to the use of sentence (1) can just as well be distinguished with respect to the use of the following sentence

(2) Two pictures are missing from the gallery.

The circumstances in which a speaker using (2) with the term *two pictures* refers to two specific pieces of art are obvious. Non-specific use is possible e.g. if every room of the gallery is fitted with its own alarm system, each of which giving distinct signals in the control room. Alarmed by two such signals, the guard could utter (2) using the term *two pictures* non-specifically. The specific/non-specific contrast also plays its role, in our opinion, in connection with sentences containing proper names or definite descriptions. Consider the following sentence

(3) Mary talked to Dr. Johnson.

A speaker could use sentence (3) using the proper name *Dr. Johnson* non-specifically, i.e. without having any idea about who the referent of the name *Dr. Johnson* is. This might occur if the speaker knows that Mary talked to every veterinarian in town and that one of them, but he doesn't know which one, happens to be called *Dr. Johnson*. This non-specific use of proper names is even a necessary requirement for the correct utterance of sentences such as

(4) I wonder which of these men is Dr. Johnson.
(5) I don't know who Dr. Johnson is.

The same holds, mutatis mutandis, for the use of definite descriptions like *the most competent veterinarian in town, the Swede Mary loves*.

Even the use of universally quantified terms, like *every picture, every one of John's friends*, we would argue, is subject to the specific/non-specific contrast. Consider the following sentence.

(6) The appointment committee interviewed every candidate.

If the chairman of the committee utters (6) while reporting the activities of the committee, he uses the term *every candidate* specifically. If someone having heard the chairman's report in which no names or other details of the candidates are given uses (6) later on to inform others who were not present, he uses the term *every candidate* non-specifically.

The various examples just given, in our opinion, give strong support to the claim that the specific/non-specific contrast applies to the use of all terms, definite, indefinite, numerical, singular and plural. However, as we shall see shortly, the factors determining the (non-)specificity of the use of existentially and numerically quantified terms are not precisely the same as those determining the (non-)specificity of the use of universally quantified terms, definite descriptions and proper names. The differences in question are related to differences in the semantics of these two distinct groups of terms. Before turning to an intuitive characterization of the various factors determining (non-)specificity, we must first take a stand on what is the main controversy over the specific/non-specific dichotomy, viz. whether it constitutes a semantic or a pragmatic distinction.

If one maintains that it is a semantic distinction, then one is committed to the view that a sentence like (7)

(7) John talked to a Swede.

is ambiguous, i.e. that it has two distinct readings represented by two different logical forms which have different truth conditions. If, on the other hand, one maintains that it is a pragmatic distinction there is no need to regard (7) as ambiguous, i.e. one can associate with (7) just one set of truth conditions and explain the distinction along the lines sketched above, in terms of the different kinds of circumstances under which (7) can be used correctly.

In Kasher & Gabbay (1976) the position is taken that the specific/non-specific contrast constitutes a semantic distinction. According to Kasher and Gabbay, sentence (7) is true on its specific reading if and only if John talked to some Swede whom the speaker can 'canonically identify'. By 'canonical identification' they mean identification by means of a proper name or a suitable definite description. On its non-specific reading, sentence (7) would be true if and only if there is some Swede whom John talked to.

In our opinion this interpretation of the specific/non-specific contrast cannot be maintained. We agree wholeheartedly with Klein when he says:

> This line of reasoning is, in my opinion, patently incorrect. However strongly a person who uttered (3.17) [our (7) G & S] conveyed that he was capable of identifying a particular Swede to whom John talked, I do not agree that he could be accused of saying something false just because either (a) he could not in fact make a canonically identifying reference to any Swede, or (b) John talked only to Swedes he could not canonically identify. (Klein, 1977, p. 17)

Besides the rather absurd predictions it makes, Kasher and Gabbay's thesis runs into other difficulties as well. Their criterion for canonical identifiability, i.e. identifiability by means of a proper name or definite description, does not guarantee specificity at all. Since, as we argued above, proper names and definite descriptions themselves can also be used non-specifically, the fact that a speaker can provide a proper name or a definite description to denote the Swede he claims John talked to, in no way guarantees that he therefore is aware of the identity of the specific individual John talked to.

Kasher and Gabbay claim that ambiguity tests, such as conjunction reduction, provide evidence for their thesis that sentences such as (7) are ambiguous. In our opinion Klein has convincingly refuted this claim. We will not repeat the respective arguments here, but refer the reader to Kasher & Gabbay (1976), Klein (1977) and (1979).

Contrary to Kasher and Gabbay then, we want to claim that the specific/non-specific contrast is of a pragmatic nature and concerns the different kinds of circumstances under which sentences, and thereby the terms occurring in them, can be used correctly. The contrast applies to sentences containing all kinds of terms, though not always in exactly the same way. We also want to claim that the specific/non-specific contrast is not a pure dichotomy, but rather that specificity comes in degrees. Before turning to a sketch of the outlines of a framework in which these claims can be formulated more precisely, we will try to describe informally the substance of these claims.

First of all, we should indicate what we mean by 'correct use' of a sentence. Roughly speaking, by this we mean use in accordance with the Gricean conversational maxims, or some amended version thereof. So, if a speaker *S* is to use a sentence *A* correctly while addressing a hearer *H*, various conditions should be fulfilled: *S* should be sincere in uttering *A*, *S* should consider his utterance of *A* to be informative for *H*, *S* should consider his utterance of *A* to be relevant to the topic of the conversation between *S* and *H* and *S* should consider *A* to be the strongest sincere, informative and relevant sentence he can utter.

The specific/non-specific contrast is determined by both (aspects of) the meaning of the terms involved and the various correctness conditions. This can perhaps best be illustrated by considering the difference between the two groups of terms distinguished above with respect to the specific/non-specific contrast. Let us group universally quantified terms, definite descriptions and proper names under the heading 'universal terms', and existentially and numerically quantified terms under the heading 'non-universal terms'. The semantic difference between these two kinds of terms is, roughly speaking, the following: a sentence containing a universal term ascribes a property to all the elements of the set associated with the universal term, whereas a sentence containing a non-universal term ascribes a property to a subset of the set associated with the non-universal term. By the set associated with a term we mean the set denoted by the common noun in case we are dealing with a quantified term, i.e. one of the form quantifier plus common noun, and if we are dealing with a proper name the unit set containing the individual it denotes.

An obvious difference between the possible uses of universal and non-universal terms is that for the former, specific use seems most natural, whereas for the latter the non-specific use seems most apt. Indeed, one may ask whether a specific use of a non-universal term does not imply incorrectness. For, if a speaker *S* uses a sentence containing a non-universal term in such a way that by the non-universal term in question he refers to a specific individual, wouldn't the correctness conditions require that *S* use a sentence containing a universal term, say a definite description or a proper name, since such a sentence would be stronger? There are at least two reasons why this need not always be the case. First of all, the information available to *S* may be such that although by using the sentence containing the non-universal term *S* refers to a specific individual, *S* simply does not have the means to refer to this individual by means of a definite description or proper name, since none of these expressions is such that the information $S$ has about its denotation allows him to use this expression to pick out this individual. Secondly, it may be the case that although $S$ in fact could sincerely utter a stronger sentence containing a description or proper name instead of the non-universal term, his use of this stronger sentence would not be correct since it would violate the condition requiring $S$ to consider his utterance of the stronger sentence to be informative for the hearer $H$. For it may well be the case that whereas $S$ knows of a description or proper name picking out the specific individual in question, according to $S$ this expression gives less information or wrong information to $H$. An example of such a situation might be one where a speaker $S$ has the information that Botticelli's 'Primavera' is missing from the Uffizi gallery and is addressing a hearer $H$ who according to $S$ has no idea whether Botticelli's 'Primavera' is a painting or a statue or another kind of object of art. If in this situation $S$ wants to inform $H$ of what he knows, it is better for $S$ to use the non-universal term *a picture* than the universal term *Botticelli's 'Primavera'*. In this situation the sentence *a picture is missing from the gallery* is according to $S$ more informative for $H$ than the sentence *Botticelli's 'Primavera' is missing from the gallery*.

One might claim that in all concrete situations both of the reasons just mentioned play a role, since there are always definite descriptions which can be used sincerely by $S$ to refer to the specific individual picked out by his use of a non-universal term, which are nevertheless ruled out by the second reason. Thus, suppose $S$ uses the term *a picture* in the sentence *a picture is missing from the gallery* to refer to a specific piece of art, then, although he may not know of a proper name to denote this piece of art, there are always the descriptions *the picture which is missing* and *the picture I mean* which $S$ can use sincerely. It will be clear that the condition of informativeness prevents the correct use of the corresponding sentences containing these terms.

A further reason legitimizing specific use of a non-universal term in a situation in which a stronger sentence containing a universal term could be used is provided by the relevancy modification of the condition requiring a speaker to utter the strongest possible sentence. In some situations it may simply not be relevant according to the speaker to use a stronger sentence containing a universal term to refer to the specific individual also picked out by his use of the non-universal term. These considerations show that the specific use of non-universal terms can be correct under certain conditions.

As we remarked above, universal terms can be used non-specifically as well as specifically. Non-specific use of a universal term does not imply incorrectness, though one might think so at first sight. The correctness condition most likely thought to be violated in such a case would be the condition requiring a speaker to be sincere in his utterance. The examples given above indicate that non-specific use of universal terms does not necessarily constitute a violation of the sincerity condition. To repeat one of these examples: one can very well say sincerely *the appointment committee interviewed every candidate* without being (fully) informed about who the candidates were.

The semantic difference between universal and non-universal terms is responsible for the intuitive link between universal terms and specific use and between non-universal terms and non-specific use. It is also responsible for the differences between the circumstances in which a non-universal term can be used specifically and those in which universal terms can be so used. If a non-universal term such as *a picture* is to be used specifically and correctly in a given situation, then this situation has to meet certain special conditions, partly due to the non-universality of the term in question. For it is due to the meaning of the term *a picture* that the sentence *Botticelli's 'Primavera' is missing from the gallery* is stronger than the sentence *a picture is missing from the gallery*. With universal terms the semantic facts are different, and so are consequently the conditions under which specific use is possible, as we have seen.

The semantic difference between universal and non-universal terms also seems to play a role in a second difference between these two groups of terms with respect to the specific/non-specific contrast. This difference is the following. If a universal term is used specifically by a speaker *S*, it is solely the information of *S* about the set associated with the universal term which identifies the individual, or set of individuals, which is specifically referred to. However, in case a non-universal term is used specifically, it may be that it is not just the information *S* has about the set associated with the non-universal term that plays a role in this identification. In some situations information of *S* about the denotation of other expressions in the sentence may be involved too.

Let us illustrate this by the following example. Suppose *S* is not fully informed about the collection of pictures which the gallery owns. In fact, *S* just has the information that Botticelli's 'Primavera' is one of them. Suppose further that *S* is fully informed about the objects of art missing from the gallery (perhaps because he has pulled the job himself): he knows that only Botticelli's 'Primavera' is taken away. In such a situation it would be correct for *S* (other things being equal) to utter the sentence *a picture is* *missing from the gallery*. Moreover, this would be an instance of specific reference (to Botticelli's 'Primavera') by means of the term *a picture*, all this despite the fact that *S* is not fully informed about the set associated with the term *a picture*. It is the particular information *S* has about the denotation of the other expressions in the sentence, i.e. about the set denoted by the predicate *be missing from the gallery*, in combination with his information about the set associated with *a picture* which identifies Botticelli's 'Primavera' as the individual which is correctly and specifically referred to by *S* using the sentence *a picture is missing from the gallery* in this situation.

This is not the only kind of situation in which specific reference is partly determined by information the speaker has about the denotation of expressions other than the non-universal term in question. That specific reference of non-universal terms very often depends on information about the denotation of other expressions is of course due to the meaning of those terms. This becomes obvious when one tries to construct similar situations involving universal terms. Because of the fact that the use of a universal term involves considering all the elements of the set determined by the universal term, specific reference by means of a universal term is possible only if the speaker has the information which set is determined by the universal term. If a speaker is not fully informed about which set is determined by the universal term, he can still use the term correctly in a predication, since his information about the denotation of the predicate expression may be such that no matter what the set determined by the universal term is, it is, according to his information always a subset of the set determined by the predicate expression.

Notice that if the speaker's information about the denotation of the predicate expression were to help to make the reference of the universal term specific this would imply that the utterance as a whole was insincere. For his information about the denotation of the predicate expression could 'decide' between the various sets which according to his information may be the ones associated with the universal term only if the predicate expression, according to his information, denotes a set which contains only one of these sets as a subset. But in such a situation *S* can never be sure that all individuals in the set associated with the universal term belong to the set denoted by the predicate expression, which the sincerity condition requires by virtue of the meaning of the universal term.

From this informal discussion of the nature of the specific/non-specific contrast and the way it applies to the use of various kinds of terms, we can conclude that it constitutes essentially a pragmatic distinction, one that distinguishes between different kinds of situations in which sentences containing a certain term can be used. Generally speaking, what determines whether a language user uses a certain term occurring in a certain sentence specifically or non-specifically is the information he has about the denotation of the descriptive expressions occurring in the sentence he is using, and, of course, the meaning of the logical expressions occurring in it. Further, the role that specific and non-specific use of terms plays in conversation should be explained in terms of the particular conditions under which such use is correct. A general informal characterization of what the specific use of a term is might be the following. A language user $x$ is said to use the term $\alpha$ in the sentence $\phi$ to refer specifically to the individual $z$ (or to the set $Z$) if and only if the individual $z$ (or the set $Z$) is what according to $x$ his assertion of $\phi$ in that situation is about. This characterization is admittedly vague and loosely formulated, but it covers the examples we have discussed and may serve as a guideline for a more formal definition.

In order to be able to give such a formal definition and to explain the interaction of the specific/non-specific contrast with correctness conditions, we need a framework in which the information of language users about the denotation of expressions and about each other's information can be adequately represented. A sketch of the outlines of such a framework will be given in the next section, along with a formalization of parts of the Gricean maxims.

## 2. EPISTEMIC PRAGMATICS

As we stipulated above, epistemic pragmatics is that part of pragmatic theory which deals with the conditions for the correct use of language which concern the information of language users. In order to formulate such conditions, we need a framework in which this information can be represented adequately. From the discussion in the previous section it will be clear that the information of a language user not only concerns the denotation of expressions, but also the information of other language users (again, both about the denotation of expressions and about the information of other language users, and so on). For the usual reasons, the representation of information should obey the compositionality principle, i.e. it should meet the requirement that the information of a language user about the denotation of a complex expression is a function of his information about the denotation of its parts.

In Section 2.1 we define a framework meeting these requirements for a propositional language. In 2.2 we will show how part of the Gricean conversational maxims can be reformulated as correctness conditions using the framework developed in 2.1. In 2.3 we will extend the framework to a language containing individual constants, predicates and quantifiers. This framework will be used in Section 3 to give an epistemic pragmatic treatment of the specific/non-specific contrast.

## 2.1. *Propositions and connectives*

The propositional language used here is built up in the usual way from a set of propositional variables $p$, $q$, $p_0$, $p_1$, . . . and the connectives $\neg$, &, $\vee$, and $\rightarrow$. The core of the framework is a definition of the notion of an 'epistemic model'. One of the purposes of defining epistemic models is to evaluate formulas of the language with respect to the information of a language user. Therefore, an epistemic model EM will contain, as one of its components, a non-empty set of language users. The values which can be assigned by the valuation function of a model to pairs consisting of a formula and a language user, represent the possible situations with respect to the information a language user may have about the denotation, i.e. the truth value of a formula. It is important to notice that the phrase 'information about the truth value of a formula' is used without any factual implications. I.e. the phrase is used in such a way that a language user can be said to have the information that a formula $\phi$ is the case even in a situation in which $\phi$ in fact is false. One can distinguish three possible situations with respect to the information a language user $x$ may have about the truth value of a formula $\phi$:

> $x$ has the information that $\phi$ is true;
> $x$ has the information that $\phi$ is false;
> $x$ has no more information than that either $\phi$ is true or $\phi$ is false: i.e. $x$ has no opinion about $\phi$

These three situations are represented by the epistemic values $\{1\}$, $\{0\}$, $\{0, 1\}$, respectively, where 1 and 0 represent the truth values 'true' and 'false'. As remarked above, we should also be able to talk about the information a language user $x$ has about the information a language user $y$ has about a formula $\phi$, or, generally, about the information $x_1$ has about . . . the information $x_n$ has about $\phi$. Therefore, the valuation function assigns epistemic values to pairs of formulas and $n$-tuples of language users. Some examples of possible situations and the values representing them, are:

> $x$ has the information that $y$ has the information that $\phi$ is true: $\{\{1\}\}$;
> $x$ has the information that $y$ has no opinion about $\phi$: $\{\{0, 1\}\}$;

$x$ has no more information than that either $y$ has the information that $\phi$ is true, or $y$ has the information that $\phi$ is false, or $y$ has no opinion about $\phi$, i.e. $x$ has no opinion about what information $y$ has about $\phi$: $\{\{1\}, \{0\}, \{0, 1\}\}$;
$x$ has the information that $y$ has the information that it is not the case that $z$ has no opinion about $\phi$: $\{\{\{0\}, \{1\}\}\}$.

The general picture is as follows: starting from $S_0$, the set of truth values $\{0, 1\}$, we build $S_1$, $\{\{0\}, \{0, 1\}, \{1\}\}$, the set of epistemic values that can be assigned to an ordered pair consisting of a formula and one language user, as follows:

$S_1 =_{df} \text{POW}(S_0)\backslash\{\emptyset\}$, where POW is the powerset operation and $\emptyset$ is the empty set

From $S_1$ we build $S_2$, the set of epistemic values that can be assigned to a pair consisting of a formula and a sequence of two language users, in the same way. In general:

$$S_n =_{df} \text{POW}(S_{n-1})\backslash\{\emptyset\}, \text{ for all } n > 0$$

We can now define an epistemic model EM as a triple $\langle I, \{0, 1\}, V\rangle$, in which $I$ is a non-empty set of language users, $\{0, 1\}$ is the set of truth values and $V$ is a valuation function taking ordered pairs consisting of a formula and an $n$-tuple of language users into $S_n$. The clause for atomic formulas and the ones for negation and conjunction of the recursive definition of $V$ are:

(1) $V(p, i^n) \in S_n$, for every ordered $n$-tuple $i^n$ of elements of $I$, $n \geqslant 0$

(2) $V(\neg\phi, i^n) = \text{NEG}[V(\phi, i^n)]$, where NEG is defined as follows:
$\text{NEG}[1] = 0; \text{NEG}[0] = 1; \text{NEG}[X] = \{\text{NEG}[x] \mid x \in X\}$, for $X \neq 1, 0$

(3) $V(\phi \,\&\, \psi, i^n) = \text{CONJ}[V(\phi, i^n), V(\psi, i^n)]$, where CONJ is defined as follows:
$\text{CONJ}[1, 1] = 1; \text{CONJ}[0, 1] = \text{CONJ}[1, 0] = \text{CONJ}[0, 0] = 0$;
$\text{CONJ}[X, Y] = \{\text{CONJ}[x, y] \mid x \in X \,\&\, y \in Y\}$, for $X, Y \neq 1, 0$

The clauses for the other connectives run parallel to that of conjunction. Since the other connectives can be defined in terms of negation and conjunction in the usual way, we have omitted their clauses.

This framework obeys the compositionality principle mentioned above. For example, if $V(p, x) = \{0, 1\}$ and $V(q, x) = \{1\}$, then the definitions imply that $V(\neg p \,\&\, q, x) = \{0, 1\}$. I.e. if a language user $x$ has no opinion about $p$ and has the information that $q$ is true, then $x$ has no opinion about $\neg p \,\&\, q$.

The definitions can be illustrated by working out this example in detail:

$$V(\neg p \,\&\, q, x) = \text{CONJ}[V(\neg p, x), V(q, x)] =$$
$$\text{CONJ}[\text{NEG}[V(p, x)], V(q, x)] = \text{CONJ}[\text{NEG}[\{0, 1\}], \{1\}] =$$
$$\text{CONJ}[\{\text{NEG}[0], \text{NEG}[1]\}, \{1\}] = \text{CONJ}[\{0, 1\}, \{1\}] =$$
$$\{\text{CONJ}[0, 1], \text{CONJ}[1, 1]\} = \{0, 1\}$$

It should be noted that the framework developed here 'contains' the classical semantics of two-valued propositional logic, in this sense, that the values assigned to pairs consisting of a formula and the empty sequence of language users, are as in classical propositional logic. Notice that the standard semantics is 'reflected' so to speak in the information of the language users. They are aware that the semantics of the language they are using is the standard semantics and are aware of each other's awareness of this fact, and so on. The framework as it is sketched here gives the basic tools for the representation of information of language users, but it needs to be (and has been [3]) enriched in such a way that in addition information of language users about logical and non-logical dependencies between formulas can be incorporated. Incorporation of information about dependences between formulas is needed, for example to give a more satisfactory treatment of disjunctions. In the framework sketched here, a language user can only have the information that a disjunction is true if he has of (at least) one of the disjuncts the information that it is true. We will not incorporate information about dependencies between formulas in this paper, because it is not strictly necessary for the treatment of the problems we want to discuss here.

### 2.2. *Correctness conditions*

Using the framework developed in the previous section, we can formulate certain conditions which taken together provide a partial characterization of the notion of a correct utterance. The latter notion can be informally described as follows.

An utterance of a formula $\phi$ by a speaker $x$ addressing a hearer $y$, given a topic of conversation $\tau$, in a situation, is correct if and only if

(a) $x$ has the information that $\phi$ is true;

(b) according to $x$, $\phi$ does not contain information that $y$ already has;

(c) according to $x$, $\phi$ is relevant to the topic $\tau$;

(d) for all $\psi$ such that $\psi$ implies $\phi$ and not vice versa, it holds either that

(i) it is not the case that $x$ has the information that $\psi$ is true, or
(ii) it is not the case that according to $x$, $\psi$ does not contain information $y$ already has, or
(iii) it is not the case that according to $x$, $\psi$ is relevant to the topic $\tau$

Grice's maxim of quality is meant to be covered by (a). His maxim of quantity is divided into two submaxims. The second submaxim, which requires a speaker not to be overinformative, is meant to be covered by (b), and the first submaxim which requires a speaker not to be underinformative, by (d). The maxim of relevance is of course to be found under (c). Notice that the maxim of manner is left out of consideration here.

The conditions (a)–(d) can be, sometimes only partly, formulated within the framework developed in the previous section. Condition (a) presents no problems, we call it the *sincerity condition*, and define it as follows.

> $S(\phi, x, \text{EM})$, $x$ is sincere in uttering $\phi$ in the situation described by the epistemic model EM, if and only if $V_{\text{EM}}(\phi, x) = \{1\}$

Condition (b) is divided into two subconditions. The first one we call the *informativeness condition* and it is defined as follows.

> $I(\phi, x, y, \text{EM})$, according to $x$, $\phi$ is informative for $y$ in EM, if and only if $V_{\text{EM}}(\phi, xy) \neq \{\{1\}\}$

This condition requires that it is not the case that according to $x$, $y$ already has the information that $\phi$ is true. More stringent versions of this condition can be formulated giving slightly different results. However, the differences in question need not concern us here.

The second subcondition is called the *maximal informativeness condition* and is defined as follows.

> $\text{MI}(\phi, x, y, \text{EM})$, according to $x$, $\phi$ is maximally informative for $y$ in EM, if and only if $\forall\psi\,[\phi \models \psi \;\&\; \psi \not\models \phi \Rightarrow [I(\psi, x, y, \text{EM}) \vee$ $\vee\, [\exists\chi\colon \chi \models \psi \;\&\; \psi \not\models \chi \;\&\; \sim I(\chi, x, y, \text{EM}) \;\&\; \forall\text{EM}'[[I(\phi, x, y, \text{EM}')$ $\&\; I(\chi, x, y, \text{EM}')] \Rightarrow I(\psi, x, y, \text{EM}')]]]]$

This condition requires in order for $\phi$ to be maximally informative, that every formula $\psi$ implied by $\phi$ is informative. This condition needs to be stated beside the informativeness condition since the latter implies that the conjunction of an informative formula with any noninformative formula will still be informative. Such formulas, however, should be ruled out for obvious reasons. The second disjunct of the consequence in the definition of MI is needed to take care of 'irrelevant' implications of $\phi$. Such irrelevant implications, for example tautologies, are allowed to be uninformative.

Condition (c) presents more problems than can be mentioned here. One of the problems is that relevance is, as (c) correctly formulates, a subjective notion. Whether one formula is considered to be relevant to another will in the great majority of cases not be determined by whether a certain logical relation exists between the two, but by whether certain factual (i.e. non-logical) dependencies are considered to exist by a language user. As we remarked in the previous section, the framework developed so far is not intended to account for information of language users about such dependencies. Some, though admittedly little, content can be given to the notion of relevance at present, since certain logical elements are involved anyway in our opinion.

Here we represent a topic of conversation by a formula. Intuitively this is to be interpreted as expressing that the topic of conversation is the question what the truth value of that formula is.

Part of the *relevance condition* (c) can now be defined as follows.

> $R(\phi, \tau, \text{EM})$, $\phi$ is relevant to the topic $\tau$ in EM if and only if $[[\tau \models \phi \vee \neg\tau \models \phi] \ \& \sim [\tau \models \phi \ \& \neg\tau \models \phi]]$

This very restricted notion of relevance claims that what is relevant for a given topic is what is implied by it or by its negation, excluding tautologies. So, according to this definition both $p$ and $q$ would be relevant for the topic $p \& q$, but $p \& q \& r$ would not. Likewise $p \vee q$ would be relevant for $p$, but not vice versa. The rationale behind this is that if the topic is whether a certain formula is true or not, the information *why* it is true/false is not strictly relevant for that topic.

The last condition mentioned above, condition (d), concerning the requirement that speakers should not be underinformative can now be formulated using the notions just defined. We call it the *strongest utterance condition* and define it as follows.

> $ST(\phi, x, y, \tau, \text{EM})$, $\phi$ is the strongest sincere, informative, maximal informative and relevant utterance $x$ can make on the topic $\tau$ addressing $y$ in EM if and only if $\forall\psi[\psi \models \phi \ \& \ \phi \not\models \psi \Rightarrow [\sim S(\psi, x, \text{EM}) \vee \sim I(\psi, x, y, \text{EM}) \vee \sim MI(\psi, x, y, \text{EM}) \vee \sim R(\psi, x, y, \tau, \text{EM})]]$

This condition will need no further comments.

The notion of *correctness* informally described above, can now be defined as follows:

> $C(\phi, x, y, \tau, \text{EM})$, $x$ is correct in uttering $\phi$ addressing $y$, given the topic $\tau$, in the situation described by the epistemic model EM if and only if $[S(\phi, x, \text{EM})$ & $I(\phi, x, y, \text{EM})$ & $MI(\phi, x, y, \text{EM})$ & $R(\phi, \tau, \text{EM})$ & $ST(\phi, x, y, \tau, \text{EM})]$

So, an utterance is correct if it gives all relevant new information the speaker can sincerely give.

Several limitations of this definition have already been pointed out, others easily could be, but discussing them in any detail would be beyond the scope of this paper, as would be a discussion of several interesting questions concerning the notions involved and the relations between them, such as the relation between the notions of relevance and informativeness.

One might ask what the conditions defined above are except complicated reformulations of what Grice's original maxims already expressed quite lucidly. The formalization of the Gricean maxims proposed here has, besides the effect of sharpening our insight into the precise content of the maxims, the advantage of expressing them in an exactly formulated framework, that of epistemic pragmatics. The recursive definitions of the various notions involved (such as $V(\phi, x)$, $V(\phi, xy)$) moreover result in a recursive characterization of the notion of correctness itself. Such exactly formulated correctness conditions also make it possible to give explicit formal derivations of the so-called 'generalized conversational implicatures'. We might define this notion along the following lines: a sentence A is a generalized conversational implicature of a sentence B if and only if the correctness of B implies that A is true.

Further, the notion of correctness defined in this section can be used in a definition of the kind of circumstances in which terms can be used specifically or non-specifically, as was suggested informally in Section 1.

### 2.3. *Predicates, constants and quantifiers*

In this section we will outline how the framework of epistemic pragmatics given in Section 2.1 for a propositional language can be extended to apply to a language with predicates, constants and quantifiers.

Let us first limit ourselves to a language only containing one-place predicates, $P$, $Q$, $P_0$, $P_1$, ..., and individual constants, $a$, $b$, $c$, $a_0$, $a_1$, ... and the propositional connectives $\neg$, &, $\vee$ and $\rightarrow$. Formulas are constructed in the usual way. The actual denotations of individual constants are, as usual, individuals. And the actual denotations of one-place predicates are sets of individuals. With respect to the information a language user $x$ may have about the denotation of an individual constant $\alpha$ a variety of situations are possible. Some examples of such situations and their representations in the framework are:

> $x$ has the information that the individual constant $\alpha$ denotes the individual **a**, this situation is represented by means of the value $\{\mathbf{a}\}$;
> $x$ has no more information than that the individual constant $\alpha$ either denotes the individual **a**, or denotes the individual **b**, his information does not tell him which of the two it is, but he does know that it is one and only one of them: $\{\mathbf{a}, \mathbf{b}\}$;
> $x$ has no information at all about the denotation of $\alpha$, as far as his information goes, the denotation of $\alpha$ could be any individual in the doman $A$: $A$.

The information a language user $x$ has about the denotation of an individual constant $\alpha$ is represented as a non-empty subset of the domain of individuals $A$ which is specified in a suitable epistemic model for this language. Such a model will, therefore, have to contain also an interpretation function $F$ which, besides assigning ordinary denotations to constants and predicates, also assigns subsets of the set of individuals $A$ to pairs consisting of an individual constant and a language user.

With respect to the information of a language user about the denotation of one-place predicates the situation is quite similar. Just as in the case of individual constants, the interpretation function $F$ assigns sets of what are the actual denotations of one-place predicates, being sets of sets of individuals, to pairs consisting of a predicate and a language user. Examples of situations with respect to the information a language user $x$ may have about the denotation of a one-place predicate $\delta$ and the corresponding representations are:

> $x$ has the information that the predicate $\delta$ is true of the individuals **a**, **b** and **c** (and false of all other individuals): $\{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$;
> $x$ has the information that the predicate $\delta$ is true of either **a** and **b**, or **a**, **b** and **c**, i.e. $x$ is not sure whether $\delta$ is true of **c**, but he is sure that $\delta$ is true of **a** and **b** and false of all other individuals: $\{\{\mathbf{a}, \mathbf{b}\}, \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$;
> $x$ has the information that $\delta$ is true of all individuals: $\{A\}$;

$x$ has the information that there is no individual of which $\delta$ is true: $\{\emptyset\}$.

As before, we not only want to represent the information of a language user about the denotation of constants and predicates, but also the information of $x_1$ about... the information of $x_n$ about the denotation of these expressions. Some examples:

$x$ has the information that $y$ has the information that $\alpha$ denotes **a**: $\{\{\mathbf{a}\}\}$;
$x$ has the information that either $y$ has the information that $\alpha$ denotes **a**, or $y$ has the information that $\alpha$ denotes **b**: $\{\{\mathbf{a}\}, \{\mathbf{b}\}\}$;
$x$ has the information that $y$ has the information that either $\alpha$ denotes **a** or **b**: $\{\{\mathbf{a}, \mathbf{b}\}\}$;
$x$ has the information that $y$ has the information that $z$ has the information that $\delta$ is true of two of the three individuals **a**, **b** and **c**: $\{\{\{\{\mathbf{a}, \mathbf{b}\}, \{\mathbf{b}, \mathbf{c}\}, \{\mathbf{a}, \mathbf{c}\}\}\}\}$

These considerations lead us to the following notion of an epistemic model for this language. An epistemic model EM is a quintuple $\langle A, I, \{0, 1\}, F, V\rangle$, in which $A$ is the domain of individuals, of which $I$, the set of language users, is a subset. $\{0, 1\}$ is the set of truth values. $F$ is the interpretation function which is defined as follows:

$F(\alpha, i^n) \in A_n$, for all individual constants $\alpha$ and $n$-tuples $i^n$ of elements of $I$, $n \geqslant 0$
$F(\delta, i^n) \in A_n^*$, for all predicates $\delta$ and $n$-tuples $i^n$, $n \geqslant 0$

The domains $A_n$, $A_n^*$ are constructed from the domain $A$ as follows:

$A_0 =_{\text{df}} A; A_n =_{\text{df}} \text{POW}(A_{n-1})\backslash\{\emptyset\}$, for $n > 0$
$A_0^* =_{\text{df}} \text{POW}(A); A_n^* =_{\text{df}} \text{POW}(A_{n-1}^*)\backslash\{\emptyset\}$, for $n > 0$

To the definition of the valuation function $V$ we add the following clause for the evaluation of atomic formulas:

(0) $V(\delta(\alpha), i^n) = \text{T}[F(\alpha, i^n), F(\delta, i^n)]$, where T is defined as follows: if $x \in A_0$, $Y \in A_0^*$, then $\text{T}[x, Y] = 1$ iff $x \in Y$, $= 0$ otherwise; if $x$, $Y$, otherwise, then $\text{T}[x, Y] = \{\text{T}[z, U] \mid z \in x \;\&\; U \in Y\}$

The following examples may serve to illustrate this definition:

suppose $F(a, x) = \{\mathbf{a}\}$ and $F(P, x) = \{\{\mathbf{a}, \mathbf{b}\}\}$, then $V(P(a), x) = \{\text{T}[z, U] \mid z \in \{\mathbf{a}\} \;\&\; U \in \{\{\mathbf{a}, \mathbf{b}\}\}\} = \{\text{T}[\mathbf{a}, \{\mathbf{a}, \mathbf{b}\}]\} = \{1\}$;

suppose $F(a, x) = \{\mathrm{a, c}\}$ and $F(P, x) = \{\{\mathrm{a, b}\}, \{\mathrm{a, b, c}\}\}$, then $V(P(a), x) = \{\mathrm{T}[\mathrm{a}, \{\mathrm{a, b, c}\}], \mathrm{T}[\mathrm{a}, \{\mathrm{a, b}\}], \mathrm{T}[\mathrm{c}, \{\mathrm{a, b, c}\}], \mathrm{T}[\mathrm{c}, \{\mathrm{a, b}\}]\} = \{0, 1\}$;
suppose $F(a, xy) = \{\{\mathrm{a}\}\}$ and
$F(P, xy) = \{\{\{\mathrm{a, b, c}\}\}, \{\{\mathrm{a, b}\}, \{\mathrm{a, b, c}\}\}\}$, then
$V(P(a), xy) = \{\mathrm{T}[\{\mathrm{a}\}, \{\{\mathrm{a, b, c}\}\}], \mathrm{T}[\{\mathrm{a}\}, \{\{\mathrm{a, b}\}, \{\mathrm{a, b, c}\}\}]\} =$
$\{\{\mathrm{T}[\mathrm{a}, \{\mathrm{a, b, c}\}]\}, \{\mathrm{T}[\mathrm{a}, \{\mathrm{a, b}\}], \mathrm{T}[\mathrm{a}, \{\mathrm{a, b, c}\}]\}\} =$
$\{\{1\}, \{1, 1\}\} = \{\{1\}\}$.

We will now extend the language with a number of quantifiers. The way in which quantifiers function within the framework of epistemic pragmatics can perhaps best be illustrated by looking at simple quantified sentences such as *all men are mortal* and *a picture is missing*. In accordance with the compositionality principle underlying the framework of epistemic pragmatics, the information a language user $x$ has about the truth value of such sentences is a function of his information about the denotations of the predicates occurring in these sentences and the meaning of the quantifier involved. E.g. a language user $x$ has the information that the sentence *all men are mortal* is true if and only if his information about the denotations of the predicates *man* and *mortal* is such that every set of individuals that according to his information could be the denotation of the predicate *man* is a subset of every set of individuals that according to his information could be the denotation of the predicate *mortal*. And $x$ has the information that the sentence *a picture is missing* is true if and only if the intersection of every two sets which according to him could be the denotation of *picture* and *missing* respectively is non-empty. This means that the incorporation of quantifiers into the framework of epistemic pragmatics consists in defining for every quantifier a function which given the information of a language user about the denotation of the predicates occurring in the quantified sentence gives his information about the truth value of the quantified sentence. Moreover, these functions should be defined generally, so as to give the right epistemic values for $n$-tuples of language users.

Notice that so far no mention has been made of such a concept as 'information of a language user about the denotation of a variable'. In fact, the incorporation of such a notion into the present framework poses technical problems and produces wrong results. We will not go into this matter here, but define a variable-free fragment of the language of predicate logic. As Quine has shown (see Quine, 1966) it is possible to do predicate logic without variables. In this paper we will not extend the framework of epistemic pragmatics to a language without variables of which the expressive power is the same as that of standard first order predicate logic since this would involve the introduction of technical apparatus not strictly needed for our present purposes. In fact, we will be concerned only with representations of sentences containing just one occurrence of a quantified term, i.e. sentences of the form *a P is Q, some P are Q, one P is Q, two P are Q, . . . , all P are Q, the P is Q*, and propositional combinations thereof. In order to represent these sentences, we add to the language the quantifiers A, SOME, ONE, TWO, . . . , ALL and THE, and the following syntactic rule:

if $\gamma$, $\delta$ are predicates and $\kappa$ is a quantifier, then $\kappa\ \gamma(\delta)$ is a formula

The interpretation of quantified formulas in an epistemic model EM is defined as follows:

(4) $V(\mathrm{A}\gamma(\delta), i^n) = Q_{\mathrm{A}}[F(\gamma, i^n), F(\delta, i^n)]$, where $Q_{\mathrm{A}}$ is defined as follows:
if $X, Y \in A_0^*$, then $Q_{\mathrm{A}}[X, Y] = 1$ iff $X \cap Y \neq \emptyset; = 0$ otherwise;
if $X, Y \in A_n^*$, $n > 1$, then $Q_{\mathrm{A}}[X, Y] = \{Q_{\mathrm{A}}[x, y] \mid x \in X \mathbin{\&} y \in Y\}$

(5) $V(\mathrm{SOME}\ \gamma(\delta), i^n) = Q_{\mathrm{SOME}}[F(\gamma, i^n), F(\delta, i^n)]$, where $Q_{\mathrm{SOME}}$ is defined as follows:
if $X, Y \in A_0^*$, then $Q_{\mathrm{SOME}}[X, Y] = 1$ iff $|X \cap Y| \geqslant 2; = 0$ otherwise;
if $X, Y \in A_n^*$, $n > 1$, then $Q_{\mathrm{SOME}}[X, Y] = \{Q_{\mathrm{SOME}}[x, y] \mid x \in X \mathbin{\&} y \in Y\}$

for all numerical quantifiers N (= ONE, TWO, . . .):

(6) $V(\mathrm{N}\ \gamma(\delta), i^n) = Q_{\mathrm{N}}[F(\gamma, i^n), F(\delta, i^n)]$, where $Q_{\mathrm{N}}$ is defined as follows:
if $X, Y \in A_0^*$, then $Q_{\mathrm{N}}[X, Y] = 1$ iff $|X \cap Y| = n; = 0$ otherwise;
if $X, Y \in A_n^*$, $n > 1$, then $Q_{\mathrm{N}}[X, Y] = \{Q_{\mathrm{N}}[x, y] \mid x \in X \mathbin{\&} y \in Y\}$

(7) $V(\mathrm{ALL}\ \gamma(\delta), i^n) = Q_{\mathrm{ALL}}[F(\gamma, i^n), F(\delta, i^n)]$, where $Q_{\mathrm{ALL}}$ is defined as follows:
if $X, Y \in A_0^*$, then $Q_{\mathrm{ALL}}[X, Y] = 1$ iff $X \subseteq Y; = 0$ otherwise;
if $X, Y \in A_n^*$, $n > 1$, then $Q_{\mathrm{ALL}}[X, Y] = \{Q_{\mathrm{ALL}}[x, y] \mid x \in X \mathbin{\&} y \in Y\}$

(8) $V(\mathrm{THE}\ \gamma(\delta), i^n) = Q_{\mathrm{THE}}[F(\gamma, i^n), F(\delta, i^n)]$, where $Q_{\mathrm{THE}}$ is defined as follows:
if $X, Y \in A_0^*$, then $Q_{\mathrm{THE}}[X, Y] = 1$ iff $|X| = 1$ and $X \subseteq Y; = 0$ otherwise;

if $X, Y \in A_n^*$, $n > 1$, then $Q_{\text{THE}}[X, Y] = \{Q_{\text{THE}}[x, y] \mid x \in X \;\&\; y \in Y\}$

In these definitions $|X|$ denotes the cardinality of $X$.

It should be noted that with respect to the empty sequence of language users, these definitions give the standard semantics of the quantifiers involved. Again, as in the propositional case, the standard semantics is 'reflected' in the information of language users: they are 'aware' that the semantics of the language they use is the standard semantics, and they are aware of each other's awareness, and so on.

To illustrate that these definitions are in accordance with our earlier remarks about the way quantifiers function in the framework of epistemic pragmatics, consider the following examples.

suppose $F(P, x) = \{\{a, c\}\}$ and $F(Q, x) = \{\{a, b\}, \{b\}\}$, then
$V(\text{A}P(Q), x) = Q_{\text{A}}[\{\{a, c\}\}, \{\{a, b\}, \{b\}\}] =$
$\{Q_{\text{A}}[\{a, c\}, \{a, b\}], Q_{\text{A}}[\{a, c\}, \{b\}]\} = \{1, 0\}$
suppose $F(P, x) = \{\{a, b\}, \{a, b, c\}\}$, and $F(Q, x) = \{\{a, b, c, d\}\}$,
then $V(\text{ALL}\ P(Q), x) = Q_{\text{ALL}}[\{\{a, b\}, \{a, b, c\}\}, \{\{a, b, c, d\}\}] =$
$= \{Q_{\text{ALL}}[\{a, b\}, \{a, b, c, d\}], Q_{\text{ALL}}[\{a, b, c\}, \{a, b, c, d\}]\} = \{1\}$
suppose $F(P, xy) = \{\{\{a, b, c\}\}\}$, and
$F(Q, xy) = \{\{\{a, b\}, \{a\}\}, \{\{a, b\}\}\}$, then $V(\text{TWO}\ P(Q), xy) =$
$Q_{\text{TWO}}[\{\{\{a, b, c\}\}\}, \{\{\{a, b\}, \{a\}\}, \{\{a, b\}\}\}] =$
$\{Q_{\text{TWO}}[\{\{a, b, c\}\}, \{\{a, b\}, \{a\}\}], Q_{\text{TWO}}[\{\{a, b, c\}\}, \{\{a, b\}\}]\} =$
$\{\{Q_{\text{TWO}}[\{a, b, c\}, \{a, b\}], Q_{\text{TWO}}[\{a, b, c\}, \{a\}]\},$
$\{Q_{\text{TWO}}[\{a, b, c\}, \{a, b\}]\}\} = \{\{1, 0\}, \{1\}\}$

As we have already remarked, the expressive power of the language discussed here is limited, but it will do for our present purposes. To obtain a language without variables with the same expressive power as that of standard first order predicate logic, one has to change the syntax of the language. E.g. one has to extend the application of quantifiers and connectives to $n$-place predicates, and add certain new operators on predicates. The epistemic pragmatic framework defined above can be extended in a straightforward way to apply to such a language.[4] Further, the remark made at the end of Section 2.1 concerning the impossibility of representing, within the present framework, information of language users about logical and non-logical dependencies between the denotation of expressions applies here too. Since removing this restriction involves a complication of the framework and since it is not strictly necessary for our present purposes, we stick to the insufficient but relatively simple framework here.

A last remark concerns the correctness conditions defined in the previous section. They apply of course to the formulas of the language discussed here too. With respect to this language one would like to extend the notion of topic somewhat, in the sense that not only the truth value of a formula, but also the denotation of a predicate or constant could be topic of conversation. Again, this extension could be made, but involves some technical complications in view of the definition of relevance.

## 3. THE SPECIFIC/NON-SPECIFIC CONTRAST IN EPISTEMIC PRAGMATICS

Having developed the framework of epistemic pragmatics, we will now turn to a formal characterization of the specific/non-specific contrast in terms of it. As we concluded in Section 1, what determines whether a term is used specifically by a language user in uttering a sentence, is the information he has about the denotation of the descriptive expressions and the meaning of the logical expressions occurring in it, if any. For the moment we will restrict ourselves to simple sentences of the form *S is/are P*, where *S* is a proper name or a quantified term, and *P* is a predicate expression. Within our framework we take these sentences to be represented by formulas of the form $\gamma(\alpha)$ or $\kappa\ \gamma(\delta)$ where $\gamma$, $\delta$ are predicates, $\alpha$ is an individual constant and $\kappa$ a quantifier. Since there are five kinds of quantifiers, we have in total six kinds of formulas for which we have to define when they are used specifically by a language user to refer to an individual or set of individuals.

We will first give the definitions and next illustrate their content by discussing some examples. What we define is the notion $SPEC(x, \phi, \Theta, \text{EM})$, in uttering $\phi$, $x$ refers specifically to $\Theta$ in the situation described by the epistemic model EM, where $\Theta$ may denote an individual $z$ or set of individuals $Z$. For the six kinds of formulas this notion is defined as follows:

(1) $SPEC(x, \gamma(\alpha), z, \text{EM})$ iff $F(\alpha, x) = \{z\}$

(2) $SPEC(x, \text{ALL}\ \gamma(\delta), Z, \text{EM})$ iff $F(\gamma, x) = \{Z\}$

(3) $SPEC(x, \text{THE}\ \gamma(\delta), z, \text{EM})$ iff $F(\gamma, x) = \{\{z\}\}$

(4) $SPEC(x, \text{A}\ \gamma(\delta), z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $X \cap Y = \{z\}$

(5) $SPEC(x, \text{SOME}\ \gamma(\delta), Z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $X \cap Y = Z$ and $|Z| \geqslant 2$

(6) $SPEC(x, \text{N}\ \gamma(\delta), Z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $X \cap Y = Z$ and $|Z| = n$

In these definitions $z \in A_{\text{EM}}$ and $Z \subseteq A_{\text{EM}}$, and $F = F_{\text{EM}}$.

These definitions clearly reflect the fact that what determines (non-) specificity is the information a language user has about the denotation of descriptive expressions and the meaning of the logical expressions, i.e. the quantifiers. In each definition reference is made to the information of the language user $x$ about the denotation of one or more of the predicates or constants involved and in each definition particular conditions are imposed upon this information depending on the meaning of the quantifier involved, if any. Compare e.g. definitions (2) and (3). Here reference is made to the information of $x$ about the same expression, but different conditions are imposed upon it, reflecting the differences in meaning between the quantifiers ALL and THE.

The first three definitions (1)–(3) concern what we have called universal terms. Note that they express the fact that the specific use of this kind of term depends solely on information about the denotation of the individual constant or of the predicate corresponding to the descriptive expression in the term. This fact was noted in our informal discussion in Section 1. It distinguishes the universal terms from the non-universal terms for which the definitions (4)–(6) are given. In the latter definitions reference is made also to information about the denotation of predicates corresponding to the predicative part of the sentence. Both groups of terms, universal and non-universal, can be divided into singular and plural terms.[5] The singular universal terms are proper names (1) and singular definite terms (3), the singular non-universal terms are the singular indefinite terms (4). The plural universal terms are the plural definite terms (2) and the plural non-universal terms are the plural indefinite terms (5) and the numerical terms (6). Singular terms can be used to refer specifically to an individual, plural terms can be used to refer specifically to a set of individuals.

Let us now turn to the discussion of some examples. In these examples we let the predicate $P$ represent the expression *picture(s)* and $Q$ the predicate *missing*.

Example (i): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$ and $F(Q, x) = \{\{\mathbf{a}, \mathbf{g}\}\}$
$SPEC(x, \text{A}P(Q), \mathbf{a}, \text{EM})$

This is a characteristic case of specific use of an indefinite term. According to $x$ there is only one object which is both a picture and missing, i.e. the object **a**, which is the object specifically referred to by $x$ in his use of the sentence A$P(Q)$ in the situation described by EM. Notice that the information $x$ has about the denotation of the predicate $P$ is not enough for specific reference.

His information about the denotation of $Q$ also plays a role in determining that a is the object that according to $x$ his assertion A $P(Q)$ is about.

As we remarked earlier, specific use of an indefinite term is not incompatible with correct use. One might think that in a situation like this $x$ could always make a stronger assertion, thereby making his assertion of A$P(Q)$ incorrect. This may not be the case for several reasons. First of all there may not be a stronger assertion which $x$ could correctly make. For example if there is no individual constant $\alpha$ such that $F(\alpha, x) = \{a\}$ (or $= \{a, g\}$, strictly speaking), then no utterance of a formula of the form $Q(\alpha)$ can be sincere for $x$. So, although such a formula would constitute a stronger assertion it could not be correct for $x$. The situation we are talking about is one in which $x$ 'knows' which picture missing, but does not 'know' its name. Analogously $x$ might lack a description to denote a. This is so if for all predicates $\gamma$ it holds that $F(\gamma, x) \neq \{\{a\}\}$. A second reason might be that although there is a stronger assertion $x$ could make, this stronger assertion is not relevant. If the topic of conversation is the formula A$P(Q)$, then formulas of the form $Q(\alpha)$ or THE $\gamma(Q)$, although stronger, and maybe correct in other respects as well, are simply not relevant. These and other reasons can be adequately formulated with the help of the correctness conditions as we defined them in Section 2.2.

There is however, another class of situations in which specific use of an indefinite term is compatible with correct use of a sentence containing it, the explanation of which would require a further elaboration of the correctness conditions. An example of such a situation would be one in which $F(c, x) = \{a\}$; $F(c, xy) = \{A\}$; $F(P, xy) = \{\{\{a, b, c\}\}\}$ and $F(Q, xy) = \{\{\{g\}\}, \{\{a, g\}\}\}$. The point is that according to $x$'s information an utterance of A$P(Q)$ would give $y$ a better clue about which objects are missing than an utterance of $Q(c)$ would, although an utterance of the latter would be stronger and correct in other respects for $x$. The reason for this is that according to $x$, $y$ has no idea whatsoever about the denotation of the constant $c$. In order to cover situations such as these, we need an extra correctness condition requiring a language user $x$ when addressing a language user $y$ to use that formulation which, if $y$ accepts the utterance of $x$ and changes his own information accordingly, gives according to $x$ the closest correspondence between $y$'s information and his own. The formulation of this correctness condition, one might call it the 'recipient design condition', would require a more complex framework than the present one. Such a framework would have to provide the means to describe the dynamics of conversation, information change, various anticipation strategies, and so on. We shall therefore ignore such situations.

The following example represents a typical situation in which $x$ can use A $P(Q)$ correctly without, however, thereby referring specifically to any object at all:

Example (ii): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$
$F(Q, x) = \{\{\mathbf{a}\}, \{\mathbf{b}\}, \{\mathbf{c}\}, \{\mathbf{a}, \mathbf{b}\}, \{\mathbf{a}, \mathbf{c}\}, \{\mathbf{b}, \mathbf{c}\}, \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$
$\sim SPEC(x,$ A $P(Q), z,$ EM), for all $z \in A$

Notice that if $F(Q, x)$ had been $\{\{\mathbf{a}\}, \{\mathbf{b}\}\}$, there would still have been no specific reference, but, in a certain sense, the latter situation would be less unspecific than the former. This is what we meant when in Section 1 we said that specificity comes in degrees.

The next example shows that neither uncertainty of $x$ about the denotation of $P$, nor uncertainty about the denotation of $Q$ necessarily prevents specific use of a non-universal term such as *two pictures*.

Example (iii): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}, \{\mathbf{a}, \mathbf{b}\}\}$ and $F(Q, x) = \{\{\mathbf{a}, \mathbf{b}\}, \{\mathbf{a}, \mathbf{b}, \mathbf{g}\}\}$
$SPEC(x,$ TWO $P(Q), \{\mathbf{a}, \mathbf{b}\},$ EM)

Notice that in this situation it also holds that $SPEC(x,$ SOME $P(Q), \{\mathbf{a}, \mathbf{b}\},$ EM). In case the topic of conversation is such that the cardinality of the set of missing pictures is not relevant, assertion of SOME $P(Q)$ could be correct, but assertion of TWO $P(Q)$ wouldn't.

Example (iv): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$ and $F(Q, c) = \{\{\mathbf{a}, \mathbf{b}\}\}$
$SPEC(x,$ TWO $P(Q), \{\mathbf{a}, \mathbf{b}\},$ EM)
$\sim SPEC(x,$ A $P(Q), \mathbf{a},$ EM) and $\sim SPEC(x,$ A $P(Q), \mathbf{b},$ EM)

So, although in this situation $x$ could use the term *two pictures* specifically, he cannot use the term *a picture* specifically. But nothing prevents $x$ from using A $P(Q)$ correctly, in a situation in which the number of missing pictures is not relevant.

Here we touch upon an important difference between the notion of specifically referring to an object and the notion of having a particular object in mind. If $x$ uses A $P(Q)$, his information about the denotation of $P$ and $Q$ being as it is, he might very well have a particular object, say **a**, in mind, but this does not mean that in using A $P(Q)$, $x$ thereby specifically refers to **a**. It must be stressed that the notion of specific reference is *objective* in this sense that if two language users have the same information about the denotation of the expressions involved and use the same sentence, it can never happen that one of them refers specifically to an object without the other also referring specifically to the same object. The notion of having a particular object in mind on the other hand is purely subjective, and therefore completely uninteresting from the viewpoint of conversation analysis. The subjective and therefore uncontrollable character prevents it from being defined, in contradistinction to the controllable notion of specific reference.

In a situation like (iv) specific reference would still be possible if the sentence in question were part of a certain sequence of sentences. Consider the following sentence *A friend of mine called me up last night.* According to our definitions, if two friends of the speaker in fact called him up last night, he cannot use this sentence to refer specifically to either one of them. He may, of course, have a particular one of them in mind. He might give more information about this individual, e.g. by continuing with the sentence *He invited us to dinner*. However, even if only one of the two friends which called the speaker up made such an invitation, this does not imply that the speaker has made a specific reference by using the first sentence. One might say that in uttering this sequence of sentences as a whole the speaker specifically refers to that one of his friends who both called him up and made the dinner invitation. This requires that the anaphoric pronoun *he* in the second sentence is bound by the quantifier in the term *a friend of mine* in the first sentence. But in that case the sequence *A friend of mine called me up last night. He invited us to dinner* is equivalent to the single sentence *A friend of mine called me up last night and invited us to dinner*. The fact that specific reference is possible with the latter sentence can be accounted for by our definition of the notion of specificity once the framework is extended with complex predicates.

The following is a characteristic case of specific use of a universal term like *all pictures* or *every picture*.

Example (v): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$ and $F(Q, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}, \{\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}\}\}$
$SPEC(x, \text{ALL}P(Q), \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}, \text{EM})$

Notice that the specification of the information of $x$ about the denotation of $P$ completely determines the (non-)specificity of the use of a universal term in which $P$ occurs. This means that the information $x$ has about the denotation of $Q$ plays no role, as becomes obvious when we compare example (v) with example (vi).

Example (vi): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$ and $F(Q, x) = \{\{\mathbf{d}, \mathbf{e}\}\}$
$SPEC(x, \text{ALL}P(Q), \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}, \text{EM})$

In this example, $x$ still refers specifically to the set $\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}$ even though his information about the denotation of $Q$ is completely different from that in example (v). Of course, $x$ could not sincerely use ALL$P(Q)$ in such a situation.

In Section 1 we remarked that if the information $x$ has about the denotation of the predicate expression played a role in determining whether a universal term is specifically used, this would imply that in all such cases utterance of the sentence in question by $x$ would be insincere. Given our definitions it is easy to see why this is so. Suppose we were to change definition (2) in such a way that information about the denotation of the predicate expression could play a role:

(2′) $SPEC(x, \text{ALL}\gamma(\delta), Z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $X \cap Y = Z$

The sincerity condition requires of formulas of the form ALL$\gamma(\delta)$:

$$\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)\colon\ X \subseteq Y$$

It is easy to see that (2′) and the sincerity condition can both be fulfilled only if it holds that $\forall X \in F(\gamma, x)$: $X = Z$. And this is exactly what our definition (2) requires. This means that in all cases in which the information of $x$ about the denotation of the predicate expression would make a real difference, utterance of the sentence as a whole would be incorrect for $x$. This makes the addition of the influence of information about the predicate expression useless. As can be seen from example (vi), the original definition (2) allows for specific but insincere use, in addition to the specific sincere cases.

This points out a major difference between universal and non-universal terms. According to our definitions (1)–(3) and (4)–(6), specific use of non-universal terms implies sincerity, whereas specific use of universal terms does not. But it should be noted that specific use of universal terms does imply what one might call 'sincere reference': one cannot refer specifically with a universal term to a set of individuals if one does not have the information that that set is the denotation of the predicate in the universal term in question. The difference in question is of course related to the fact that information about the denotation of expressions other than the term in question does play a role in determining (non-)specificity of non-universal terms, but does not play this role with universal terms.

In the end one is, we think, only interested in the notion of *correct* specific use. As far as non-compound formulas are concerned, this notion can be characterized as a simple conjunction of the notions of specificity and correctness. The requirement of correctness cannot be built into the definition of specificity as such. As will become clear, this leads to complications when compound formulas are taken into consideration.

If we consider the possibility of specific reference by means of a negated sentence, we are again confronted with a difference between universal and non-universal terms.[6] Compare the following sentences.

(a) It is not the case that every picture/the picture/John is missing

(b) It is not the case that a picture/two pictures/some pictures is/are missing

The sentences of the first type, containing a universal term, allow for specific reference, whereas the sentences of the second type, containing a non-universal term do not. This can be checked as follows. The nature of specific reference is such that it allows for anaphoric reference in subsequent sentences. Notice that this is only a necessary condition, not a sufficient one, see the discussion of example (iv). It is clear that sentences of the first type can be followed by sentences of the following type:

(c) They/it/he is/are still there

interpreting the pronoun as an anaphoric reference to the universal term in (a). With sentences of the second type this is clearly not possible.[7] From this we conclude that it is possible to use a universal term in a negated sentence to make a specific reference, but that no such possibility exists for non-universal terms. These facts can be accounted for as follows.

Let $\phi$ be a non-compound formula, then

(7) $SPEC(x, \neg\phi, \Theta, \text{EM})$ iff $SPEC(x, \phi, \Theta, \text{EM})$ and $S(\neg\phi, x, \text{EM})$

It is clear that this definition prevents specific reference with a non-universal term in the negated formula $\neg\phi$. As we have seen, specific use of a non-universal term implies sincerity of the formula used. Definition (7) requires both that $x$ uses the non-universal term specifically to refer to $\Theta$ in using $\phi$ and requires that $\neg\phi$ be sincere for $x$. But the first requirement implies that $\phi$ should be sincere for $x$. So no specific reference with non-universal terms in negated sentences is possible. For universal terms things are different, since specific use of them does not imply sincerity of the sentence used. The following is an example of specific reference with a univeral term in a negated formula:

Example (vii): $F(P, x) = \{\{a, b, c\}\}$ and $F(Q, x) = \{\{a, b\}\}$
$SPEC(x, \neg(\text{ALL}P(Q)), \{\{a, b, c\}\}, \text{EM})$

This suggests that we can generalize our analysis of specific reference by defining a notion of 'sincere specific reference' along the following lines:

(8) $S\text{-}SPEC(x, \phi, \Theta, \text{EM})$ iff
(i) $S(\phi, x, \text{EM})$
(ii) $\exists\psi: \psi$ is a non-compound subformula of $\phi$ & $SPEC(x, \psi, \Theta, \text{EM})$

By a non-compound formula we understand a formula which is of the form $\gamma(\alpha)$ or of the form $\kappa\ \gamma(\delta)$, where $\gamma$, $\delta$ are predicates, $\alpha$ an individual constant, $\kappa$ a quantifier. The role of the non-compound subformula $\psi$ in this definition is that for specific reference a term is required together with that part of the context in which the term occurs, which in some situations may play a role in determining the (non-)specificity of the reference. To put it differently, in order to determine the (non-)specificity of the reference one looks for a term and its scope. This is what the notion of non-compound subformula gives us.

Notice that in definition (8) the definitions (1)–(6) play a role via clause (ii). If $\phi$ itself is a non-compound formula, then the notion *S-SPEC* and the notion *SPEC* coincide in case we are considering a non-universal term, since, as we have already noticed, specific reference with non-universal terms in this case implies sincerity. For non-compound formulas containing universal terms, definition (8) gives us all cases of sincere specific reference, which form a proper subclass of the class determined by definitions (1)–(3). Further it should be noted that for negations of non-compound formulas (8) gives the same results as (7). Definition (8) gives satisfactory results for compound formulas which are simple negations and simple conjunctions. However, the definition does not account for all cases of specific reference by the use of disjunctive formulas (and ipso facto of negations of conjunctive formulas, etc.).

Consider the following example. Suppose we are back in the control room of the gallery. Some time ago a special alarm system has been installed to guard Botticelli's 'Primavera'. As it happens this system has given a false alarm several times within the last few weeks. Suppose the system gives an alarm. Now the guard could very well utter the following sentence:

(d) A picture is missing or the system is giving a false alarm again.

(We assume that he is addressing a hearer for whom the term *Botticelli's 'Primavera'* does not ring any bell.)

In our opinion, the guard using sentence (d) is making a specific reference to the picture in question in this situation. What we have here is a situation of the following kind:

Example (viii): $F(P, x) = \{\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$ and $F(Q, x) = \{\{\mathbf{a}\}, \emptyset\}$

Notice first of all that the framework as developed up to now cannot account for the fact that in a situation like this the formula $\text{A}P(Q) \vee p$ (where $p$ represents *the system gives a false alarm again*) is used sincerely since we cannot account for the information the speaker has about the non-logical dependency between the denotation of the predicate $Q$ and the truth value of $p$, viz. that $Q$ denotes $\emptyset$ if and only if $p$ is true. Suppose we have extended the framework in such a way that information of language users about logical and non-logical dependencies can be represented so as to account for the fact that a disjunction can be used sincerely without one of its disjuncts being sincere.

Definition (8) could still not account for the situation just described, since it implies that for specific reference by means of $\text{A}P(Q) \vee p$ it is required that specific reference is made by means of the non-compound subformula $\text{A}P(Q)$ according to definition (4). But the latter implies, as we have seen, sincerity of $\text{A}P(Q)$. So, the problems with disjunctive statements have two sources, both the analysis of disjunction given sofar and the too strict requirements imposed by definitions (4)–(6).

The problems arising from the latter can be overcome as follows. First, we give a definition of the notion of 'potential specific reference'. This notion will be defined for each of the six classes of non-compound formulas. Then, on the basis of these definitions, we define the notion of 'sincere specific reference' generally for all formulas, compound and non-compound, using the notion of potential specific reference and the notion of sincerity. The notion of potential specific reference, *P-SPEC*, is defined as follows:

(1′) $\textit{P-SPEC}(x, \gamma(\alpha), z, \text{EM})$ iff $F(\alpha, x) = \{z\}$

(2′) $\textit{P-SPEC}(x, \text{ALL}\,\gamma(\delta), Z, \text{EM})$ iff $F(\gamma, x) = \{Z\}$

(3′) $\textit{P-SPEC}(x, \text{THE}\,\gamma(\delta), z, \text{EM})$ iff $F(\gamma, x) = \{\{z\}\}$

(4′) $\textit{P-SPEC}(x, \text{A}\,\gamma(\delta), z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $X \cap Y \neq \emptyset \Rightarrow X \cap Y = \{z\}$

(5′) $\textit{P-SPEC}(x, \text{SOME}\,\gamma(\delta), Z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $|X \cap Y| \geqslant 2 \Rightarrow X \cap Y = Z$

(6′) $\textit{P-SPEC}(x, \text{N}\,\gamma(\delta), Z, \text{EM})$ iff $\forall X \in F(\gamma, x), \forall Y \in F(\delta, x)$: $|X \cap Y| = n \Rightarrow X \cap Y = Z$

In these definitions $z \in A_{\text{EM}}$ and $Z \subseteq A_{\text{EM}}$, and $F = F_{\text{EM}}$.

The notion of sincere specific reference is now redefined as:

(8′) $S\text{-}SPEC(x, \phi, \Theta, \text{EM})$ iff
(i) $S(\phi, x, \text{EM})$
(ii) $\exists\psi$: $\psi$ is a non-compound subformula of $\phi$ & $P\text{-}SPEC(x, \psi, \Theta, \text{EM})$

First of all, it should be noted that definitions (1′)–(3′) are identical to the original definitions (1)–(3). Secondly, notice that definitions (4′)–(6′) are weaker than (4)–(6), i.e. what was covered by (4)–(6) is also covered by (4′)–(6′), but not vice versa. Informally, what e.g. (4′) requires is the following. If $x$ is to make a potential specific reference to $z$ using A$P(Q)$, his information about the denotation of $P$ and $Q$ should be such that if different possibilities with regard to the denotation of $P$ and $Q$ are open according to him, those which, if realized, would make $x$'s utterance of A$P(Q)$ sincere, would also make his utterance of A$P(Q)$ one that specifically refers to $z$. Thirdly, definition (8′) in combination with (4′)–(6′), to which it refers, in case we are dealing with a non-universal term, gives the same results with respect to non-compound formulas as did (4)–(6). The relaxation in (4′)–(6′) is canceled by the sincerity requirement (i) in (8′). Fourthly, with respect to non-compound formulas containing universal terms, definition (8′) in combination with (1′)–(3′) gives slightly different results than did our original (1)–(3), since what (8′) defines is the notion of *sincere* specific reference, which is stronger than what (1)–(3) defined. As a matter of fact, (8) and (8′) give the same results with respect to both compound and non-compound formulas as far as universal terms are concerned. The reason why for universal terms the notion of potential specific reference is the same as what was defined by (1)–(3) is that since (1)–(3) had no implications regarding sincerity there seem to be no potential specific references which were not covered by (1)–(3). Compare the following sentences:

(e) If Botticelli's 'Primavera' is not a picture, then all pictures are missing from the gallery.
(f) If Botticelli's 'Primavera' is a picture, then a picture is missing from the gallery.

In our opinion, someone using (e) could never thereby refer to a specific set of objects which according to him is the set of pictures, whereas someone using (f) could very well thereby refer to a specific object. Examples such as these show that a relaxation analogous to the one inherent in (4′)–(6′) would lead to wrong results when extended to (1′)–(3′).

Finally, as far as compound formulas go, it should be noted that definition

(8′) gives the same results with respect to simple negations and conjunctions as did (8). In particular, (8′) still rules out the possibility of using a non-universal term specifically in a negated formula, while allowing for that possibility with respect to universal terms. For disjunctive compound formulas definition (8′) indeed does what it was devised to do. If we were to extend the present framework in such a way that a disjunction could come out sincere without any of its disjuncts being sincere, then definition (4′) would predict that in example (viii) $x$ potentially refers specifically to **a** with the formula $\mathrm{A}\,P(Q)$. Definition (8′) would then predict that $x$ makes a sincere specific reference to **a** with the formula $\mathrm{A}\,P(Q) \vee p$.

The extension of the framework alluded to can be roughly outlined as follows. Formulas are evaluated not only with respect to a language user $x$, but also with respect to a possible world $w$, in such a way, that all possible worlds $w'$ in which the information available to $x$ in $w$ is strengthened are taken into account. Information about dependencies is accounted for by the fact that some possible combinations of pieces of information may be ruled out. E.g., in the situation partly described in example (viii) the information about the dependency referred to there is accounted for by the fact that in all relevant possible worlds $w'$: $F(Q, x, w') = \{\emptyset\}$ iff $V(p, x, w') = \{1\}$. The value of a formula with respect to a language user $x$ and a possible world $w$ is computed from the values of its parts with respect to $x$ and the relevant possible worlds $w'$. Incorporation of this extension, in particular in a general form, i.e. also for sequences of language users, would have involved introducing a lot of technical details which are not strictly necessary for the analysis of specificity given here.

Our analysis of the specific/non-specific contrast is thus embodied in the definitions (1′)–(6′) and (8′). Of course, we do not want to claim that our analysis has anything final, but we do feel that it shows that a pragmatic analysis of the specific/non-specific contrast is feasible and can be given in a more or less precise way. Further refinements should be made. We will mention three. First of all a language with more expressive power than the one discussed here should be investigated. Second, it may prove to be useful to strengthen the notion of sincere specific reference to correct specific reference for reasons that concern speaker-hearer interaction. Third, a generalization of the form 'according to $x$ . . . according to $y$ $z$ uses $\phi$ to refer specifically and sincerely to $\Theta$' might prove to be useful for similar reasons.

At the end of the next section, which concerns the application of the framework of epistemic pragmatics to the *de dicto/de re* ambiguity concerning objects of belief, some remarks will be made about the (non-)existence of interrelations between the specific/non-specific contrast and the *de dicto/de re* ambiguity.

## 4. AN AMBIGUITY CONCERNING OBJECTS OF BELIEF

In this section we will discuss another application of the framework of epistemic pragmatics developed in Section 2. We will be concerned with the two distinct readings of sentences such as

(a) John believes that Bill passed the exam.

On its first reading sentence (a) is true if and only if John believes of a certain individual that he passed the exam, and this individual is in fact called Bill. On this reading it does not matter whether or not John also believes that the individual he believes to have passed the exam, is called Bill. He may not know his name or may believe that he is called Tim, for example. On its second reading, sentence (a) is true if and only if either John believes that the individual who he believes to be called Bill passed the exam, or, if John is not sure which individual is called Bill, John believes of every individual who according to his beliefs could be called Bill, that he passed the exam. On this reading it does not matter whether the individual who is in fact called Bill passed the exam, nor does it matter that anyone else has. It also doesn't matter whether the individual which John believes to be called Bill is in fact called Bill. The first reading is often called the *de re* reading, the second the *de dicto* reading. The ambiguity in question concerns here the object of John's belief: on the first reading it is an individual who in fact is called Bill, on the second reading it is an individual John believes to be called Bill.

We will argue that the framework of epistemic pragmatics enables one to handle this ambiguity in a natural way. It should be noted that this does not imply that we claim that the ambiguity in question isn't a truly semantic one. It is, as our discussion of (a) indicates. The reason that the framework of epistemic pragmatics is a suitable instrument to handle the ambiguity is twofold: first, it accounts for the information of language users in a compositional manner, and second, it contains a level of semantics. The second aspect makes it possible to incorporate within the framework of semantic analysis of expressions which refer, in some way or other, to the information of language users. The verb *believe* is, obviously, one of them.

In order to be able to represent sentences such as (a), we add to the language given in Section 2.3 a set of indexed operators $B_i, B_j, B_{i_0}, B_{i_1}, \ldots$, and the following syntactic rule:

> if $\phi$ is a formula and $B_x$ an indexed operator, then $B_x(\phi)$ is a formula.

A formula of the form $B_x(\phi)$ is to represent, of course, a sentence of the form $x$ *believes that* $\phi$. The valuation of such a formula is as follows. With respect to the empty sequence of language users, i.e. on the semantic level, a formula of the form $B_x(\phi)$ is assigned the value 1 if and only if $x$ has the information that $\phi$ is true (remember that the phrase 'has the information that' is used without any factive implications), and the value 0 otherwise. With respect to a language user $y$ the value of $B_x(\phi)$ will depend on the value of $\phi$ with respect to the sequence $yx$. I.e. the information a language user $y$ has about the truth value of a formula of the form $B_x(\phi)$ depends on the information $y$ has about the information $x$ has about the truth value of $\phi$. For example, $y$ has the information that $B_x(\phi)$ is true if and only if $y$ has the information that $x$ has the information that $\phi$ is true. This leads to the following clause in the definition of the valuation function $V$ in an epistemic model:

(9) $V(B_x(\phi), i^n) = \text{BEL}[V(\phi, i^n{}^\frown x)]$, where BEL is defined as follows:
$\text{BEL}[\{1\}] = 1,\ \text{BEL}[\{0\}] = \text{BEL}[\{0, 1\}] = 0;$
$\text{BEL}[Y] = \{\text{BEL}[y] \mid y \in Y\},\ \text{for}\ Y \neq \{1\}, \{0\}, \{0, 1\}$

In this definition $i^n{}^\frown x$ stands for the concatenation of $i^n$ and $x$.[8]

It should be noted that according to this definition, indexed operators create intensional contexts, i.e. contexts in which substitution of expressions with the same value does not guarantee that the value of the entire expression remains the same. For the value of $B_x(\phi)$ with respect to some sequence $i^n$ is not computed from the value of $B_x$ with respect to $i^n$ and the value of $\phi$ with respect to $i^n$, but, as the definition shows, from the value of $B_x$ with respect to $i^n$ and the value of $\phi$ with respect to the sequence $i^n{}^\frown x$. And the value of $\phi$ with respect to $i^n$ is, generally, independent of the value of $\phi$ with respect to $i^n{}^\frown x$.

The following example shows the intensional character of indexed operators on the semantic level:

Let $e$ be the empty sequence of language users. $V(B_i(\gamma(\alpha)), e) = 1$ if and only if $\text{BEL}[V(\gamma(\alpha), i)] = 1$, and this is the case if and only if $V(\gamma(\alpha), i) = \{1\}$. And this is the case if and only if every element in $F(\alpha, i)$ is an element of every element in $F(\gamma, i)$.

So, the actual denotations of the constant $\alpha$ and the predicate $\gamma$ do not enter into the evaluation of the actual denotation, i.e. truth value, of the formula $B_i(\gamma(\alpha))$. Of course, more could and should be said about the analysis of the indexed operators representing belief, especially in connection with a representation and analysis of knowledge, but what has been said so far will suffice for the discussion of examples such as sentence (a).

If we consider the formula $B_j(P(b))$ to be a representation of sentence (a), letting $j$ and $b$ represent the proper names *John* and *Bill* respectively and the predicate $P$ the verb phrase *passed the exam*, what we get is a representation of the *de dicto* reading of (a). In order to obtain a representation of the *de re* reading as well we have to enrich the syntax of our logical language.

A general feature of a language without variables is that the various sentential operators, such as the connectives, quantifiers, tense operators and also the indexed operators we have just introduced, do not operate only on sentences, but on predicates too. To put it somewhat differently, these expressions operate on predicates with an arbitrary number of places, where formulas are considered to be zero-place predicates. The need for this can be illustrated by a very simple example. In order to construct in a language without variables a formula which corresponds to the following formula of a language with variables: $\exists x(P(x) \,\&\, \neg Q(x))$, we need to apply negation as an operation on the predicate $Q$. In that way we can obtain the formula $\mathrm{A}P(\neg Q)$. If we couldn't do this, we could only construct the formula $\neg(\mathrm{A}P(Q))$, which is the non-variable equivalent of $\neg\exists x(P(x) \,\&\, Q(x))$. The interpretation of the application of negation to a (one-place) predicate $\delta$ is straightforward:

$F(\neg\delta, i^n) = \mathrm{COMPL}[F(\delta, i^n)]$, where COMPL is defined as follows:
(a) if $X \in A_0^*$, then $\mathrm{COMPL}[X] = A - X$
(b) if $X \in A_n^*, n > 0$, then $\mathrm{COMPL}[X] = \{\mathrm{COMPL}[x] \mid x \in X\}$

It is easy to see that, given this definition, $\mathrm{A}P(\neg Q)$ expresses the same proposition as $\exists x(P(x) \,\&\, \neg Q(x))$. The interpretation of the applications of the other connectives and the quantifiers to predicates follows the same pattern. We will not discuss them here, but turn to the interpretation of the indexed operator when applied to predicates.

We add the following syntactic rule:

> if $\delta$ is a one-place predicate and $B_x$ is an indexed operator, then $B_x(\delta)$ is a one-place predicate

The interpretation of the thus obtained complex one-place predicates is as follows:

$F(B_x(\delta), i^n) = \text{INTER}[F(\delta, i^n{}^\frown x)]$, where INTER is defined as follows:

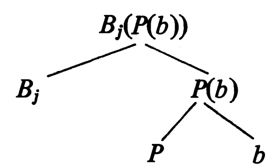
(a) if $X \in A_0^*$, then $\text{INTER}[X] = \cap X$

(b) if $X \in A_n^*, n > 1$, then $\text{INTER}[X] = \{\text{INTER}[x] \,|\, x \in X\}$

It will be clear that indexed operators create intensional contexts also when they are applied to predicates. For, as the definition shows, the value of the result of such application, i.e. $F(B_x(\delta), i^n)$, is defined not in terms of $F(\delta, i^n)$, but in terms of $F(\delta, i^n{}^\frown x)$.

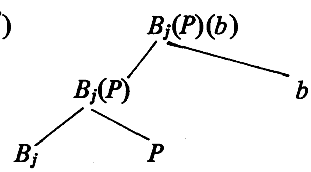
We are now in a position to construct two different formulas each representing one reading of sentence (a):

(a′)



*de dicto*

(a″)



*de re*

What remains to be shown is that the formulas $B_j(P(b))$ and $B_j(P)(b)$ are assigned different truth conditions in our framework, i.e. that they are assigned the value 1 under different conditions, when evaluated with respect to the empty sequence of language users. For

(a′): $V(B_j(P(b)), e) = 1$ iff $\text{BEL}[V(P(b), j)] = 1$ iff $V(P(b), j) = \{1\}$ iff $\{\text{T}[x, Y] \,|\, x \in F(b, j) \;\&\; Y \in F(P, j)\} = \{1\}$ iff $\forall x \in F(b, j)$, $\forall Y \in F(P, j): x \in Y$

I.e. (a′) is true if and only if every individual that according to the individual $j$ could be the denotation of the constant $b$ is an element of every set of individuals that according to the individual $j$ could be the denotation of the predicate $P$. For

(a″): $V(B_j(P)(b), e) = 1$ iff $\text{T}[F(b, e), F(B_j(P), e)] = 1$ iff $F(b, e) \in$ $\in F(B_j,(P), e)$ iff $F(b, e) \in \text{INTER}F(P, j)$ iff $F(b, e) \in \cap F(P, j)$ iff $\forall X \in F(P, j): F(b, e) \in X$

I.e. (a″) is true if and only if the individual which is the actual denotation of the constant $b$ is an element of every set of individuals which according to the individual $j$ could be the denotation of the predicate $P$.

If one compares the truth conditions of (a′) and (a″) respectively with the circumscription of the two readings of sentence (a), given at the beginning of this section, it will be clear that formula (a′) represents the *de dicto* reading of sentence (a) and formula (a″) its *de re* reading. Clearly, the truth conditions of (a′) and (a″) are different, in fact neither one of them implies the other, as can be seen from the following examples:

> suppose $F(b, e) = \mathbf{a}$, $F(b, j) = \{\mathbf{b}\}$ and $F(P, j) = \{\{\mathbf{b}, \mathbf{c}, \mathbf{d}\}\}$, in this situation $V(B_j(P(b)), e) = 1$ and $V(B_j(P)(b), e) = 0$
> suppose $F(b, e) = \mathbf{a}$, $F(b, j) = \{\mathbf{b}\}$ and $F(P, j) = \{\{\mathbf{a}, \mathbf{c}, \mathbf{d}\}\}$, in this situation $V(B_j(P(b)), e) = 0$ and $V(B_j(P)(b), e) = 1$

In the first situation, the *de dicto* reading is true, the *de re* reading false; in the second situation, the *de dicto* reading is false, the *de re* reading true.

Let us conclude this section by making a few short remarks about the relation between the specific/non-specific contrast and the *de dicto/de re* ambiguity. Two questions can be distinguished. First, the question whether the term *Bill* can be said to be used specifically by a language user $x$ both in uttering (a) on its *de re* reading and in uttering (a) on its *de dicto* reading. According to our intuitions, the question of specific reference only arises when $x$ uses (a) on its *de re* reading, not when he is using (a) on its *de dicto* reading. The reason behind this is the following.

On its *de re* reading the term *Bill* is outside the scope of the *believe*-predicate, and therefore, when (a) is evaluated with respect to $x$, what plays a role is what according to $x$ is the denotation of the proper name *Bill*. On its *de dicto* reading however, the proper name *Bill* is inside the scope of the *believe*-predicate and therefore, when (a) is evaluated with respect to $x$, what according to $x$ is the denotation of *Bill* does not play a role. The question of specific reference with a term by a language user in uttering a certain formula only arises if in evaluating that formula with respect to the language user the information of that language user about the denotation of the term in question plays a role. In order to account for this, the definition of *S-SPEC*, definition (8′), should be extended with a proviso which requires that the non-compound *P-SPEC* subformula does not occur within the scope of an indexed operator of which the index is different from the language user in question. (The last condition is added to allow for specific use of a term in a sentence of the form *I believe that* $\phi$, even on its *de dicto* reading.) That specific reference on the *de re* reading remains possible if this proviso is added is clear, since in this case the indexed operator forms part of the predicate and the non-compound subformula in question is the formula itself.

The second question is whether the (non-)specific use of sentence

(b) Bill passed the exam.

by the language user John has anything to do with the truth of falsity of sentence (a) on its *de dicto* or *de re* reading. It is easy to see that in case $S\text{-}SPEC(j, P(b), z, \text{EM})$ the truth of $B_j(P(b))$, i.e. the *de dicto* reading of (a), follows, but that the *de re* reading, $B_j(P)(b)$, can still be false.

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## NOTES

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[1] See Groenendijk & Stokhof (1978b) for empirical and theoretical arguments in favour of this assumption.

[2] See the references in Kasher & Gabbay (1976).

[3] See Groenendijk & Stokhof (in preparation).

[4] For details, see Quine (1966) and Groenendijk & Stokhof (in preparation).

[5] Notice that the notions 'singular' and 'plural' are not used here in their 'grammatical' sense, but are used to distinguish terms according to what they refer to, an individual or a set of individuals. Accordingly, *every P* and *all P* are considered here to be both plural terms, despite their obvious differences which, however, do not concern us here.

[6] By a negated sentence we mean one in which negation has widest scope.

[7] It might be thought that the following examples falsify this claim:

(a) Mary does not want to marry a Swede. She just wants to have an affair with him.
(b) It is not the case that some pictures are missing. They are still there.

We do not think they do. As for (a), it is only acceptable if *a Swede* has wide scope with respect to the negation. Only then is anaphoric reference possible, which however does not imply that the term *a Swede* is used specifically. Cf. the discussion of example (iv). If *a Swede* has narrow scope with respect to the negation only the following seems acceptable:

(c) Mary does not want to marry a Swede. She just wants to have an affair with one.

As for (b), it should be noted that *they* can refer anaphorically, but not to some specific subset of the set of pictures, it can only refer to the entire set of pictures.

[8] Notice that the indices of the operators are used as expressions both of the object language and of the meta language. We take it that no confusion will arise from this.

A more complex definition which allows also for a 'language user(s) dependent interpretation' of the index of the operator could also be given, but is not, in order to avoid unnecessary complications. For details, see Groenendijk & Stokhof (in preparation).

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