Dynamics and Pragmatics of “Peirce’s Puzzle”

Paul Dekker

ILLC/Department of Philosophy
Faculty of Humanities
University of Amsterdam

Abstract
An intriguing puzzle due to Charles Sanders Peirce (Peirce 1906) has recently regained the interest of semanticists. It has been argued that the puzzle should be analyzed by means of a dynamic or E-type analysis of non-bound pronouns.

In this paper we will first argue that “Peirce’s Puzzle”, basically, doesn’t have anything to do with non-bound pronouns and that, consequently, a dynamic or E-type analysis of pronouns misses the point.

We next show that Peirce’s own, intuitively correct, observations can be seen to follow from independently motivated principles governing the use of indefinite noun phrases. The puzzle constitutes further motivation for a perspective upon the semantics / pragmatic interface recently under development in a dynamic setting.

“Peirce’s Puzzle” is concerned with logical principles which do not seem to correspond to intuitive patterns of reasoning. In first order logic the following two formulas are equivalent:

(1) $\exists x\phi(x) \leftarrow \forall x\psi(x)$
(2) $\exists x(\phi(x) \leftarrow \psi(x))$

To see why, assume that (1) is true. In that case $\forall x\psi(x)$ is false, or $\exists x\phi(x)$ is true. So there is some individual, say d, which is not ψ, or there is some individual, say d', which is ϕ. In either case there is an individual which is ϕ if it is ψ. For d is ϕ if it is ψ, since d is not ψ, or d' is ϕ if it is ψ, since d' is ϕ. In both cases (2) is true. In an essentially similar way we can reason back from the truth of (2) to that of (1).

By a similar line of reasoning (3) and (4) are seen to be equivalent:

(3) $\exists x\phi(x) \vee \exists x\psi(x)$
(4) $\exists x(\phi(x) \vee \psi(x))$

For in case (3) is true, we have an individual, d, which is ϕ or an individual, d', which is ψ. In any case, we have an individual d'' which is ϕ or ψ. It can be d in the first case, and d' in the second case.

The above patterns of reasoning (only) involve basic principles of first order (predicate) logic. Let us now take a look at what seem to be natural language paraphrases of (1–4). Natural language counterparts of the above formulas can be evaluated against the background of a situation taken from (Read 1992 and Gillon 1996) where a sweepstakes takes place. One-thousand people can (but need not) participate, and each participant is required to bring in one dollar. One participant will win the stake. The following two sentences appear to be true in this situation:

(5) Someone wins \$1.000 if everyone takes part.
(6) Someone wins \$1.000 or someone will not take part.

However, the following two sentences are qualified as dubious in the very same situation:

(7) Someone wins \$1.000 if he takes part.
(8) Someone wins \$1.000 or he will not take part.

For if someone ('he', or 'the winner') takes part, this does not imply that everyone takes part, so there is no guarantee that the price will be \$1.000. "Peirce's Puzzle" now can be taken to be this. The first two sentences (5) and (6), which are judged true, are associated with the logical forms (1) and (3), respectively. By the patterns of reasoning displayed above, these formulas are equivalent to the formulas (2) and (4), respectively. But (7) and (8), the alleged natural language counterparts of (2) and (4), are qualified as (extremely) dubious. There appears to be a mismatch here between formal logic and reasoning in natural language. (As Michiel van Lambalgen (p.c.) pointed out, (1) and (2) are not equivalent in, for instance, intuitionistic logic, or under a 'strict implication' reading of $\leftarrow$. However, even if the puzzle dissolves in an alternative logic, one may still wonder whether it constitutes a decisive argument for such a logic.)

At the present stage several harsh conclusions can be drawn. One can conclude that classical logic shows itself to be wrong empirically speaking. One can conclude that folk reasoning needs to be improved logically speaking. One can also conclude that we haven't (yet) established the correct relation between natural language phrases and corresponding logical forms. We find the three possible conclusions as such dubious on methodological grounds. The first two appeal to judgments from *one* domain of *justification* (that of logic or that of empirical science) and apply them in the other domain, which is dubious practice. The third is ad hoc if it is not independently motivated.

In this paper we want to approach the puzzle from a rather conservative angle. For as far as it is possible we would like to preserve both (first order) logical principles and native speaker's intuitions. We propose to analyze "Peirce's Puzzle" at the semantics / pragmatics interface, where meaning and interpretation meet. We think one can and should separate logical/semantic rules from hermeneutic/pragmatic principles in the first place, but, in the second place, allow them to interact in a dynamic and flexible way. As will be seen in due course most of our opinions regarding "Peirce's Puzzle" can be accounted for on the basis of a classical logical analysis of the meanings of sentences, by appealing to Gricean principles governing their use and a 'free variable' style analysis of indefinites. However, before we turn to our own analysis, we'll first inspect some analyses of "Peirce's Puzzle" which have been proposed before.

1 Two recent analyses of "Peirce's Puzzle"

"Peirce's Puzzle" has quite recently been analyzed as a problem of non-bound anaphora (Gillon 1996; van Rooy 1997b). Gillon and van Rooy conceive of the pronoun *he* in (7) and (8) as a pronoun which is not syntactically bound by the indefinite term *someone*, but as an anaphoric pronoun which has the indefinite as its antecedent and which should be analyzed as an E-type pronoun.

1.1 The E-type Approach

According to the E-type analysis of pronouns presented in (Evans 1977; Neale 1990), a non-bound pronoun denotes the unique individual satisfying the description by means of which the antecedent was introduced in previous discourse. It should be the one and only individual that satisfies both the description under which it was introduced and the one predicated of it in the remainder of the hosting sentential clause. Gillon and van Rooy propose to analyze the pronoun in (7) or (8) in this fashion too.

Under a strict E-type analysis, then, examples (7) and (8) are interpreted as ($7'$) and ($8'$), respectively:

($7'$) Someone wins \$1.000 if the person who wins \$1.000 takes part.

($8'$) Someone wins \$1.000 or the person who wins \$1.000 does not take part.

It is easily seen that this is not very satisfactory. The occurrence of the pronoun *he* in the original examples is expanded into the definite description *the person who wins \$1.000*, which can be analyzed in a Russellian or a Fregean (or Strawsonian) way. (Clearly, we should not analyze it as an *anaphoric* definite, because this would threaten to render the analysis circular.) Upon its Russellian analysis, example ($7'$) says that if there is one and only one person who wins \$1.000, and who takes part, then someone wins \$1.000. This is a tautology. In a similar vein, example ($8'$) can be seen to be equivalent, under a Russellian analysis, to the statement that someone wins \$1.000. Clearly, these results are at odds with our intuitive understanding of the original examples (7) and (8), which ($7'$) and ($8'$) are supposed to give an analysis of.

Alternatively, the definite descriptions in ($7'$) and ($8'$) can be taken to invoke a Fregean or Strawsonian presupposition that there is a person who wins \$1.000. However, assuming that the examples inherit this presupposition, then they are, if defined, vacuously true. For, if the presupposition that someone wins \$1.000 is satisfied, then the consequent clause of ($7'$) and the left disjunct of ($8'$) are true as well. In other words, under a Fregean analysis of the definite descriptions, the examples ($7'$) and ($8'$) do not assert anything but only presuppose something. Again, this does not at all correspond to our intuitions regarding (7) and (8). If noone wins \$1.000 (7) can still be true, for instance if the person does not take part who *would* win \$1.000 if he took part. And (7) can be false, for instance if one person does not take part, who would have lost anyway. Clearly these two situations do not make (7) infelicitous!

As a matter of fact, the counterintuitive results which we obtain under a strict E-type analysis point at a deeper problem of an E-type approach to "Peirce's Puzzle". The description into which the pronoun gets expanded is constructed from descriptive material in the antecedent clause of (7) or from that of the first disjunct in (8). The Russellian assertion or the Fregean presupposition that there exists a person satisfying that description, will, therefore, always entail the antecedent clause or the first disjunct. So, under a strict E-type analysis a Peirce conditional is bound to have no assertive content whatsoever, and a Peirce disjunction is bound to be equivalent with its first disjunct—under a Russellian analysis, or to presuppose its first disjunct—under the Fregean one.

1.2 Gillon's Subjunctive Analysis

(Gillon 1996) improves upon the strict E-type analysis, by adopting alternative analyses of the pronoun. In order to distinguish such non-literal analyses from the strict E-type ones, we will refer to them as 'sloppy E-type' analyses.

In the case of "Peirce's Puzzle" Gillon suggests an expansion of the pronoun into *the person who wins $1.000 should everyone take part*. Gillon's sloppy E-type expansion qualifies the original description by means of a proviso. It does not (necessarily) refer to the person, if any, who actually wins $1.000, or to the person, if any, who actually wins if everybody actually takes part, but to the person, if any, who *would* win $1.000 if everybody *were* to take part. The subjunctive *should* thus invokes the consideration of possible and counterfactual course of events.

Under Gillon's sloppy E-type analysis (7) amounts to (7″):

(7) Someone wins $1.000 if he takes part.

(7″) Someone wins $1.000 if the person takes part who wins $1.000 should everyone take part.

Gillon's (7″) is best understood in a Fregean way. The sentence presupposes the existence of a particular person who would win $1.000 if everyone were to take part and it asserts that if this person actually takes part, then somebody wins $1.000. Since somebody can win $1.000 only if everybody participates, the one who wins if our person takes part must be the very same person. It is precisely the implied existence of such a lucky bird which seems to make (7) and (8) so much stronger than (5) and (6). Besides, it is also implicated that the participation of our lucky gambler brings along the participation of all other 999 candidates, and this implication makes the sentence even more dubious in the given circumstances.

Gillon's sloppy E-type analysis does much better than the strict one, but it seems it does not go the full way to meet our intuitions. Suppose for instance that (7) is true, and indeed invokes some lucky bird. Let us call her Daisy. Intuitively we would consider it some *syntactic* or *analytic* consequence of (7) that if Daisy takes part then Daisy wins $1.000. This is different in (7″). It is an analytic consequence from (7″) that if Daisy takes part then someone wins $1.000. However, the fact that Daisy herself must be the winner in that case only follows from (7″) plus what we know about the sweepstakes under consideration. For one can only win $1.000 if all (1.000) candidates participate, and only relative to that condition Daisy is presupposed to be a predestined winner.

Another, more theoretical, problem about the sloppy E-type analysis is that it appears to leave us without any systematic analysis at all. Which expansions are and which are not allowed? It may be feared that the expansion of the pronoun appropriate for (7) is specifically designed for the "Peirce's Puzzle" / sweepstakes setting, and it is not clear if, and how, such an account can be generalized.

Even in the case of a minor variant of (7) it is not obvious what expansions to use. Consider (9):

(9) Someone wins \$500 or more if he takes part.

Example (9) is an obvious and logical consequence of (7). If some individual wins \$1000 if he takes part, then that very same individual wins \$500 or more if he takes part. Therefore, as a consequence of ($7''$) the following would do:

($9'$) Someone wins \$500 or more if the person takes part who wins \$1.000 should everyone take part.

But if this of the interpretation is allowed, then it seems anything goes. One might think that a more principled expansion could do, like *the person who wins \$500 or more should 500 or more people take part*. But notice that that expansion, read in the Fregean style, would come with the presupposition that Daisy indeed takes part if at least 500 people participate. Obviously (9) has no such presupposition. (And under a Russellian interpretation it would be asserted that such a lucky bird would take part, if, that is, she exists.)

Now we might go on and inspect more fancy situations, and more fancy descriptions, but we fear this would not be quite productive. On the one hand we think our intuitions about the invoked presuppositions and counterfactuals tend to get too shaky when more baroque situations are studied. On the other hand we think there is a more serious defect with the E-type approach which we will come back to below. First, however, we turn for a moment to van Rooy's proposal.

1.3 Van Rooy's Analysis

(van Rooy 1997a; van Rooy 1997b) discusses example (10), an expansion of (8), and treats it in a strict E-type fashion:

(10) Either someone will win \$1.000, if everyone would take part, or he will not take part.

According to van Rooy, the logical form of (10) is ($10'$):

($10'$) $\exists x(\phi(x) \lhd \forall y \psi(y)) \vee \neg\psi(x)$

where $\phi(x)$ indicates that x wins \$1.000, and $\psi(x)$ that x takes part. A formula of the form $\beta \lhd \alpha$ is a strict implication which says that β would be true if α were. The real point is said to reside in the analysis of the free variable x as an E-type pronoun. The pronoun is taken to refer to the person who *would* win \$1.000 should everyone take part. Notice that there is no apparent mismatch between the description associated with the pronoun in (10) and the description by means of which the antecedent of the pronoun is introduced. Moreover, this analysis of (10) indeed entails the existence of a predestined winner.

However, although van Rooy's results seem to be fine, they do not withstand closer scrutiny. For one thing, van Rooy himself claims that (10) is false in the sweepstakes situation, if, first, the person (Daisy) takes part who would win \$1.000 if everyone were to take part, but, second, if she does not win \$1.000 because somebody else does not take part. However, if there is such a ‘lucky’ Daisy, someone who would win \$1.000 should everyone take part, then nothing more is required to make the first disjunct of van Rooy’s (10′) true, and, consequently, the whole disjunction. This fact remains true, also if we were to analyze the disjunction (10′) as an exclusive one. According to van Rooy’s own description of the situation, the first disjunct is true, and the second is false. (Notice that the present problem really is the one which, as we argued above, any strict E-type analysis of “Peirce’s Puzzle” faces.)

We submit that the examples (8) and (10) are definitely dubious in the situation described by van Rooy, but not because his reading (10′) is false—like we said it is true. Rather, it seems that role of the conditional clause *if everyone would take part* in (10) is quite different from the one suggested by (10′). To our opinion this clause figures as an appositive, which gives a further specification of the possible situation described by the first disjunct. What (10) seems to say, is that there is someone such that either everybody takes part and that person wins \$1.000, or he does not take part. That is, we might better render van Rooy’s (10) as (10″):

(10″) $\exists x(\phi(x) \wedge \forall y \psi(y)) \vee \neg\psi(x)$

If we now adopt van Rooy’s E-type interpretation of the free variable x, this says, in colloquial terms, that either everybody takes part and someone wins \$1.000, or the person does not take part who would win \$1.000 should everyone take part. This seems to be closer to our intuitive understanding of (10).

However, with this reanalysis we move further away from our original problem. First observe that the alleged E-type pronoun in (10) is not any longer analyzed in a strict E-type fashion. Upon its not implausible analysis (10″), the first disjunct of (8) describes one possibility in the sweepstakes situation, one in which everybody takes part and somebody wins \$1.000; it takes quite some syntactic manipulation to turn this into the given description. Secondly, and more importantly, it is becoming quite unclear what sentences with logical forms as displayed in (10″), however interesting, should teach us about sentences with the totally different logical form (4). This relates to the more general problem which we alluded to at the end of the previous subsection, and which we will turn to now.

1.4 Applicability of the E-type Approach

As Gillon himself observes his E-type approach involves the analysis of pronouns in bound positions as non-bound pronouns. This, however, casts serious doubts upon any E-type (or other, say, dynamic) approach to “Peirce’s Puzzle”. The E-type analysis by definition applies to non-bound pronouns, so according to the E-type analysis the pronouns in (7) and (8) really are non-bound pronouns. The sentences should therefore be associated with logical forms (2′) and (4′) or (2″) and (4″):

(2′) $\exists x(\phi(x) \leftarrow \psi(y))$
(4′) $\exists x(\phi(x) \vee \psi(y))$
(2″) $\exists x \phi(x) \leftarrow \psi(x)$

(4″) $\exists x\phi(x) \vee \psi(x)$

However, as we saw above, “Peirce's Puzzle” related to (2) and (4):

(2) $\exists x(\phi(x) \leftarrow \psi(x))$
(4) $\exists x(\phi(x) \vee \psi(x))$

Obviously, these are different logical forms. So even if the E-type strategy yields intuitively acceptable readings of sentences which have the logical forms displayed in (2′) and (4′), it doesn't say anything about sentences which “Peirce's Puzzle” is concerned with, i.e., sentences which have logical forms displayed in (2) and (4).

Recall that “Peirce's Puzzle” is not primarily concerned with sentences which do or do not give an accurate description of the sweepstakes situation. “Peirce's Puzzle”is basically concerned with the fact that (i) there are sentences which are not felt to be equivalent, whereas (ii) their apparent logical forms (1)–(4) *are*. Since none of (1)–(4) are equivalent to (2′) and (4′) or (2″) and (4″), there is nothing “Peirce Puzzling” about sentences with these logical forms, and any E-type or other analysis of the free variable in (2′) and (4′) or (2″) and (4″) simply misses the point. (Bart Geurts (p.c.) has noted that it is possible that a pronoun in the syntactic scope of a binding expression carries a different index, but is linked to the binder by some pragmatic mechanism. That would indeed be a case where, as in (2′) and (4′), an E-type analysis of a Peirce example might be attempted. However, the analysis would again be besides the point, because in the very same situation there still is the possibility of syntactic binding (coindexing), which remains unanalyzed.)

The E-type approach still could be taken to solve “Peirce's Puzzle”, if it were submitted that (all) sentences which *seem* to have logical forms like (2) and (4) *really* have a logical form like that of (2′) and (4′) or (2″) and (4″), and that these can be analyzed satisfactorily (which has not be shown yet). This, however, we consider a moot point. There are sentences with logical forms like (2) and (4) and with respect to which “Peirce's Puzzle” arises. If the puzzle were to be solved by claiming that these sentences, after all, do not have their intuitive logical forms, independent motivation should be given for that claim. So far any such motivation is lacking.

2 Peirce's Intensional Analysis

Before we take our own shot at “Peirce's Puzzle” it is useful to consider Peirce's own view of the matter, which is laid down in (Peirce 1906, §546) and (Peirce 1960, §580).

2.1 Peirce's Possibilities

Peirce discusses the assertion of the following sentence:

(11) There is some married woman who will commit suicide in case her husband fails in business.

The pronoun in (11) Peirce apparently conceives of as a bound one, and he understands the utterance as saying that there is *some* married couple of which the wife is of a certain temper. (In (Peirce 1960, § 580) he discusses the proposition that "there is a man who if *he* goes bankrupt will commit suicide." It seems nearly impossible to conceive of the pronoun here as a free one.)

Peirce discusses (11) to point out that besides actual things, possibilities should be taken into account. By means of a line of reasoning which is typically that of extensional first order logic, he sets up a reduction ad absurdum of the claim that only actual things count. If "nothing is real but existing things," he argues, then the proposition expressed by (11) turns out equivalent with the assertion that:

(12) Some married woman will commit suicide if all married men fail in business.

Peirce puts the blame for this "absurd result" on "admitting no reality but existence," and his diagnosis consists in taking *possible* courses of event into account. What is really meant by an assertion of (11), Peirce claims, is that "[t]here is some *one* married woman who under all possible conditions would commit suicide or else her husband would not have failed."

Peirce's examples, which appear to have logical forms like (1) and (2), are understood to involve universal quantification over possible course of events. The conditional sentence (12) states that on all courses of events in which all men fail in business, some or other woman commits suicide. An assertion of (11) is much stronger. It states the existence of some woman who, on all courses of events in which her husband fails in business, commits suicide.

Peirce's observations have been transposed to the sweepstakes setting by Stephen Read. Consider the utterance of a natural language analogue of (2):

(13) There is someone who wins $1.000 if he takes part.

If we generalize Peirce's observations about (11) and apply them to (13), the assertion of this sentence amounts to the proposition that there is a person who, upon all courses of events, wins $1.000 if she takes part. (So, there is Daisy again.) Let us assume that the utterance of (13) is not trivial, so that it is still open whether or not Daisy chooses to takes part. The utterance then actually claims that Daisy can win the whole lot, simply by joining the sweepstakes. In more colloquial terms this means that, if the whole sweepstakes is not a hoax, Daisy really has got an angel behind her. In any case, the proposed interpretation of (13) is much stronger than that of (5). Upon an analysis along the lines of Peirce an assertion of that sentence only says that upon every course of events in which everybody takes part somebody wins $1.000. This simply follows from the description of the sweepstakes situation and this lacks any suggestion of a predestined winner like Daisy.

2.2 A Strict Implication

According to Read, Peirce's interpretation of examples (5) and (13) should be obtained by an interpretation of the conditional clauses not as material implications but as so-called strict implications. Such a strict implication, which we indicate as $\lhd$, corresponds to Peirce's talk about courses of events if we define it in the following way:

(14) $\phi \lhd \psi \equiv \Box(\phi \leftarrow \psi)$

(Where $\Box$ involves universal quantification over possible courses of events.) Using $\lhd$, (5) and (13) can be rendered as ($5^\wedge$) and ($13^\wedge$), respectively:

(5) Someone wins \$1.000 if everyone takes part.
($5^\wedge$) $\exists x\phi(x) \lhd \forall x\psi(x)$

(13) There is someone who wins \$1.000 if he takes part.
($13^\wedge$) $\exists x(\phi(x) \lhd \psi(x))$

Example (5) thus gets the following interpretation:

($5^\wedge$) $\exists x\phi(x) \lhd \forall x\psi(x) \Leftrightarrow$
$\Box(\exists x\phi(x) \leftarrow \forall x\psi(x)) \Leftrightarrow \Box\exists x(\phi(x) \leftarrow \psi(x))$

(The last equivalence is essentially that of (1) and (2).) Example ($13^\wedge$) comes down to this:

($13^\wedge$) $\exists x(\phi(x) \lhd \psi(x)) \Leftrightarrow$
$\exists x\Box(\phi(x) \leftarrow \psi(x))$

The difference between (5) and (13) turns out to be that between two propositions of the form $\Box\exists x\chi$ and $\exists x\Box\chi$, respectively, which corresponds to Peirce's description of the case.

Under Read's analysis the examples (5) and (13) are given an appropriate interpretation in the spirit of Peirce, without fiddling with the logical forms intuitively associated with (5) and (13). Although the formulas (1) and (2) first associaited with (5) and (13) are not identical with ($5^\wedge$) and ($13^\wedge$), they are isomorphic. Read's analysis only involves the re-interpretation of the conditional as a strict implication, that is, the interpretation of $\leftarrow$ as $\lhd$.

Although Read agrees with Peirce about the intended interpretation of utterances of (5) and (13), only Read explicitly attributes the strong reading of in particular (13) to the strict implication analysis of the conditional. Peirce's view is less specific. In Peirce's own discussion about the sentences he generally refers to the propositions expressed by *assertions* of these examples, and he does not differentiate matters of meaning and use. As can be seen from the definition of $\lhd$, the same effects can in principle be obtained from an interpretation of the conditional as a material implication ($\leftarrow$) in a modal context ($\Box$). As we will argue below, such a modal setting need not necessarily be semantically given, but can also be seen to be of a pragmatic nature.

Bearing the possibilitiy of a pragmatic analysis of $\Box$ in mind, the approaches along the lines of Peirce and Read potentially differ, not in truth-conditions, but in falsity-conditions. Read explicitly has it that (13) can be false in situations where (5) is true. Upon a more pragmatic explanation of $\Box$ sentence (13) may fail to be alright without automatically having to come out false. We will come back to this issue below. Before that, we first turn to another example in which possible courses of events seem to play a role as well, that of Peirce's disjunction.

2.3 Peirce's Disjunction

Gillon has argued against Read's strict implication solution of "Peirce's Puzzle", observing that essentially the same problem arises in connection with disjunctions. Let us inspect an example which really has the logical form (4) and compare it with the alleged equivalent (6):

(6) Someone wins \$1.000 or someone will not take part.
(15) Someone wins \$1.000 or does not take part.

Example (15), like (8), seems to come with the suggestion that some individual is somehow predestined to win \$1.000 if (s)he takes part. As we already have seen, this suggestion is definitely absent from (6).

Since essentially the same problem arises in disjunctions as in conditionals, Gillon concludes that the problem cannot be really that of material implication, and that is where his E-type alternative comes in. However, although the strict implication analysis by itself provides no solution to the disjunction (15), there is no need to do away with Peirce's own solution. Peirce's view upon (5) and (13) can be easily generalized so as to cover the disjunctions too.

Peirce's solution to "Peirce's Puzzle" basically consists in universal quantification over possible courses of events and this method can also be used in the analysis of (6) and (15). The first can be understood to state that on all possible courses of events someone wins \$1.000 or someone does not take part and the result of this is yet another true description of the sweepstakes situation. The second example can then be taken to mean that there is someone who, on all possible course of events, either wins \$1.000 or does not take part. Again, this seems to relate to our lucky bird, Daisy. Under such an intensional analysis of the disjunction the two examples turn out equivalent with (5) and (13), respectively, which seems to be appropriate.

(As an anonymous reviewer pointed out example (15) is a further indication that an E-type (or a dynamic, for that matter) analysis of pronouns misses the point in "Peirce's Puzzle". As (15) does not contain a pronoun, and as it raises the same problems as example (8), it is highly implausible that the problems with (8) derive from the interpretation of the pronoun.)

An analysis of the disjunction along the lines indicated may as well be given a formulation in the style of Read. Next to a notion of strict implication, we could adopt an intensional notion of disjunction, indicated by $\bigtriangledown$:

(16) $\phi \bigtriangledown \psi \equiv \Box(\phi \vee \psi)$

Obviously, such an intensional notion of disjunction corresponds to that of strict implication:

(17) $\phi \bigtriangledown \psi \Leftrightarrow \phi \lhd \neg\psi$

Our examples (6) and (15) can now be rendered as ($6^\wedge$) and ($15^\wedge$), respectively:

(6) Someone wins \$1.000 or someone will not take part.
($6^\wedge$) $\exists x\phi(x) \bigtriangledown \exists x\psi(x) \Leftrightarrow$
$\Box(\exists x\phi(x) \vee \exists x\psi(x)) \Leftrightarrow \Box\exists x(\phi(x) \vee \psi(x))$

(15) Someone wins \$1.000 or does not take part.
($15^\wedge$) $\exists x(\phi(x) \bigtriangledown \psi(x)) \Leftrightarrow$
$\exists x\Box(\phi(x) \vee \psi(x))$

The analyses of (6) and (15) are completely analogous to those of (5) and (13), and give intuitively correct results.

2.4 The Source of the Modality

Under an analysis in the spirit of Peirce, the problematic examples (13) and (15) are assigned an intuitively satisfying interpretation, but as a solution to "Peirce's Puzzle", the analysis can still be evaluated in two ways. Like Read, one may conclude that what is at issue in (13) really is a strong implication ($\lhd$), and, likewise, an intensional notion of disjunction ($\bigtriangledown$) in (15). Alternatively, and possibly more in the spirit of what Peirce himself says, one might argue that what plays a role in both cases is an independently required form of quantification over possible course of events ($\Box$). Of course the result of both analyses is the same (as $\lhd$ and $\bigtriangledown$ are stated in terms of $\Box$), but the presence of the relevant modalities can be given a different explanation.

There seem to be no hard and decidable arguments for or against any of the two options besides, possibly, methodological ones. For instance, for Read a sentence like (13) is just one among a whole lot of examples showing the need of a strict implication analysis of conditionals, and for one who is already convinced of this need the strict implication analysis of (13) comes for free. Of course, this solution leaves the analysis of (15) still an open issue. Alternatively, if it is possible to explain the $\Box$-effects in an independent way, one can account for (13) and (15) in a uniform way.

In this paper we elaborate upon the last approach and try and develop an alternative explanation of the $\Box$-effects. The idea is to keep to a classical and uniform interpretation of the connectives and explain the special (intensional, strict implicational) effects in an alternative, pragmatic way. We thus want to comply with Grice's rule that "[s]enses are not to be multiplied beyond necessity," a rule he dubbed "modified Occam's razor" (Grice 1978). Of course, we also do not want to follow the proverbial practice of throwing semantic problems in the 'pragmatic wastebasket', so we actually have to provide a pragmatic explanation of our special effects.

In the following two sections we will argue that the $\Box$-effects of the discussed examples really derive from a Gricean notion of 'support' or 'licensing'. Linguistic agents are generally assumed to say things which they have evidence for, and such 'speaker's commitments' can be modeled by requiring a speaker not to depict the world in a way (s)he knows it not to be. Of all possible ways the world might be like for as far as the speaker knows, not one should be excluded by what (s)he says. Peirce's quantification over possible courses of events can thus be seen to derive from quantification over ways the world might be according to a speaker, and this pragmatic type of information is the source of our $\Box$-effects.

In addition we will argue that speakers also ought to (pretend they) know, in some relevant sense of 'knowing', what they talk about. If one asserts, of some individual, that he is so–and–so, one somehow implies having the information, about that individual, that he is so–and–so. This type of information will turn out to be crucial for the support of utterances of examples (13) and (15). As we will see a formal analysis along these lines naturally suggests itself in the setting of recent frameworks of dynamic semantics, in which pragmatic and semantic aspects of interpretation are dealt with in an integrated fashion.

3 A dynamic / pragmatic approach

Current systems of dynamic semantics give us a handle on "Peirce's Puzzle", *not* because of their treatment of pronouns as (bound) variables, but because of their treatment of indefinite noun phrases, partly, as (free) variables (Heim 1982; Kamp and Reyle 1993; Groenendijk and Stokhof 1991; Dekker 2001). Indefinite noun phrases can be used to set up 'discourse referents', labeled by variables, which coindexed pronouns later may refer back to. This use of indefinites appears to be governed by a conversational principle which turns out to be immediately relevant for "Peirce's Puzzle". This principle can be conceived of as a first order specification of Grice's maxim of quality. Since this specification is not a trivial issue, we give it some further motivation before we apply it to "Peirce's Puzzle".

3.1 Grice's Quality and Quantity

Grice's well-known maxim of quality "[t]ry to make your contribution one that is true" (Grice 1975) is crucial for the purpose of reliable information exchange. The maxim can be given a formal specification, roughly, along the following lines. For this, we first need a formally explicit notion of an information state which allows us to model the information (linguistic) agents may have in a suitable (simplified) way. Second, we need a formalized language to represent the (simplified logical forms of) the sentences which agents are in principle able to utter. Third, we need a support relation $\models$ which characterizes when an agent's information state σ supports a sentence or formula ϕ: $\sigma \models \phi$. In terms of such a notion of support we then can characterize when an agent is or is not licensed to make a certain utterance:

(18) agent a is licensed to state ϕ only if his state $\sigma_a \models \phi$

Let us illustrate this by means of a simple example. Think of a formal language like that of propositional logic, which is evaluated relative to a model of modal propositional logic. The information which agents have can then be assumed to be information about the world and it can be characterized by the sets of possible worlds which the real world could be like according to the information which the agents have. As is fairly standard, the formulas of the language can be associated with sets of possible worlds, too. The meaning $[\![\phi]\!]$ of a formula ϕ can then be equated with the set of possible worlds in which ϕ is true.

Relative to such a simple model it is easy to see what the support, and, hence, the licensing relation should amount to:

(19) $\sigma \models \phi$ iff $\sigma \subseteq [\![\phi]\!]$

An agent a is licensed to state ϕ only if ϕ does not exclude the world to be in a certain way which a thinks it could be. Put the other way around, if ϕ indicates that the world is a certain way, then a has the information that the world is that way.

This simple exercise in defining a Gricean notion of quality already gives us the first half of our reply to the question where the modality in "Peirce's Puzzle" comes from. An agent a is licensed to state ϕ only if ϕ holds *in all worlds* which the agent conceives possible. If, as is pretty natural, the agent has only partial knowledge about what the future will be like, a statement *Will* ϕ is licensed only if ϕ holds on all courses of events a conceives possible. This corresponds with the way Peirce put it.

The point can be sharpened when we also take Grice's first maxim of quantity into account: "make your contribution as informative as is required." If we focus in on conditional sentences $\phi \rightarrow \psi$, this maxim basically (but not inflexibly) adds that an agent a is licensed to utter $\phi \rightarrow \psi$ only if $\sigma \not\models \neg\phi$ and $\sigma \not\models \psi$, for otherwise a could have made a stronger statement, viz., $\neg\phi$ or ψ, respectively. Taken together, the two maxims constrain the utterance of conditional sentences in the following way:

(20) an agent a is licensed to utter $\phi \rightarrow \psi$ only if (i) a does conceive events possible where ϕ holds, and also events where ψ doesn't hold, but (ii) on all courses of events a conceives possible, if ϕ holds there, then so does ψ

Here we see that an appropriate statement of $\phi \rightarrow \psi$ really indicates that the speaker has information supporting a dependency between the two propositions, very much like the one given by the strict implication reading of the conditional.

3.2 First Order Information

Talk about quality and quantity gets puzzling as soon as we start to look at first order extensions of our propositional language. Think of the question what should license the utterance of open propositions, propositions expressed by formulas with free variables or pronouns. A related problem concerns indefinite noun phrases which introduce 'discourse referents', which subsequent anaphoric pronouns refer back to. How should the support of such expressions be evaluated? It may be obvious that, within the classical possible worlds framework there do not seem to be straightforward and intuitively acceptable answers to these questions. We here face a familiar issue, concerned with the notion of knowledge of individuals, and (not) knowing *who*.

It seems to have become a commonplace that although epistemic agents can be said to have information of individuals in the world, such an epistemic relation should not be construed as a direct relation. Agents may have information of individuals from different points of view, from different perceptual or cognitive perspectives, from hear-say, etc., and they can have different bits of information about one and the same individual without realizing that one and the same individual is involved. As Frege pointed out it can be a contingent empirical discovery that a heavenly body seen from two perspectives really is one and the same entity seen from two perspectives. Similarly, Quine's protagonist Ralph has (conflicting) bits of information relating to one and the same individual (Ortcutt) known from two different (types of) situations (Quine 1956). It would be inappropriate to construe the epistemic relation between Ralph and Ortcutt as an direct relation, for this would amount to ascribing him a belief in inconsistent propositions. As is clear, Ralph need not be inconsistent himself. The fact that the bits of information are about Ortcutt, and that they, thus, are consistent, can only be established as an *external* fact about Ralph's belief state.

Facts like these can be modeled in an attractive way if we adopt the kind of information states which have been developed in systems of dynamic semantics. Dynamic semantic information states dress information around discourse referents, or 'belief objects', which can be understood to be the representatives of the entities which a (linguistic) agent is concerned with. (Cf., van Rooy 1997a; Zimmermann 1999; Dekker 2000 for recent statements of similar opinions.) It can very well be that the information state actually fails to identify the individual which a belief object is supposed to stand in for, but there is a general assumption that these objects do, objectively, stand in for real, and unique individuals. That is to say that if some agent a has some belief object o, then o is given to a at least with some conceptualization which, for a, is uniquely identifying. These conceptualizations can be of various kinds, of course. They can be of the form of a visual or acoustic impression of a cat nearby, or of a description like "my boss," "the man seen on the beach," or even "the present king of France." A conceptualization can also be of some indirect, intentional, form, like "the person Tim intended to refer to when he told me that a man had ruined Ben's office." Especially the latter type is interesting. It shows, on the one hand, that the concept may easily fail to actually denote an individual, or to denote a unique one. On the other hand, it also shows that it need not enable the agent to actually identify the referent among a common domain of individuals. All that is required is that the agent believes that there is one individual which Tim intended to refer to on the mentioned occasion, and if that belief is correct, the belief object stands in for *that* individual. (And even Tim need not be required to know whom, in a colloquial sense, he is referring to: Tim himself may have the individual in mind which Ben intended to refer to when Ben told Tim that someone had ruined his office.)

For practical and logical purposes there is no need in specifying the ways in which the belief objects are given to an agent. What counts, in what follows, is that information is dressed around belief objects and that these are *assumed* to stand in for real individuals.

3.3 First Order Information Exchange

In (Dekker 2001) dynamic semantics information states are used to extend the Gricean notion of support to the first order level. Basically, it implements a first order reformulation of Grice's maxim, which may read as follows:

(21) try to make your contribution one that is true *of the individuals you intend to refer to*

What an agent says about individuals should be motivated by information he has dressed around certain belief objects of his. This reformulation seems to be intuitive (or indeed trivial) enough when we are concerned with an agent's use of proper names, definite descriptions or demonstrative pronouns. But the reformulation also affects the use of indefinite noun phrases (and anaphoric pronouns), as the following discussion intends to show.

Imagine the following situation. Liz was visited by two HiWi's yesterday, who both inquired after the secretary's office; one of them (Wilburt) did, and the other (Norbert) did not wear pink pumps. Liz is also fully aware of this, and does not suffer from hallucinations or amnesia. Now consider the following dialogue:

(22) *Liz:* Yesterday, a HiWi ran into my office who inquired after the secretary's office.

(23) *Dib:* Was he wearing pink pumps?

(24) *Liz:* He was indeed.

Clearly, Liz's answer to Dib's question can be right or wrong, true or false. But it seems we can only make sense of this if it is clear whom Liz was talking about. Apparently, Liz must have had either or Wilburt or Norbert in mind when she uttered (22). If it was Wilburt, her reply (24) is licensed (and true), if it was Norbert, it is not (so false and misleading).

Now take the same situation, assume there are no further relevant data, and suppose Liz alternatively replies with (25) upon Dib's question (23):

(25) *Liz:* I don't know. If it was Wilburt he was, if it was Norbert, he was not.

(This example is due to Ede Zimmermann, p.c.) Surely (25) is an odd reply. We claim the reason is again that Liz must have had either or Wilburt or Norbert in mind when she uttered (22). If she had had Wilburt in mind she could have come up with a more informative answer, and also if she had had Norbert in mind, so in both cases she would violate Grice's first maxim of quantity. The only reason which Liz could have for not being able to furnish a better answer than (25) could be that she doesn't know herself whom she was referring to when uttering (22), that, when uttering (22), she had not yet decided whom she was going to talk about. But that is really exotic.

It may be noticed that a reply like (25) is not always odd, as our last example shows. Suppose the situation is similar to the previous one, but there are some other relevant facts. Liz missed her keys after Norbert and Wilburt had ran into her office and she is convinced that one of the two took them. Now consider the following dialogue:

(26) *Liz:* Yesterday, one of the HiWi's took my keys.

(27) *Dib:* Was he wearing pink pumps?

(28) *Liz:* I don't know. If you really want to know, if it was Wilburt he was, if it was Norbert, he was not.

The reason why (28) can be alright this time is that Liz does not have two belief objects but three. There are the persons known as Wilburt and Norbert, as before, but this time there is the individual known as *the person who took Liz's keys*, and which is either Wilburt or Norbert. And even though Liz does not know which of the two it is who took her keys, she can be confident enough that there is one such individual, and she is eager to find out who that particular person really is.

The upshot of the preceding examples is that also indefinite noun phrases generally are or ought to be used with referential intentions, mediated by a speaker's belief objects. Even though the speaker may fail to know—in some sense—which individual he is actually referring to, he is required to assume that the individual is determined in *some*, for the speaker uniquely identifying, way. (We must immediately add that this Gricean constraint on the use of indefinite noun phrases does not apply to all indefinite noun phrases. It mainly applies to 'surface' indefinites, indefinites which are not in the scope of quantifiers, or conditional or modal operators. See (Dekker 2001) for some further discussion and motivation.)

We also may have to emphasize that our constraint is a pretty weak one indeed. For one thing, it does not all entail that indefinite noun phrases are referential expressions, or that they are always 'specific'. It only requires the speaker to have some concept of an intended referent which is uniquely identifying for him, and this concept does not at all contribute to the semantic content of what the speaker says.

3.4 First Order Support

The observations from the previous subsection can be made formally explicit in the following way. The basic ideas are that (i) indefinite noun phrases partly behave like free variables and (ii) that surface indefinites are associated with belief objects, characterizing the intended referent. The first idea goes back to (Lewis 1975) and has been developed in file change semantics (*FCS*, Heim 1982), discourse representation theory (*DRT*, Kamp and Reyle 1993) and dynamic predicate logic (*DPL*, Groenendijk and Stokhof 1991). The second idea has been motivated and worked out further in (Dekker 2001).

To begin with we employ a notion of first order information which is basically that of Heim, and which is used to chacterize both the contents of sentences and that of the information states of epistemic agents. What count as a discourse referent in the one thus counts as a belief object in the other. These information states consist of a domain of variables and sets of pairs consisting of a world and an assignment to the variables in that domain. The variables in the domains of these states figure as labels for the discourse referents or belief objects. (Often, the domain of the state can be skipped, as it can be reconstructed from the variable assignments.) The language is that of first order logic, in (Dekker 2001) extended with a category of anaphoric pronouns. (The latter paper deals with the dynamics of anaphoric binding by means of a dynamic conjunction of static meanings, but this is not really relevant for the purposes of this paper.)

When it comes to generalizing the notion of support (and licensing) to the first order level, sets of possible worlds are replaced by the more general information states from Heim. What we want to say, intuitively, is that the utterance of a formula ϕ by an agent a is licensed only if the belief objects which a has in mind with the utterance of ϕ, have the properties attributed to them with that utterance. Formally, this involves a linking relation l, which specifies, for each discourse discourse referent mentioned in ϕ, which belief object the speaker had in mind when mentioning it. A link can be taken to be a sequence of labels, the first corresponding to the first indefinite (existential quantifier) in ϕ, the second with the second one, etc. Furthermore, we have assignments i which this time associate the free variables of ϕ with belief objects.

The supports relation thus may hold of an information σ and a formula ϕ relative to an assignment function i and a link l, which is written as $\sigma \models_{i,l} \phi$. And although it can be defined in terms of an independently specified notion of satisfaction (Dekker 2001), the relation itself can also be stated independently in a recursive way. Two crucial clauses in such a definition are the following:

(29) $\sigma \models_{i,l} P(x)$ iff $\forall\langle w, g\rangle \in \sigma$: $g(i(x))$ is P in w

(30) $\sigma \models_{i,l} \exists x\phi$ iff $\sigma \models_{i[x/l_1],l-1} \phi$

(Where $l-1$ is the sequence l with the first element stripped off.) Thus, a state σ supports a formula $\exists x P(x)$ relative to a link l, iff the belief object of σ indicated by l indeed has the property P in all possibilities in σ.

For Liz to be licensed to utter (26) above, she must assume have an individual in mind which, according to her information, is a HiWi who took her keys. Similarly, for someone to be licensed to utter (13), he must have an individual in mind about which he has the information that if that individual takes part, (s)he wins \$1.000. If such a speaker does not violate general conversational principles, she must have *some* idea *who* it is that wins by simply partaking.

4 Back to "Peirce's Puzzle"

The pragmatic / semantic perspective on the meaning and use of indefinite noun phrases which we sketched in the previous section immediately applies to the examples figuring in "Peirce's Puzzle". First observe that there is nothing peculiar about the (unproblematic) examples (5) and (6):

(5) Someone wins \$1.000 if everyone takes part.

(6) Someone wins \$1.000 or someone will not take part.

An agent a is licensed to utter (5) or (6) only if in all the worlds which he considers possible, someone wins \$1.000 if everybody takes part. For this to be the case it suffices that a knows about the sweepstakes (and about the number of potential participants).

4.1 The Frame Up

Things are significantly different when we consider the support for an utterance of the (problematic) examples (13) and (15):

(13) There is someone who wins \$1.000 if he takes part.

(15) Someone wins \$1.000 or does not take part.

Both examples contain a surface indefinite noun phrase. According to our notion of support such a noun phrase must relate to an object in the information state of the speaker a, and for any one of the two (equivalent) sentences to be felicitously uttered, this must be a belief object which is dressed with the property of either being a winner of \$1.000 or not taking part.

Let us assume then, as before, that an utterance of (13) or (15) relates to a lottery which has not taken place yet. If the speaker a in that case has information about somebody that if (s)he takes part she wins \$1.000, then a should have the information about him or her that, on any possible outcome of the lottery, this person will either not take part or win \$1.000. This neatly corresponds to Peirce's interpretation of (13) and (15).

Let us consider the case in a bit more detail. In the sketched circumstances, a has information dressed around a certain belief object, let's say it is Daisy for a. To be licensed to utter (13) or (15), a must have the information that on any possible outcome of the lottery, Daisy either does not take part or wins \$1.000. This can be true in the following three cases:

1. a has the information that Daisy wins anyhow
2. a has the information that Daisy will not take part anyway
3. a does not have the information that Daisy participates or not, but a does have the information that if she participates she wins \$1.000

It must be clear that, in case of (1) or (2), an utterance of (13) or (15) constitutes a violation of Grice's maxim of quantity. In that case it were more appropriate and informative for a either to say that someone is going to win \$1.000 or to say that someone does not take part (i.e., that noone is going to win \$1.000).

This leaves us with the third case, which suggests a has prior knowledge about the drawing of the lots. This can have several explanations. For instance, the lottery can be known to be framed up, or a simply knows that the mentioned individual is a lucky bird. Notice that it is precisely this kind of foreknowledge which an utterance of (13) or (15) seems to convey. A speaker indicates that he has information about a person, that she may or may not take part, but that in case she does take part, then everybody will and she wins the whole \$1.000. Indeed this is the type of information which also gets conveyed upon Peirce's and Read's analysis.

Notice, that our explanation only works because it is required that (surface) indefinites ought to be used with referential intentions. Without our first order extension of the notion of support, a's utterance of (13) or (15) would require (2) to be true on all possibilities a conceives possible, but as we have seen at the first pages of this paper, that is identical with the requirement that (1) be true on all these possibilities, which simply means that a knows about the sweepstakes setting. It is indeed because a is required to know these things *with reference to* some individual or object that a's utterance of (13) get this stronger force. What is added is precisely what in Peirce's own analysis is stated as the difference between $\Box\exists x\chi$ and $\exists x\Box\chi$.

Indeed, in either case, frame up or lucky bird, our agent a is required to have the information that the truth-conditions are satisfied which Peirce and Read associate with an utterance of the examples (13) and (15), and which (loosely) correspond with an intuitionistic reading. The difference is that, upon our analysis, the additional type of information is derived in a pragmatic fashion from a classical (extensional) interpretation of the sentential connectives.

4.2 A Queer Object

Key to the understanding of our notion of support is that an agent's belief objects represent real objects for him. The exchange of information about individuals is concerned with the real individuals and not with their representatives in epistemic states. This issue is not unimportant since, as we have seen above, there need not be a one to one correspondence between an agent's belief objects and the individuals which they represent.

The individual whom Liz knew as the person who took her keys in example (26) was a properly determined belief object, with a definite reference. But this object could either stand for Wilburt or for Norbert, depending upon whether it was Wilburt who actually took Liz's keys or Norbert. This possibility indicates that, theoretically speaking, we have the possibility of making up a mixed belief object which represents the individual d which wins \$1.000 if everybody actually takes part, and otherwise an individual d' which does not take part, say the *first one* who decides not to partake. It turns out that if a belief object is defined thus, it can be used to support (13) and (15), without this requiring there to be a person known as a predestined winner.

Surely, everybody probably senses that there is something very queer about an object like the one we have determined just now; for one thing, nobody would probably ever come up with a object thus defined, if it were not a formal semanticist trying to test the limits of his recently developed framework. Nevertheless, we would like to know why exactly such a mixed belief object appears to be so queer. To our opinion, the suggested belief object is not a proper one, because it is not referential.

When Liz has partial knowledge about the identity of the key-thief, this involves partial knowledge about the actual situation. Liz does not know whether she lives in a world in which Wilburt took the keys, or in one in which Norbert did. Nevertheless, she has the properly motivated intention to refer to the one and only individual which actually took her keys. Things are quite different in the case of our blended belief object. This is a composite creature which cannot be identified in the current situation. It may turn out to be different individuals depending upon the different course of events which the future takes. Thus, it cannot be referential in the way the key-thief is.

The last argument can be seen to rely on a 'branching view' of time, the view upon which at a certain moment in time things may turn out this way or that, and the true non-identity of our odd object consists in its dependence on which of these possible futures actually materializes. Under this conception, the object is improper because it is not (yet) determined. Now one might object that under a non-branching view of time our problematic object would again be fully determined, and this is indeed correct.

If time is not branching then the future is contained in the present, so to speak. So if it is actually true that someone is going to win \$1.000 (or if it is actually true that somebody is going to be the first one not to take part), then that person is now predestined to win (or not to take part). But this observation corresponds with those of Peirce. If we only take *actual* course of events into account, then (5) and (6) trivially mean the same as (13) and (15). In contrast, our intuitions about the examples indicate that we are concerned with actual individuals, and with their whereabouts in possible states of affairs.

4.3 The Pronominal Examples

Let us now return to the type of examples which Gillon and van Rooy discuss, those that, unlike (13) and (15) do involve free variables:

(7) Someone wins \$1.000 if he takes part.
(8) Someone wins \$1.000 or he will not take part.

If we respect the apparent surface structure of these examples it appears that the main connectives are *if* and *or* and that they combine two different sentential clauses, one which contains the indefinite *someone* and one which contains the anaphoric pronoun *he*. The examples, thus, contain (syntactically) free or non-bound pronouns.

If the pronouns in the examples (7), (8) are indeed (syntactically) free, then we need some device to interpret them in relation to the preceding noun phrases. Two types of analysis are known in the literature which deal with anaphoric dependencies of this kind. There is the E-type pronoun approach, which we discussed earlier in this paper. Furthermore, there are (extended) dynamic analyses which generalize over and improve upon Montague's technique of 'quantifying in'. In the final part of this section we will show how the latter type of technique renders a satisfactory analysis of the above cases as well as of a couple of more involved ones.

For simple cases like that of (7) and (8), Montague's schematic rule of quantification (S14) gives satisfactory results (Montague 1974). By means of this rule, the noun phrase *someone* can be quantified into a structure with two occurrences of a free variable x:

(31) x wins \$1.000 if x takes part

(32) x wins \$1.000 or x does not take part

Syntactically the quantification rule amounts to replacing the first occurrence of x by the noun phrase *someone*, and the second one by a pronoun of the appropriate type. Thus, our sentences (7) and (8) result. Semantically, the rule involves the existential closure of the variable x. The examples come out stating that there is someone who wins \$1.000 if he takes part and that someone wins \$1.000 or does not take part. Upon this analysis (7) and (8) are equivalent with (13) and (15), as required. If the (Montagovian) analysis is embedded in the pragmatic / semantic framework which we argue for, we also obtain the intuitively correct interpretation of these examples.

4.4 Type Shifting

Montague's rules of quantification give rather bad results when it comes to downward monotonic noun phrases like, for instance, *noone*. Consider:

(33) Noone wins \$1.000 if he takes part.

If we use Montague's rule (S14) to quantify *noone* into (31) then the resulting sentence (33) is assigned an interpretation equivalent with (34):

(34) Noone wins \$1.000 and everyone takes part.

For if there is no x of which (31) holds, then for every x the negation of (31) holds, so that for every x we find that x does take part and x does not win \$1.000. Obviously, this is not a sensible reading of example (33). The intuitive interpretation of (33) is rather that of (35):

(35) Noone who takes part wins \$1.000.

It may be noticed here that a strict implication analysis of the bound clause (31) would not produce satisfactory results either. Under the strict implication analysis, this clause says that some x is predestined to win. Thus, if the noun phrase *noone* is quantified into (31) under this interpretation, example (33) comes out to mean that noone is predestined to win \$1.000. Really, this is the negation of example (13) under the analysis of Read, who claims (13) to be false if nobody is predestined to win. But although this is a sensible thing to say, that nobody is predestined to win, it does not seem to be what example (33) conveys.

In (Groenendijk and Stokhof 1990; Dekker 1999) dynamic generalizations and improvements of Montague's rules of quantification have been proposed which avoid the mentioned problem. In (Dekker 1999) we have proposed a way of dealing with non-standard scope extensions ('telescoping') which is based on Hendriks' system of flexible type assignment (Hendriks 1993, Ch. 2). Hendriks' system provides for a principled way to 'lift' the (semantic) scope of a quantifier beyond its local binding domain. By means of this system, too, noun phrases can be assigned wide scope over the construction in which they figure.

For downward monotonic expressions Hendriks's lifts have been assigned an alternative interpretation in (Dekker 1999) which preserve monotonicity properties. By means of a fully compositionally defined notion of ('dynamic') negation, a sentence *noone wins $1.000* can be assigned exactly the same 'telescoping' interpration as *everyone does not win $1.000*, and under such a telescoping interpretation the following two sentences are rendered equivalent:

(36) Everyone does not win $1.000 if he takes part.

(37) Everyone who takes part does not win $1.000.

Consequently, we find in this system that:

(33) Noone wins $1.000 if he takes part.

is rendered equivalent with (35) too:

(35) Noone who takes part wins $1.000.

which is the required result.

5 Conclusion

In this paper we have discussed "Peirce's Puzzle", a puzzle concerned with sentences which do not feel to be equivalent but which appear to have equivalent logical forms. We have discussed two previous diagnoses of the puzzle. As a solution to the puzzle Read (and possibly Peirce himself) propose a strict implication analysis of conditional sentences and as Gillon has argued, such a solution should preferrably be extended with some equally intensional notion of disjunction. Alternatively, Gillon and van Rooy take the puzzle to motivate an E-type analysis of non-bound pronouns. The specific E-type interpretation of the pronouns in certain sentences could then be held responsible for the special readings which these examples seem to have.

We have found both analyses unsatisfactory. The E-type approach, we argued, does not really address "Peirce's Puzzle" because in its original statement the puzzle does not involve free variables or non-bound pronouns. Besides, a strict E-type analysis was argued to be untenable, and only a non-principled analysis appears to be able to produce appropriate results. The intensional approach was felt to be incomplete in that it does not provide a motivating ground for the intensionality involved. Besides, on a semantic intensional analysis like that of Read, the appropriate, strong truth conditions of (13) and (15) seem to come with inappropriately weak falsity conditions. To our opinion (13) is not false, and (33) is not true, if everybody takes part and if it is still an open issue who will win:

(13) There is someone who wins \$1.000 if he takes part.

(33) Noone wins \$1.000 if he takes part.

As a matter of fact, we think that (33) is false on that occasion.

We have finally given our own solution to "Peirce's Puzzle", which is a combined semantic / pragmatic one. Drawing from independently motivated Gricean principles, lifted to a first order level, our intuitions regarding "Peirce's Puzzle" can be explained on the basis of a classical interpretation of both conditional sentences and bound pronouns.

Key to our analysis is an extension of Grice's quality maxim to a first order level. Linguistic agents should have information supporting what they say—or at least should pretend to have that information—and when they attribute properties to individuals, they should have the information that these individuals have these properties. The crux is that this also holds in case indefinite noun phrases are used. Although indefinites are not used, normally, with an intention to reveal their referent, it is assumed that a speaker does have a specific referent in mind. That is to say, by means of an utterance of (13) the utterer must have somebody in mind, let us say Daisy, and he must have the information about her which is expressed by the following sentence:

(38) Daisy wins \$1.000 if she takes part.

Surely, (38) comes with the suggestion of a predestined winner, like (13), without this requiring an alternative (strict) interpretation of the conditional or an alternative (E-type) analysis of the pronoun. Example (38) is true if and only if either Daisy wins \$1.000 or she does not take part. And an utterance of (38) is supported only if the utterer has the information that, whatever way things go, (38) is true. In case the utterer does not yet know whether Daisy takes part or not, he indicates 'secret' knowledge about how things go in case Daisy in fact decides to part.

Similar considerations imply that (13) is certainly not false if the outcome of the sweepstakes is still open, although we know that everybody takes part. According to our view, (13) is strictly speaking true in that case. The only problem is that it is unsupportable.

Like we said, "Peirce's Puzzle" does not involve unbound pronouns, so it does not require any dynamic or E-type binding of free variables. But although "Peirce's Puzzle" is not dynamic in the narrow sense of the word—in which it relates to context change and transitions—it is dynamic in a wider, and we think preferrable sense of the word. Upon our explanation of "Peirce's Puzzle" it relates to the special pragmatic and semantic behaviour of indefinite noun phrases in natural language and to the interaction between semantic and pragmatic information. The study of such features of the larger contexts of information interchange arguably belongs to the dynamic theory of interpretation broadly conceived.

Let us finally return to the questions we raised at the end of the introduction. What moral should be drawn from our study of "Peirce's Puzzle"? It will be clear that we do not deem formal logic 'wrong' for empirical reasons, nor do we think folk reasoning has to be improved upon. So we are left with the third possibility, the logical analysis of (utterances of) natural language sentences. Like we said, indefinite noun phrases have certain traits generally attributed to free variables. More things can be and are ascribed to their possible values which are hardly characterizable if they are just existentially closed expressions. But even so there are still two relatively different ways to proceed. If, on the one hand, one considers it a point worth formal logical investigation that indefinite noun phrases (also) behave like free variables, then it is expedient to make these features formally explicit, and one probably ends up with some dynamic notion of meaning (in a broad sense), reminiscent of the notions of meaning endorsed in *DRT*, *FCS*, or *DPL*. If, on the other hand, one deems these aspects of the use of indefinite noun phrases purely pragmatic, then one may as well stick to the classical (extensional and static) notion of meaning.

In this paper we did not, and we will not, choose between these two options. We firmly believe that the two options are compatible, as much as the dynamic and static notions of meaning are. A choice between the two is sensible only relative to the philosophical, descriptive or logical goals one aims to achieve in a most transparant way.

Paul Dekker
ILLC/Department of Philosophy
Nieuwe Doelenstraat 15
NL-1012 CP Amsterdam
The Netherlands
`dekker@hum.uva.nl`

Acknowledgements

I would like to thank Bart Geurts, Brendan Gillon, Michiel van Lambalgen, Mats Rooth, Robert van Rooy, Ede Zimmermann and an anonymous reviewer for the Journal of Semantics for inspiring discussions and comments. The research for this work is supported by a fellowship from the Royal Netherlands Academy of Arts and Sciences (KNAW), which is gratefully acknowledged. The work is part of the *Logic in Communication* project, which is funded by a Spinoza award from the Dutch Organization for Scientific Research (NWO).

Bibliography

Dekker, Paul (1999), 'Scopes in discourse'. *Language and Computation* **1**: 7–32.

Dekker, Paul (2000), 'Coreference and representationalism'. In Heusinger, Klaus von & Urs Egli (eds.), *Reference and Anaphorical Relations*. Kluwer. Dordrecht. 287–310.

Dekker, Paul (2001), 'Meaning and use of indefinite expressions'. *Journal of Logic, Language and Information* **10**: in print.

Evans, Gareth (1977), 'Pronouns, quantifiers and relative clauses (1)'. *The Canadian Journal of Philosophy* **7**: 467–536. Reprinted in Evans, Gareth (1985), *Collected papers*. Foris. Dordrecht. 76–152.

Gillon, Brendan S. (1996), 'Three theories of anaphora and a puzzle from C. S. Peirce'. In Dekker, Paul & Martin Stokhof (eds.), *Proceedings of the Tenth Amsterdam Colloquium*. ILLC, University of Amsterdam. Amsterdam. 283–297.

Grice, Paul (1975), 'Logic and conversation'. In Cole, Peter & Jerry L. Morgan (eds.), *Syntax and Semantics, Vol III: Speech Acts*. Academic Press. New York. 41–58.

Grice, Paul (1978), 'Further notes on logic and conversation'. In Cole, Peter (ed.), *Syntax and Semantics, Vol IX: Radical Pragmatics*. Academic Press. New York. 113–127.

Groenendijk, Jeroen & Martin Stokhof (1990), 'Dynamic Montague grammar'. In Kálmán, László & László Pólos (eds.), *Papers from The Second Symposium on Logic and Language*. Akadémiai Kiadó. Budapest. 3–48.

Groenendijk, Jeroen & Martin Stokhof (1991), 'Dynamic predicate logic'. *Linguistics and Philosophy* **14**: 39–100.

Heim, Irene (1982), *The Semantics of Definite and Indefinite Noun Phrases*. Ph.D. thesis. Department of Linguistics. University of Massachusetts. Amherst. Published in 1988 by Garland, New York.

Hendriks, Herman (1993), *Studied Flexibility*. Ph.D. thesis. Department of Philosophy. University of Amsterdam. Amsterdam.

Kamp, Hans & Uwe Reyle (1993), *From Discourse to Logic*. Kluwer. Dordrecht.

Lewis, David (1975), 'Adverbs of quantification'. In Keenan, Edward L. (ed.), *Formal Semantics*. Cambridge University Press. Cambridge, UK. 3–15.

Montague, Richard (1974), 'The proper treatment of quantification in ordinary English'. In Thomason, Richmond (ed.), *Formal Philosophy. Selected papers of Richard Montague*. Yale University Press. New Haven. 247–70.

Neale, Stephen (1990), *Descriptions*. MIT Press. Cambridge, MA.

Peirce, Charles S. (1906), 'Prolegomena to an apology for pragmaticism'. *The Monist* **16**: 492–546.

Peirce, Charles S. (1960), 'An improvement of the gamma graphs'. In Hartshorne, Charles & Paul Weiss (eds.), *Collected Papers of Charles Sanders Peirce, Vol IV, The Simplest Mathematics*. Harvard UP. Cambridge, MA. 464–470.

Quine, Willard V. (1956), 'Quantifiers and propositional attitudes'. *Journal of Philosophy* **53**: 177–187.

Read, Stephen (1992), 'Conditionals are not truth-functional: an argument from Peirce'. *Analysis* **52**: 5–12.

Rooy, Robert van (1997a), *Attitudes and Changing Contexts*. Ph.D. thesis. Institut für Maschinelle Sprachverarbeitung. Stuttgart University. Stuttgart.

Rooy, Robert van (1997b), 'Descriptive pronouns in dynamic semantics'. In Dekker, Paul, Martin Stokhof & Yde Venema (eds.), *Proceedings of the Eleventh Amsterdam Colloquium*. ILLC, University of Amsterdam. Amsterdam. 265–270.

Zimmermann, Thomas E. (1999), 'Remarks on the epistemic rôle of discourse referents'. In Moss, Lawrence S., Jonathan Ginzburg & Maarten de Rijke (eds.), *Logic, Language and Computation, Vol II*. Kluwer. Dordrecht. 346–368.