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# The Context-Dependency of Implicit Arguments

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## 1 Introduction

Context-dependency is traditionally taken to involve the context of utterance and meanings are specified as functions from contexts to content (Cresswell 1973, Kaplan 1989a, Lewis 1981, Stalnaker 1972).<sup>1</sup> Context-dependent linguistic expressions are assumed to comprise a small inventory of closed-class elements, such as tense, indexicals, deictic and demonstrative pronouns, and context determines content to the extent that it supplies values for these expressions. Empirical demands and theoretical developments, however, have greatly expanded the notion and scope of context-dependency. With the advent of dynamic semantics, for example, context has been construed in such a way as to incorporate information derived from previous linguistic discourse<sup>2</sup> and context-dependency has been expanded to include pronominal anaphora.

Mitchell (1986) and Partee (1989) have demonstrated that context-

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<sup>2</sup>The idea goes back to Stalnaker (1978) where the propositional content of previous linguistic discourse is available as a contextual parameter. DRT and dynamic semantics provide more fine-grained conceptions of context so as to account for intersentential and sentence-internal anaphora.

dependence extends even beyond the pronominal domain to encompass a large open class of contentful linguistic expressions.<sup>3</sup> Relational predicates such as *win*, *local*, *imminent* can be construed with an implicit argument and in order for them to be interpretable the context, linguistic or extra-linguistic, must supply a certain kind of information.<sup>4</sup> As observed by Mitchell and Partee, implicit arguments of such predicates have deictic, discourse anaphoric and bound variable readings. Given the similarity of implicit argument with overt pronominal elements in the type of context-dependency they exhibit and their range of readings, Partee (1989) argued for the need to extend the analyses of pronominal anaphora so as to cover the entire class of context-dependent expressions and for the need to integrate indexicality with variable binding.

In this paper we will assume that contentful context-dependent expressions are relational predicates with at least one implicit argument.<sup>5</sup> Our aim is to give a unified account of the readings of their implicit arguments and to characterize the type of context-dependency involved. We claim that context-dependent predicates are associated with familiarity presuppositions with respect to their implicit arguments and that these presuppositions account for the particular kind of context-dependency and for the readings of implicit arguments. In section 2 we distinguish implicit argument predicates that are crucially context-dependent from those that are not and describe their range of readings. In section 3 we provide an analysis of the anaphoric readings of implicit arguments. In section 4 we integrate the anaphoric and indexical readings of implicit arguments.

## 2 The Problem of Implicit Arguments

### 2.1 Types of Implicit Arguments

It is well-known that implicit arguments of verbal predicates can be interpreted in at least two ways (see, e.g., Fillmore 1969, 1986, Shopen 1973, Thomas 1979, Fodor & Fodor 1980, Dowty 1981). The implicit arguments of one type of predicate, such as *eat*, get an existential interpretation, whereas the implicit arguments of another type of predicate, such as *apply*, get an anaphoric interpretation.<sup>6</sup> This contrast is exemplified in (1).

- (1) a. There was a piece of bread on the table but John didn't eat.  
b. There was a good job available here but Fred didn't apply.

(1a) implies that John didn't eat anything, whereas (1b) implies simply that Fred didn't apply for the good job that was available here (although he may have applied for other jobs).

This difference in interpretation turns out to be a consequence of a more basic contrast: predicates like *apply* depend on the context in an essential way, whereas predicates like *eat* do not. For this reason, the two types of predicates behave differently when used without any prior linguistic context. Predicates with existential implicit arguments are perfectly acceptable in such contexts, as in (2a), whereas predicates with anaphoric implicit arguments are infelicitous, as in (2b).

- (2) a. I painted last week.  
b. # I applied last week.

Another consequence of the inherent context-dependence of anaphoric implicit arguments is that they can take wide scope with respect to other quantifiers in the sentence, as can be seen in (3b) and (1b). Implicit arguments with an existential interpretation, on the other hand, take narrow scope with respect to all sentential operators, as can be seen in (3a) and (1a).<sup>7</sup>

- (3) a. I have been painting all week.  
b. I have been calling all week.

Predicates of both types may impose selectional restrictions on their implicit arguments, so this property crosscuts the basic context-dependent vs. non-context-dependent classification:

- (4) a. We need a lot of bricks for the construction job but no one is baking these days.  
b. The most attractive prize was a 20 pound turkey. John won.

*Bake* construed with an implicit argument, receiving an existential interpretation, can only be about the baking of bread or other baked goods, and not, for example, about roasts, or bricks. Similarly, the implicit argument of *win*, which gets an anaphoric interpretation, is understood to be a contest-type of entity rather than a prize-type of entity.

Although verbal predicates with implicit arguments have received the most attention, predicates of any syntactic category can be construed with an implicit argument. In (5) we give some examples of

<sup>7</sup>This contrast was originally pointed out by Fodor & Fodor (1980), who, moreover, claimed that anaphoric implicit arguments take exclusively wide scope. Narrow scope readings of anaphoric implicit arguments, however, are available, as shown already by Dowty (1981). We discuss them in detail in later sections.

<sup>3</sup>Mitchell (1986) calls them *perspectival expressions*.

<sup>4</sup>For a different perspective see Perry (1986).

<sup>5</sup>Partee considered this possibility but opted for a different one, whereby an expression of this sort indexes to a context rather than taking an extra argument. Indexing to contexts is not an easily available option within non-representational theories of context, such as the one we will be assuming.

<sup>6</sup>This distinction corresponds to Fillmore's (1986) distinction between indefinite and definite null complements, Shopen's (1973) distinction between indefinite and definite ellipsis and Thomas's (1979) distinction between nonrealization and ellipsis.

predicates construed with a context-dependent implicit argument. For clarity, the implicit argument predicate is italicized and the necessary information for its interpretation is supplied in the same sentence.

- (5) a. He observed the ceremony from ten yards *away/across* the street.  
 b. Lee sold his Vermeer after Marion bought a *similar* painting.  
 c. When they put a locked gate on the road to the beach, Sal no longer had *access*.

The term 'non-context-dependent' should not be taken to imply that context does not in any way affect the way we understand non-context-dependent implicit arguments. In a particular context we may draw certain inferences on the basis of relevance considerations, discourse relations between sentences, etc., so as to derive additional information about the implicit argument. For instance, the discourses in (6a) and (6b) both imply that I have been baking pastries for the party.

- (6) a. We needed a lot of pastries for the party.  
       I have been baking all week.  
 b. I have been baking all week.  
       We needed a lot of pastries for the party.

The crucial difference between the two types of predicates is that the context-dependency of context-dependent predicates is built into their *meaning*. As a result, (i) infelicity arises whenever the context cannot provide an element for their interpretation ((2a) vs. (2b)) and (ii) there are restrictions on what elements in a discourse can supply a value for an implicit argument, due to the way semantic interpretation works. As a result, it is the *prior* linguistic discourse that determines the felicity and interpretation of context-dependent implicit arguments. The order between two sentences makes a critical difference since the information contributed by the first is part of the context relative to which the second is interpreted but not vice versa. (7) and (6) contrast for this reason.

- (7) a. An explosives warehouse on the other side of town exploded yesterday. A nearby bar was seriously damaged.  
 b. A nearby bar was seriously damaged. An explosives warehouse on the other side of town exploded yesterday.

(7a) and (7b) differ in that the location needed for the interpretation of *nearby* can be provided by the NP *an explosives warehouse* in (7a) but not in (7b). Hence (7a) and (7b) give rise to different inferences about the strength of the explosion in each case.

One may legitimately ask whether the lexical semantics of a given predicate determines in some way whether its implicit argument is given

an existential or an anaphoric interpretation. Hopefully, the answer will turn out to be 'yes' but nobody has managed to show that<sup>8</sup> and we will not concentrate on this question here. Even if there exists such a connection, one still has to specify what the context-dependency amounts to and how it affects and is affected by the interpretation of the whole sentence. This is what we will concentrate on in this paper.

## 2.2 The Readings of Implicit Arguments

The interpretation of context-dependent predicates depends on circumstances of their use and, in order to be fixed, the context of utterance, the previous linguistic discourse, or the sentence in which they occur must supply information to fix the value of their implicit argument. For example, to determine whether there is a bar verifying the sentences in (8), we must have a specified location relative to which the bar is local. That location can be provided in a variety of ways depending on the context in which the predicate *local* appears.<sup>9</sup>

- (8) a. A local bar is selling cheap beer.  
 b. A reporter for the *Times* got seriously drunk.  
       A local bar was selling cheap beer.  
 c. Every sports fan watched the Superbowl in a local bar.

In (8a) the relevant location is provided by the context of utterance—it is the location in which the utterance takes place. In (8b) it is provided by the previous sentence—it is the location of the reporter for the *Times*. In (8c) it is provided sentence internally and is dependent on the domain of the quantifier—for a given choice of sports fan in the domain it is the location of that sports fan.

The variety of readings, then, an implicit argument exhibits depends on the kind of context-dependency involved. Specifically, if it is dependent on the context of utterance, it gets a deictic interpretation, as in (8a), if it is dependent on previous linguistic discourse, it gets a discourse anaphoric reading, as in (8b), and if it is dependent on a quantificational element, it gets a bound variable reading, as in (8c). (8a)–(8c) may have other readings as well—for instance, (8c) can have a reading in which the implicit argument is controlled by the context of utterance—but since our aim here is to delimit the range of possible readings we want to focus on the readings described above. The crucial fact is that the implicit argument *can* be controlled by the context of

<sup>8</sup>Fillmore (1986) discusses predicates such as *contribute*, whose implicit theme argument is existential and implicit recipient argument is anaphoric.

<sup>9</sup>The predicate *local* is also vague and, therefore, is context-dependent in another dimension, namely with respect to the degree of precision specifying the range within which something counts as local (Kamp 1975). We will ignore this aspect in what follows. In general, we consider the context-dependency of vague predicates and that of predicates with implicit arguments as distinct phenomena.

utterance, that it *can* be controlled by the previous linguistic discourse, and that it *can* have a bound variable reading when in the scope of a quantificational element.

Certain context-dependent expressions place further restrictions on what types of context can determine their interpretation. For example, *ago* can only pick out its temporal reference relative to the utterance situation, whereas *before* excludes this possibility and can only be controlled by the linguistic context. Thus, in the absence of any prior linguistic discourse, (9a) is felicitous but (9b) is not.

- (9) a. Jill visited Madison two years ago.  
b. # Jill visited Madison two years before.

A somewhat similar contrast exists between *present*, which can only be controlled by the context of utterance, and *current*, which can be controlled either by the context of utterance or the linguistic context, as pointed out by Nunberg (1992).

A theory of context-dependent elements, therefore, must account both for the different types of context-dependency and for the range of readings of elements in each class.

### 2.3 Anaphora and Implicit Arguments

Partee (1989) distinguished descriptively between three different kinds of contexts: the external context of the utterance, the discourse-level linguistic context and the sentence-internal linguistic context. Taking the bound-variable-like behavior of implicit arguments as central, she argued for the need to provide a sufficiently general notion of context-dependence and to integrate contextual information with “the recursive mechanisms of sentence grammar.” We can amplify her point by noting that there are substantive restrictions on what can supply a value for an implicit argument, which are ultimately semantic. One such case was discussed with respect to the contrast between (7a) and (7b). Similarly, (10a) and (10b) differ in that the location of the bar can be dependent on the choice of Italian neighborhood in (10a) but not in (10b) (assuming both indefinite descriptions are within the scope of the adverb of quantification *always*).<sup>10</sup>

- (10) a. When John visits an Italian neighborhood, he always goes to a local bar.

<sup>10</sup>The contrasts exemplified by (7) and (10) show that the contextual determination of the interpretation of implicit arguments is not just a matter of pragmatic principles. Compare with Crimmins’s (1992:151) claim that “hearers standardly interpret unarticulated constructions [implicit arguments] by relying only on common knowledge and general pragmatic rules, with only the thinnest of semantic rules to go on.”

- b. When John goes to a local bar, he always visits an Italian neighborhood.

The generalization is one familiar from discussions of anaphoric binding: the element that supplies the interpretation for the implicit argument, the implicit argument’s antecedent, must have the predicate with the implicit argument in its scope. In order to account for this generalization we must have a theory that would allow us to have a proper construal of semantic scope.<sup>11</sup> A dynamic framework is best suited for this task.

Relying on the semantic theory of Kamp (1981), Partee (1989) sketches an account in which a context-dependent element indexes to a context, in this case an accessible DRS. Given the nesting of DRS’s, a context-dependent element may anchor to any superordinate DRS. The question then is what the requirements are that a context-dependent element places on the DRS it is indexed to and how they are satisfied. Partee assumes that temporal context-dependent predicates place the requirement that the DRS they anchor to contain a reference time, spatial context-dependent predicates place the requirement that it contain a reference location, etc. Although the context-dependent predicate itself does not have as an argument a variable corresponding to a reference time or location, the DRS it anchors to must.<sup>12</sup>

More generally, Partee, seconded by Nunberg (1992), claims that a dependent element—be it a pronoun or the implicit argument of a relational predicate—has associated with it the specifications in (11), which account for its interpretation.

- (11) a. what kinds of context it can anchor to  
b. requirements on the context for the element to be felicitous  
c. meaning

According to Partee and Nunberg, (11a) is needed to distinguish between different types of context-dependent elements, such as those that can only be controlled by the context of utterance (e.g., pure indexicals, implicit argument of *ago*, *present*), those that can be controlled by any one of the three kinds of contexts (e.g., pronouns, implicit argument of *local*) and those that exclude control by the context of utterance (e.g.,

<sup>11</sup>Syntactic constraints can enter the picture at this point since they play a role in determining semantic scope.

<sup>12</sup>This is assuming that reference times, locations, etc., are treated as a special type of discourse referents, as in the treatment of temporal anaphora in Kamp & Rohrer (1983), Partee (1984), Hinrichs (1986). Alternatively, reference times, locations, etc. can be construed as parameters of evaluation for a context. The issues we raise do not hinge on this choice and can be reformulated appropriately.

reflexives, *before*).<sup>13</sup> The challenge for a unified analysis of context-dependency is to characterize the three kinds of contexts in a uniform way without losing the distinction between them.

Kamp (1981) and Heim (1982) unified the deictic use of pronouns with all their other uses by assuming that the top-level discourse context subsumes the external context of the utterance. Information about individuals salient in the context of utterance and the “guise” (in the sense of Lewis (1979)) under which they are salient is accommodated in the top-level context.<sup>14</sup> As Heim (1982) puts it, deictic reference is mediated by the file and the context of utterance supplies “not simply individuals but ‘individuals in guises’” (p. 318). In taking deictic pronouns to be only context-sensitive, Kamp and Heim departed from previous analyses of deictic uses of pronouns, which took them to be both context-sensitive and directly referential. These analyses are based on Kaplan’s (1989a) fundamental distinction between context and circumstances of evaluation. According to such analyses, the denotation of a deictic pronoun might vary from context of utterance to context of utterance, but once the context of utterance is fixed, then its denotation does not vary from one circumstance of evaluation to another. Having deictic reference mediated by a file results in a radically different theory, since then deictic reference does not involve direct reference and, therefore, the denotation of a deictic pronoun can vary from one circumstance of evaluation to another, relative to the same context of utterance.<sup>15</sup>

Partee differs from Kamp and Heim in keeping the external context separate; in the representations she gives, it is the outermost context and every other context is nested within it.<sup>16</sup> The external context encodes information about the utterance situation, such as the speaker, the time and location of the utterance.

## 2.4 Indexicality and Implicit Arguments

The separation of the external context from the top-level discourse context is necessitated by the semantic properties of pure indexicals. Pure indexicals such as *I*, *here*, *now* anchor to the external context and are directly referential. They cannot be given an account parallel to that of deictic pronouns in Kamp (1981) and Heim (1982) for the rea-

sons that motivated direct reference theories in the first place (Kaplan 1979, 1989a, 1989b, Perry 1977 *inter alia*). The descriptive conditions associated with their meaning are responsible for picking out the right individual in a given context of utterance but do not enter the content of what is said. As Kaplan (1989a, 500) puts it, “the descriptive meaning of a pure indexical determines the referent of the indexical with respect to a context of use but is either inapplicable or irrelevant to determining a referent with respect to a circumstance of evaluation.”

As a consequence, (12a) is not synonymous with (12b): the proposition expressed by (12b) relative to any context of utterance is necessarily true, while that expressed by (12a) is not.

- (12) a. I am the speaker (of this utterance).  
b. The speaker (of this utterance) is the speaker (of this utterance).

Following Nunberg (1992, 1993), we will use the term *indicativeness* to characterize the property of certain linguistic elements (such as pure indexicals) that the conditions determining their reference do not enter into their content. We intend this only as a descriptive term; those elements that are indicative must be so as a result of their meaning specification.

Like indexicals, implicit arguments can be controlled by the context of utterance. Can they, like indexicals, be indicative? Nunberg (1992) claims that control by the context of utterance and indicativeness do not go hand in hand and uses, in fact, implicit arguments as a case in point. We will argue that implicit arguments have indexical readings and in that case they are indicative.

In the following section we show that implicit arguments pattern with definite descriptions on their anaphoric reading and in section 4 we argue that they behave like true indexicals on their deictic reading.

## 3 Implicit Arguments as Implicit Descriptions

### 3.1 Contexts for Implicit Arguments

What information should the context provide for the interpretation of implicit arguments? In the examples considered so far where the implicit argument is not controlled by the utterance situation, there is an overt linguistic element that can be identified as the antecedent of the implicit argument. Within a theory that allows for dynamic binding, one can analyze the antecedent as directly binding the implicit argument. Furthermore, Partee (1989) assumed that a subset of open-class context-dependent expressions exploit those aspects of contexts that are always present and always unique, such as reference time, reference location, and point of view. The reference time, reference

<sup>13</sup>Plural context-dependent elements may combine the different types of context-dependency. See the discussion on the first person plural pronoun *we* in Partee (1989) and Nunberg (1993).

<sup>14</sup>A similar proposal is made by Karttunen (1969), whereby contextual salience is sufficient for the introduction of a discourse referent.

<sup>15</sup>For an indication of the consequences of this move see Heim’s discussion on presupposed coreference and deictic pronouns (Ch. III, Sec. 2.3).

<sup>16</sup>See Kamp (1990) for an explicit treatment of indexicality within DRT.

location and point of view of the external context can be assumed to be, respectively, the time, place and speaker of the utterance. Putting the two assumptions together, we can formulate the hypothesis that an implicit argument is bound either by an overt accessible antecedent or by some implicit element which is always present in a context and unique relative to that context.<sup>17</sup> However, these cases do not exhaust the range of possibilities: there need not be an *overt* antecedent,<sup>18</sup> even when the implicit argument is not controlled by some element always present in a context.

As we will show below, contexts for predicates with implicit arguments are those that entail, or can be extended (via accommodation) so as to entail, the existence of an entity that satisfies the selectional restrictions imposed by the predicate for that argument. In that respect implicit arguments pattern with definite descriptions rather than pronouns in allowing for associative anaphoric readings. Saying, then, that implicit arguments function like pronouns in terms of the context-dependency they exhibit is true in one respect but not in another: implicit arguments are like pronouns in their capacity to anchor to any kind of context; however, they are unlike pronouns and more like definite descriptions in not demanding an overt antecedent.

The sentences in (13) illustrate the way in which implicit arguments pattern with definite descriptions. Even without an overt antecedent denoting a bet, the sentences (13a) and (13b) share a reading on which every man won the wager he made on the outcome of the Superbowl. The pronoun in (13c) lacks this reading. Clearly, (13a) does not constitute a case where the implicit argument is controlled by some fixed aspect of context, since contexts in general do not contain information about the existence of bets.

- (13) a. Every man who bet on the Superbowl won.  
 b. Every man who bet on the Superbowl won the bet.  
 c. Every man who bet on the Superbowl won it.

Given the restriction of the quantifier, for every man in the domain of quantification there is entailed to be a bet and that is sufficient for the interpretation of the implicit argument of *win*. It is exactly this

<sup>17</sup>Partee surmised that these two options correspond to different types of context-dependency and that therefore the classes of context-dependent elements are distinguished along these lines—*third-person-like dependents* and *first-person-like dependents*, as she calls them. The analysis we develop accepts that there is a division but groups the class of implicit arguments discussed so far (except for those that are always indexical) in the first rather than the second category. See the discussion in section 4.2.

<sup>18</sup>Partee (1989) made a similar observation but she did not draw from it the conclusions we are drawing.

entailment that is responsible for the felicity of the dependent definite *the bet* in (13b) as well.

Thus, implicit arguments have a wider range of readings than pronouns. Implicit arguments also have a wider range of readings than elements which are strictly dependent on reference parameters. Temporal expressions with implicit arguments, for example, need not be anaphoric on the reference time of any accessible context. For instance, (14a) has a reading which is equivalent to that of (14b) although there is no reason to assume that the context of the restriction of the quantifier contains a reference time corresponding to the time of the escape.<sup>19</sup> Similarly, (14c) has a reading which is equivalent to that of (14d) even if nothing in the previous discourse has triggered the introduction of a reference time corresponding to the time of the baking of the cake.

- (14) a. Every fugitive was caught within a month.  
 b. Every fugitive was caught within a month of the time he escaped authority control.  
 c. The cake tasted better after two days.  
 d. The cake tasted better two days after the time it was baked.

Being a fugitive entails having escaped authority control at some point and this entailment is sufficient to provide the information for the implicit argument of *within a month*, just as it is to provide the information for the felicity of the dependent definite *the time he escaped authority control*. As for (14c), from the fact that something is a cake we can infer that it was baked; a context with information about a cake then can be extended to a context with information about the time of the baking of the cake.

A piece of evidence that there is no reference time corresponding to the time of the escape in the restriction of the quantifier in (14a), or a reference time corresponding to the baking of the cake in (14c)<sup>20</sup> is the contrast between the implicit argument predicates in (14) and those that can only be anaphoric on a reference time, such as the adverbs *afterwards*, *beforehand*, *thereafter*. While (15a) has a reading equivalent to that of (15b), (15c) does not.<sup>21</sup> Similarly, for (15f) the implicit

<sup>19</sup>Even if the nominal predicate *fugitive* is assumed to have a temporal argument (e.g., Eng 1986), the value of that temporal argument is the interval during which a given individual was a fugitive, not the time of his escape.

<sup>20</sup>This is assuming that nothing in the previous discourse has introduced such a reference time.

<sup>21</sup>Adverbs that are anaphoric on a reference time have the bound variable reading only if there is quantification over reference times, as is the case with *when*-clauses:

Whenever a prisoner escaped, he became a respectable citizen some time afterwards.

argument of *afterwards* cannot be taken to be the time of the baking of the cake unless that time is already introduced in the discourse.

- (15) a. Every fugitive became a respectable citizen after some time.  
 b. Every fugitive became a respectable citizen after some time from the time he escaped authority control.  
 c. Every fugitive became a respectable citizen some time afterwards.  
 d. The cake tasted good even after a long time.  
 e. The cake tasted good even after a long time from the time it was baked.  
 f. The cake tasted good even a long time afterwards.

For (15c) and (15f) there must be some salient time in the discourse relative to which *afterwards* is evaluated. Thus, the analysis that Partee (1989) proposed for the entire class of context-dependent predicates with anaphoric readings seems to fit best a restricted subclass of them.

An implicit argument can also be dependent on a context which is itself implicit, i.e., does not correspond to any overt linguistic material. For example, (16a) has a reading equivalent to that of (16b) and one equivalent to that of (16c). The implicit argument of *within a day*, then, can be construed so as to get the available linguistic element as its antecedent and so as to be equivalent with a definite description taking narrow scope with respect to the modal.

- (16) a. He might leave today. He should return within a day.  
 b. He might leave today. He should return tomorrow.  
 c. He might leave today. He should return within a day of the day he leaves.

Although the modal *should* has no overt restriction, because of the previous sentence in the discourse it is taken to quantify over those possible worlds in which he leaves (today or at some time or other). This is a case of modal subordination (Roberts 1989) and the interpretation of the implicit argument depends on the way the restriction of the modal quantifier is construed.<sup>22</sup> *Today*, although a potential antecedent, does not have to bind the implicit argument nor does it have to determine the implicit restriction. The time of leaving is dependent upon the choice of modal base for the modal *should*, which does not have to be chosen in such a way that the time of leaving is today.

### 3.2 Our Proposal

In our analysis of implicit arguments, we will reconstruct the requirement that an implicit argument places on a context (Partee's (11b)

<sup>22</sup>As we will discuss below, the implicit restriction does not have to be an explicit piece of some representation.

above) as well as the specifications of what kinds of contexts are acceptable anchors (Partee's (11a) above) as felicity conditions. Following recent work in dynamic semantics (Heim 1982, Groenendijk & Stokhof 1991, Dekker 1993), we construe contexts as information states and take the meaning of a sentence to be specified in terms of how it updates a given information state. Meanings, in general, are characterized as possibly partial functions from information states to information states. Following Heim (1982, 1983) and Beaver (1993), we take felicity conditions to be requirements on an information state in order for the meaning function to be defined on that information state. An information state is specified as follows:

An information state  $S$  is a set of pairs of worlds and assignments such that all the assignments have the same domain, which we call  $V_S$ . We call the set of worlds determined by  $S$   $W_S$ , and the set of assignments determined by  $S$   $F_S$ .

We base our analysis of implicit arguments on Heim's (1982) analysis of definite NPs, according to which their interpretation depends on the felicity conditions they impose on input information states. Definite descriptions require familiarity of their corresponding variable and their descriptive content. (17) exemplifies the analysis of standard definite descriptions.

- (17)  $S \llbracket \text{the man}_x \text{ plays duets} \rrbracket =$   
 $\{ \langle w, f \rangle \in S \mid f(x) \in w(\text{play-duets}) \}$   
 iff  $x \in V_S$  and  $\forall \langle w, f \rangle \in S: f(x) \in w(\text{man})$ .  
 Else undefined.

We analyze the implicit arguments of relational predicates on a par with definite descriptions. Implicit arguments are associated with familiarity conditions for their corresponding variable and their descriptive content. The descriptive conditions associated with an implicit argument are, minimally, the sortal properties required by the predicate the implicit argument is an argument of.

(18b) illustrates our account of the implicit argument of *local*.<sup>23</sup> The only felicity condition placed by the predicate *local* is that the filler of its second argument be a location (essentially just the selectional

<sup>23</sup>If the indexing to contexts approach is spelled out in a particular way that recognizes *local* to be a relational predicate, then as far as we can see, it is not substantially different from the proposal put forth here. For instance, some world-assignment pair  $\langle w, f \rangle$  would satisfy the condition  $local_C(x)$  iff  $\langle f(x), f(y) \rangle \in w(\text{local})$ , where  $y$  is some discourse marker in  $C$  such that if  $\langle w', g \rangle$  satisfies  $C$  then  $g(y) \in w'(\text{location})$ . This formulation is appropriate for cases in which the implicit argument exploits a feature of context that is always present. For other cases, we would have to distinguish between licit and illicit indexings to a context according to whether that context contains the information necessary for the interpretation of the implicit argument.

restriction on that argument). What reading the implicit argument gets depends on what information S contains. (18d) illustrates the way the discourse anaphoric reading comes about, assuming S is the information state resulting from updating with the first sentence of (18c).<sup>24</sup>

- (18) a. A local<sub>z</sub> bar<sub>y</sub> was selling cheap beer.  
 b. S [ [ a local<sub>z</sub> bar<sub>y</sub> was selling cheap beer ] =  
 $\{\langle w, f \rangle \mid \exists \langle w, g \rangle \in S: g <_y f, f(y) \in w(\text{bar})$   
 $\langle f(y), f(z) \rangle \in w(\text{local}), f(y) \in w(\text{sell-cheap-beer})\}$   
 iff  $y \notin V_S$  and  $z \in V_S$  and  $\forall \langle w, f \rangle \in S: f(z) \in w(\text{location})$ .  
 Else undefined.  
 c. A reporter<sub>x</sub> for the Times got seriously drunk.  
 A local<sub>z</sub> bar<sub>y</sub> was selling cheap beer.  
 d. S [ [ a local<sub>z</sub> bar<sub>y</sub> was selling cheap beer ] =  
 $\{\langle w, f \rangle \mid \exists \langle w, g \rangle \in S': g <_y f, f(y) \in w(\text{bar}),$   
 $\langle f(y), f(z) \rangle \in w(\text{local}), f(y) \in w(\text{sell-cheap-beer})\}$   
 iff  $y \notin V_{S'}$  and  $z \in V_{S'}$  and  $\forall \langle w, f \rangle \in S': f(z) \in w(\text{location})$ ,  
 where  $S' = \{\langle w, f \rangle \mid \exists \langle w, f' \rangle \in S: f' <_z f$  and  
 $\langle f(z), f(x) \rangle \in w(\text{location-of})\}$ .  
 Else undefined.

The difference between S and S' is accommodated information. In order for the felicity conditions of *local* to be satisfied, S' accommodates a new variable, z, assigned to a location and related to the variable x in S, assigned to a reporter. This is why in the reading represented for (18c), the bar is understood to be local to the reporter for the *Times* mentioned in the previous sentence.

The accommodation of the necessary information in order to satisfy an implicit argument's felicity conditions is analogous to the accommodation brought about in order to satisfy the felicity conditions of a definite NP which is not directly anaphorically related to anything mentioned in the discourse thus far:

- (19) The Porsche lurched to a stop. The engine was smoking.

The engine in (19) is understood as the engine of the Porsche. In accommodating the information for the felicity of the definite we satisfy the felicity conditions of the definite by connecting the newly introduced entity to some already mentioned entity in the discourse (Heim 1982).

<sup>24</sup>The meaning specifications we provide throughout the paper make use of three relations between assignment functions, defined as follows:

$$g \leq f \text{ iff } \text{Dom}(g) \subseteq \text{Dom}(f) \text{ and } \forall v \in \text{Dom}(g): f(v) = g(v)$$

$$g < f \text{ iff } \text{Dom}(g) \subset \text{Dom}(f) \text{ and } \forall v \in \text{Dom}(g): f(v) = g(v)$$

$$g <_y f \text{ iff } g < f \text{ and } \text{Dom}(f) = \text{Dom}(g) \cup \{y\}$$

Accommodation is necessary in (19) to capture the dependency of the definite *the engine* on the NP *the Porsche* as well as to get the right truth conditions for the NP *the engine*.

Following Heim, the kind of accommodation illustrated in (18d) and (19) basically implements the following strategy:

### Ordinary Accommodation

The information necessary to satisfy the familiarity condition of a definite NP may be accommodated to a state S, yielding a new state S', by relating the definite's discourse marker through some relation to a discourse marker in the domain of S.

If the definite's discourse marker is x, the relation is R, and the discourse marker to be related to x is y, then for an input state S, we can define a new state by way of a 4-place function on S, R, x, and y:

$$\text{Accom}(S, R, x, y) = \{\langle w, f \rangle \mid \exists \langle w, g \rangle \in S: g <_x f \text{ and}$$

$$\langle f(x), f(y) \rangle \in w(R)\}$$

There are various kinds of conditions one might put on Accom to refine the theory of accommodation, such as that the world set of S and S' be the same (the accommodated entity was entailed to exist), and that R be functional, but these would lead us far afield into tangled issues in the semantics of definites. For now, we assume an underconstrained theory of Accom, which doubtlessly allows too much to be accommodated.

Using Accom, (18d) can be reformulated as in (20).

- (20) S [ [ a local<sub>z</sub> bar<sub>y</sub> was selling cheap beer ] =  
 $\{\langle w, f \rangle \mid \exists \langle w, g \rangle \in \text{Accom}(S, \text{location-of}, z, x): g <_y f,$   
 $f(y) \in w(\text{bar}), \langle f(y), f(z) \rangle \in w(\text{local}),$   
 $f(y) \in w(\text{sell-cheap-beer})\}$   
 iff  $y \notin V_S$  and  $\forall \langle w, f \rangle \in \text{Accom}(S, \text{location-of}, z, x):$   
 $f(z) \in w(\text{location})$ .  
 Else undefined.

And if the first argument of the relation location-of is guaranteed by a meaning postulate to be a location, this becomes simply:

- (21) S [ [ a local<sub>z</sub> bar<sub>y</sub> was selling cheap beer ] =  
 $\{\langle w, f \rangle \mid \exists \langle w, g \rangle \in \text{Accom}(S, \text{location-of}, z, x): g <_y f,$   
 $f(y) \in w(\text{bar}), \langle f(y), f(z) \rangle \in w(\text{local}),$   
 $f(y) \in w(\text{sell-cheap-beer})\}$   
 iff  $y \notin V_S$ .  
 Else undefined.

An implicit argument can exhibit scopal effects through ordinary accommodation. Its scope, as it were, is determined by the information state that entails its presuppositions. When the implicit argument is

within a quantificational context, then its presuppositional conditions can be satisfied by the auxiliary information states that come about in the calculation of the information update brought about by a quantifier. In that case, the implicit argument has the bound-variable-like reading, or more appropriately in our terms, a dependent reading (as with dependent definite descriptions). This is illustrated in (22).

- (22) a. Every man<sub>x</sub> who bet on the Superbowl won<sub>z</sub>.  
 b.  $S \llbracket \text{every man}_x \text{ who bet on the Superbowl won}_z \rrbracket =$   
 $\{\langle w, f \rangle \in S \mid \forall h: f <_x h \text{ [if } \langle w, h \rangle \in S', \text{ then } \exists g: h \leq g,$   
 $\langle w, g \rangle \in \text{Accom}(S', \text{bet-of}, z, x) \llbracket \text{won}(x, z) \rrbracket]\}$   
 iff  $x \notin V_S$  and  $\forall \langle w, h \rangle \in \text{Accom}(S', \text{bet-of}, z, x):$   
 $h(z) \in w(\text{contest})$   
 where  $S' = \{\langle w, f \rangle \in S \mid \exists g: f <_x g, g(x) \in w(\text{man}),$   
 $g(x) \in w(\text{bet-on-the-Superbowl})\}$   
 Else undefined.

The narrow scope readings with respect to a modal, as in (16a), arise when the information state construed on the basis of the modal base of the modal is compatible with the information necessary to satisfy the felicity conditions of the implicit argument and this information can thus be accommodated relative to that information state. The way the narrow scope reading of the implicit argument of (16a) arises is shown in (23). The modals are taken to have an epistemic modal base;  $\text{Acc}(w)$  is a set of epistemically accessible worlds from  $w$ .

- (23) a. He<sub>x</sub> might leave today. He<sub>x</sub> should return within<sub>t</sub> a day.  
 b.  $S \llbracket \text{he}_x \text{ might leave today} \rrbracket = S' =$   
 $\{\langle w, f \rangle \in S \mid \{\langle w', f \rangle \mid w' \in \text{Acc}(w)\} \llbracket \text{he}_x \text{ leaves today} \rrbracket \neq \emptyset\}$   
 c.  $S^* \llbracket \text{he}_x \text{ should return within}_t \text{ a day} \rrbracket =$   
 $\{\langle w, f \rangle \in S^* \mid S_{\text{acc},w} \llbracket \text{he}_x \text{ returns within}_t \text{ a day} \rrbracket = S'_{\text{acc},w}\}$   
 where  $S^* = \{\langle w, g \rangle \mid \exists \langle w, h \rangle \in S': h <_t g, \forall w' \in \text{Acc}(w):$   
 $g(t) \in w'(\text{time}), \langle g(x), g(t) \rangle \in w'(\text{leave})\},$   
 $S_{\text{acc},w} = \{\langle w', g \rangle \mid w' \in \text{Acc}(w), f <_t g, \text{ where}$   
 $\langle w, f \rangle \in S^*\}$  and  
 $S'_{\text{acc},w}$  is such that  $W_{S_{\text{acc},w}} = W_{S'_{\text{acc},w}}$  and  $V_{S_{\text{acc},w}} \subseteq V_{S'_{\text{acc},w}}$ .

$S^*$  is an information state such that its world set is comprised of worlds in which he leaves at some time and it has a discourse marker for the time of the leaving.  $S^*$  then satisfies the felicity conditions of the implicit argument of *within* and can thus be updated with *he<sub>x</sub> returns within<sub>t</sub> a day*.

Having an overt variable corresponding to the implicit argument, we do not require accommodation at some representational level since we

specify the presuppositions and the anchoring conditions of the implicit argument in terms of definedness conditions on an information state. The indexing to contexts approach, on the other hand, cannot sidestep the need for representational accommodation.

Assuming that contentful context-dependent elements correspond to relational predicates with an implicit argument does not commit us to the presence of a phonologically null argument at the syntactic level. It also does not commit us to there being a one-to-one syntactic or semantic correspondence between an expression with an implicit argument and one with an overt argument. There are clearly syntactic differences between the two: syntactically present arguments require case marking and they might require certain prepositions in addition (*a local bar, a bar local to the neighborhood*); predicates with implicit arguments may have a different syntactic distribution than predicates whose arguments are syntactically expressed. For instance, predicates that are nominal modifiers may appear prenominally if they have no syntactic complements and postnominally if they do (*a local bar, a bar local to the neighborhood*). As pointed out in section 2.1, the selectional restrictions of a predicate with an overt argument and the corresponding one with an implicit argument may also be different.

Finally, if an overt argument is purely anaphoric, then it must have an overt antecedent. As we have seen, no such requirement exists for an implicit argument. This we believe is the right perspective to have on such differences as illustrated by the contrast in (24), discussed by Partee (1989).

- (24) a. In all my travels, whenever I have called for a doctor, one has arrived within an hour.  
 b. # In all my travels, whenever I have called for a doctor, one has arrived there within an hour.

*There* is anaphoric and like personal pronouns it requires an overt antecedent. Adverbial elements that require an overt antecedent also share with personal pronouns the property of requiring an overt antecedent even when the antecedent does not semantically bind them. Informally, we can say that all semantically anaphoric elements can have E-type readings, as for example in (25). In that respect then anaphoric elements requiring an explicit antecedent and those that do not, such as definite descriptions and implicit arguments, are similar.

- (25) a. He wants to move to a big city. But there must be a good beach not far away.  
 b. He wants to move to a big city. But there must be a good beach not far away from there.

- c. He wants to move to a big city. But there must be a good beach not far away from the center.

How to formulate a theory that can capture this notion of antecedent-hood remains an open problem and we will not address it here.<sup>25</sup>

## 4 Indexicality and Implicit Arguments

### 4.1 Unifying the Analysis

In this section we provide an account of indexicals and of the indexical readings of implicit arguments. Thus far, our account of implicit arguments treats them like definites and invokes the device of accommodation to handle a number of crucial cases. This suggests a natural strategy for handling the indexical readings of implicit arguments, such as that of (8a), repeated here.

(26) A local bar was selling cheap beer.

To handle the reading on which locality is relative to the speaker, why not simply accommodate one discourse marker for the speaker and another for the speaker's location?

One immediate obstacle to this account is that accommodation as we have defined it requires an object already in the discourse and a relation by which to accommodate, and yet (26) seems to retain the indexical reading in almost any context. There is also something a little unnatural about an account which can introduce speakers into discourses only by way of something prior and more familiar. Invoking accommodation for the indexical readings, then, would probably require enriching our theory of accommodation, something we should do only with great care.

But there is a much more important reason for not handling the indexical readings by appealing to more accommodation: in their indexical readings, implicit arguments do not behave as definites do, but rather as indexicals do.

A property of indexicals that plays a central role in motivating the account of Kaplan (1989a) is their *referentiality*. For example, if the second author of this paper utters (27a), he expresses the proposition that it ought to be the case that Mark Gawron is a woman. On the other hand, if Mark Gawron utters (27b), he may express that same deontic judgement, but he can also express another, more sweeping judgement, that it ought to be the case that whoever makes this utterance is a woman.

- (27) a. I ought to be a woman.  
b. The speaker of this utterance ought to be a woman.

<sup>25</sup>It is discussed in some length by Heim (1990) and Chierchia (1992).

Thus, the definite in (27b) can be captured by the deontic operator, the indexical in (27a) cannot. Kaplan argued that no operator can capture an indexical in its scope.

More generally, the referentiality property of indexicals is this: relative to a given context of utterance an indexical refers to a particular individual—the unique individual who in that context satisfies the descriptive conditions associated with the meaning of the indexical—and reference to that individual persists, regardless of the circumstances of evaluation relative to which other parts of the sentence in which the indexical occurs are evaluated, and regardless of what that indexical may be referring to relative to other contexts of utterance. Kaplan captures the referentiality property of indexicals by assuming that indexicals are directly referential and by postulating a condition ruling out operators that operate on characters.

The problem Kaplan's analysis faces from the point of view of a unified account of context-dependency is that it is forced to claiming ambiguity for any expression that can have both an indexical and a non-indexical reading.

Implicit arguments that anchor to the external context exhibit the referentiality property of pure indexicals. Consider the sentences in (28), all uttered in a context in which the speaker is arriving at an outdoor location and is asked to evaluate the environs for their aesthetic merits:

- (28) a. There could have been a river near here.  
b. There could have been a river near the location of this utterance.  
c. There could have been a river nearby.

Examples (28a) and (28b) show the expected contrast between indexicals and definite descriptions. If (28b) is in fact uttered in Palo Alto, a riverless city, then it can be made true by counterfactual alternatives in which that sentence is uttered at a place that does have a river, say, in the woods of the Sierra foothills. If, on the other hand, (28a) is uttered in Palo Alto, it remains stubbornly anchored to Palo Alto. The only counterfactual alternatives that can make it true involve geological or climactic changes that steer a river through Palo Alto. Thus, the indexical remains referential, its reference constraining the set of alternatives we consider. Example (28c) has the reading of (28a), but not of (28b). In a context in which the implicit argument is constrained to be the location of the utterance, the implicit argument patterns with the indexical. If implicit arguments can have what can be described as "narrow scope readings" with respect to modal operators (as in (16a) and (25a)), why is that not the case in (28c)?

The challenge for us is to integrate the analysis provided in section 3 within a proper theory of indexicality. Following Kaplan, we will pursue an account not by providing a mechanism that always assigns indexicals wide scope, but by making them obligatorily referential.

## 4.2 Sketch of an Account of Indexicals

In Kaplan's theory, meanings (characters in his terms) are functions from contexts to contents. The meaning of a sentence, for example, is a function from contexts to sets of circumstances of evaluation. The truth-conditional content of a sentence with respect to a context  $c$  is the set of all circumstances of evaluation with respect to which the sentence is true relative to  $c$ . In a dynamic theory that takes contexts into account, meanings should be functions from contexts to functions from information states to information states:

### Revising Sentence Meaning

Let  $\Sigma$  be the set of information-states. Let  $C$  be the set of contexts (to be explained below). Then sentence meanings are elements of

$$(\Sigma^\Sigma)^C.$$

For a sentence  $\phi$  we will symbolize the result of applying  $\llbracket \phi \rrbracket$  to a context  $c$  as  $\llbracket \phi \rrbracket^c$ .

A context  $c$  is an information state such that  $F_c$  contains only a single assignment function  $f_c$  and  $W_c$  contains only a single world  $w_c$ , the world in which a given utterance takes place. Every expression  $\alpha$ ,<sup>26</sup> context  $c$  and state  $S$  that is an argument of  $\llbracket \alpha \rrbracket^c$  must satisfy the Utterance Condition and the Consistency Condition, given below.

#### • Utterance Condition

There is a  $\mathbf{u}$  which is an utterance token of  $\alpha$  in  $w_c$ , that is,

$$\langle \mathbf{u}, \alpha \rangle \in w_c(\text{utterance-token-of})$$

and there are  $\mathbf{u}$ ,  $\mathbf{s}$ ,  $\mathbf{l}$ , and  $\mathbf{t}$ , with  $\mathbf{u}$ ,  $\mathbf{s}$ ,  $\mathbf{l}$ ,  $\mathbf{t}$  all distinct, such that

$$\langle \mathbf{s}, \mathbf{u}, \mathbf{l}, \mathbf{t} \rangle \in w_c(\text{speaking-at}).$$

There must also be three variables  $x$ ,  $y$ ,  $z$ , such that

$$\{x, y, z\} \subseteq V_c \text{ and} \\ f_c(x) = \mathbf{s}, f_c(y) = \mathbf{l}, f_c(z) = \mathbf{t}.$$

We refer to the unique  $\mathbf{s}$ ,  $\mathbf{l}$ ,  $\mathbf{t}$  selected by the  $f_c$  of some context  $c$  as  $\mathbf{ego}_c$ ,  $\mathbf{here}_c$ , and  $\mathbf{now}_c$ , respectively. We refer to them collectively as *contextual roles*. Contextual roles are features of an utterance situation and any context must contain information about them, if it is to satisfy the Utterance Condition, regardless of whether a language has an

<sup>26</sup>We assume the expressions of the language have been disambiguated; that is, they are expressions of the sort to which we assign meanings.

indexical expression that picks one of them as its referent.<sup>27</sup> A context that satisfies the Utterance Condition is such that it characterizes an utterance situation: for a world to be in the world set of such a context an act of utterance must be taking place in it.<sup>28</sup>

#### • Consistency Condition

$S$  and  $c$  must be consistent.

An information state  $S$  and a context  $c$  are consistent if and only if

$$\forall f \in F_S: f_c \leq f.$$

The Consistency Condition requires that all the assignments made by a context be preserved by the assignment functions of an information state.

Pure indexicals, like *I*, *here*, *now*, as well as expressions with indexical implicit arguments, such as *ago*, *present*, have a variable associated with them, like other NPs and implicit argument predicates. That variable must be assigned to the right individual corresponding to a given contextual role. Indexical elements thus place requirements on information states in order for the meaning of the sentence in which they occur to be defined and are therefore associated with certain felicity conditions. Indexicals (or expressions containing indexicals) are felicitous only relative to information states assigning their corresponding variable to the right individual supplied by the context.<sup>29</sup> For any context  $c$  that satisfies the Utterance Condition and any information state  $S$  that is consistent with it, it will be the case that every assignment function in  $F_S$  assigns some variable to  $\mathbf{ego}_c$ ,  $\mathbf{here}_c$  and  $\mathbf{now}_c$ .

The meaning of a sentence with *I* can then be specified as in (29).<sup>30</sup>

<sup>27</sup>Given our account of the indexical readings of implicit arguments below, it follows that a language that does not have an indexical corresponding to English *here* can still have implicit arguments with an indexical reading. Such implicit arguments would select  $\mathbf{here}_c$  as their referent relative to context  $c$ .

<sup>28</sup>For Kaplan, a context must include an agent but need not include an utterance. He characterizes occurrences of a sentence in a context, rather than utterances of a sentence in a context. Here we are following the lead of Barwise & Perry (1983) in trying to derive some important properties of indexicals from their connection to utterances in utterance situations.

<sup>29</sup>We are assuming free indexing so an indexical might bear any index whatsoever; illicit indexings are ruled out by the felicity conditions associated with the indexical. An occurrence of an indexical such as  $I_r$  might be infelicitous relative to an information state  $S$  and a context  $c$  even though  $c$  satisfies the Utterance Condition and therefore contains an  $\mathbf{ego}_c$ . This will be the case when  $S$  entails that  $f(r)$  is distinct from  $\mathbf{ego}_c$ .

<sup>30</sup>On this proposal, the meaning of *I*, and of indexicals in general, is such that it yields a constant character: for instance, for any  $c$  and  $c'$ ,  $S \llbracket I_r \text{ play duets} \rrbracket^c$  and  $S \llbracket I_r \text{ play duets} \rrbracket^{c'}$  are equal if both are defined.

- (29)  $S \llbracket I_r \text{ play duets} \rrbracket^c =$   
 $\{\langle w, f \rangle \mid \langle w, f \rangle \in S \text{ and } f(r) \in w(\text{play-duets})\}$   
 iff  $\forall f \in F_S: f(r) = \text{ego}_c$ .  
 Else undefined.

Relative to a given context of utterance then, an indexical, in effect, refers to a particular individual, namely the unique individual who in that context fulfills the contextual role required by the felicity condition associated with the indexical. Relative to that context of utterance the indexical would refer to that individual with respect to any information state that is consistent with the context, regardless of whether the information entailed by the information state about that individual is compatible with the information entailed by the context.<sup>31</sup>

We turn now to accounting for the possibility of an indexical reading for implicit argument predicates like *local* or *nearby*. According to the account of implicit arguments presented in section 3 and our new treatment of context, the implicit argument of such predicates will now *necessarily* be allowed an indexical interpretation in any context. The indexical interpretation is allowed because in any context  $c$ , the location role of *local* can be filled with  $\text{here}_c$ . Consider (8a) and (28c). The Consistency Condition guarantees that any information state for which the meaning function relative to a context  $c$  is defined will be such that all its assignment functions assign some variable to  $\text{here}_c$ . Thus, any interpretation using  $\text{here}_c$  will satisfy the presuppositional requirements of *local* or *nearby*. In general, anchoring to the context of utterance for an implicit argument means that its corresponding variable is assigned to one of the contextual roles.

On our account, the indexical interpretation of an implicit argument functions as a kind of default. The utterance context is always present and the information it provides always available via the information state. So in the absence of any linguistic context generating entailments to fill the implicit argument role the utterance context will serve. It is perhaps no accident, then, that the vocabulary of implicit arguments is replete with words connected with space and time, when these are two of the principal features of the utterance context.

More generally, the kinds of contexts a dependent element can anchor to (as described in section 2) depends on the specificity of its felicity conditions and need not be stated independently. The elements that are descriptively characterized as anchoring to the context of utterance are those whose felicity conditions require that they be assigned to some contextual role. The elements that are descriptively characterized

<sup>31</sup>This implies, for example, that  $I$  picks out the  $\text{ego}$  determined by a context  $c$  even relative to information states that contain the information that the individual satisfying the contextual role of  $\text{ego}$  in  $c$  is not uttering anything.

as anchoring to any context whatsoever are those whose felicity conditions require that they be assigned to some familiar (in the technical sense) entity.<sup>32</sup>

### 4.3 Operators and Implicit Arguments

We turn now to examining how the behavior of implicit arguments under operators differs from that of definite descriptions. We have claimed that the implicit argument in (28c) has an indexical interpretation, i.e., the implicit argument is indicative and referential. In the right context, however, the implicit argument can be interpreted as non-referential. Consider (30):

- (30) a. If I had uttered this sentence in a forest, there could have been a river nearby.  
 b. If I had uttered this sentence in a forest, there could have been a river near the location of this utterance.

Example (30a) has a reading very close to the alternative-utterance-locations reading of (30b). Consider once again example (28), reproduced here as (31):

- (31) a. There could have been a river near here.  
 b. There could have been a river near the location of this utterance.  
 c. There could have been a river nearby.

Recall that in contrast to (31b), (31c), in a context in which the implicit argument is constrained to be the location of the utterance, lacks the reading on which alternative utterance locations are considered (a reading available for 31b). One available reading is an indexical reading like that of (31a). Example (30) makes it clear that the absence of the alternative-locations reading has nothing to do with the *meaning* of (31c), but with how it is evaluated in the absence of any contextual help.

In fact, given some natural assumptions about the possibility of accommodation, the contrast in the available readings for (31b) and (31c) is predicted by our account. Let us first see how the non-referential reading of (31b) is possible.

In a context providing no discourse marker for the utterance and its location, the definite in (31b) can only be licensed by ordinary accommodation; as discussed in Section 3, ordinary accommodation involves

<sup>32</sup>Elements that are descriptively characterized as anchoring to any context but the context of utterance might not form a homogeneous class. The properties of reflexives should follow from their requirement for syntactic binding, rather than any special felicity conditions. Elements like *before*, on the other hand, can be associated with an extra felicity conditions such that their anchoring to the context of utterance is excluded.

relating a new discourse marker to some marker already in the domain of the discourse.

Now let us consider the definite in (31b). On the relevant reading, the most natural way to accommodate the definite *the location of this utterance* is given by the content of the noun phrase itself. That is, if the definite's marker is  $l$  and the marker for the utterance is  $u$ , the definite is accommodated by way of the relation:

$$(32) \text{ location-of}(l, u)$$

But there is no reason to expect a neutral context to supply the discourse marker  $u$  for the utterance. Thus, this accommodation is only possible if there is a prior accommodation, called for by the presence of the demonstrative *this utterance*.

This is not the place to sketch out a full account of demonstratives. The key point is that a felicitous utterance of a demonstrative requires that its denotation be in the discourse. Thus, having a discourse marker  $u$  for the utterance in a neutral context is possible because the demonstrative *this utterance* forces one to be in the discourse. Let us assume for concreteness that demonstratives are definites accommodated by relating the demonstrative discourse marker to the demonstration that introduces the definite.

For the sake of illustration, let us assume an account of counterfactuals along the lines of Stalnaker (1968) and Lewis (1973). We assume a revision relation *Revises*, based on a world similarity relation, such that

$$\text{Revises}(w_0, w_1, W)$$

is true if and only world  $w_0 \in W$ ,  $W$  a set of worlds, and there is no element of  $W$  that is more similar to  $w_1$  than  $w_0$ . Note that in requiring  $w_0$  to be in  $W$  we exclude the case where  $W$  is empty. This means that when  $W$  is a necessarily false proposition (the empty set), the *Revises* relation never holds.

To capture the semantics of counterfactual *could*, we also need a function that takes us from the meaning of the antecedent of a counterfactual evaluated against a context  $c$ ,  $\llbracket \phi \rrbracket^c$ , to the proposition (set of worlds) that meaning expresses in that context. We call this function  $\mathcal{W}$ :

$$\mathcal{W}(\llbracket \phi \rrbracket^c) = \{w \mid \text{There is a state } S, w \in W_S, \text{ and a state } S', S' = S\llbracket \phi \rrbracket^c, \text{ and } w \in W_{S'}\}$$

The set  $\mathcal{W}(\llbracket \phi \rrbracket^c)$  consists of worlds  $w$  such that  $w$  is both in the world set of some state  $S$  and in the world set of  $S'$ , the result of updating  $S$  with  $\phi$ . Thus,  $\mathcal{W}(\llbracket \phi \rrbracket^c)$  is just the set of worlds that makes  $\phi$  true relative to  $c$ .

Then the semantics of counterfactual *could*, designated as *could*<sup>CF</sup>, is:

$$(33) \quad S\llbracket \phi \text{ could}^{CF} \psi \rrbracket^c = \{ \langle w, f \rangle \in S \mid \text{If there is } w' \text{ such that } \text{Revises}(w', w, \mathcal{W}(\llbracket \phi \rrbracket^c)), \text{ then } \{ \langle w', f \rangle \mid \text{Revises}(w', w, \mathcal{W}(\llbracket \phi \rrbracket^c))\} \llbracket \phi \rrbracket^c \llbracket \psi \rrbracket^c \neq \emptyset \}$$

We assume a bare counterfactual exploits some contextually salient proposition or set of propositions to play the role of  $\mathcal{W}(\llbracket \phi \rrbracket^c)$  in the above definition. Let

$$(34) \quad \llbracket \text{a river be near the location}_l \text{ of this utterance}_u \rrbracket^c$$

be the meaning of the consequent in (31b) evaluated against a context  $c$ . If we attempt to employ (33) to analyze (31b), using (34) for  $\llbracket \psi \rrbracket^c$  and using a contextually salient set of worlds  $W_0$  in place of  $\mathcal{W}(\llbracket \phi \rrbracket^c)$ , we will have an undefined result unless the input state already contains discourse markers  $l$  for the location of this utterance, and  $u$  for the utterance.

This is because of the kinds of states that (33) requires us to evaluate  $\llbracket \psi \rrbracket^c$  against. Let  $R(W, w, f)$  be:

$$\{ \langle w', f \rangle \mid \text{Revises}(w', w, W) \}$$

for a worldset  $W$  and for any world  $w$  and assignment  $f$ . Then, using (33) without an overt antecedent means evaluating

$$R(W_0, w, f) \llbracket \psi \rrbracket^c$$

for the pragmatically given  $W_0$  and for each  $w$  and  $f$  in the input state. In a counterfactual with an overt antecedent, the analogous update for each  $w$  and  $f$  would on the other hand be:

$$R(\mathcal{W}(\llbracket \phi \rrbracket^c), w, f) \llbracket \phi \rrbracket^c \llbracket \psi \rrbracket^c$$

and  $\llbracket \phi \rrbracket^c$  may thus provide an antecedent for any discourse marker in  $\psi$ . In the case of  $l$  and  $u$  in (34), this would allow for a reading on which the location of the utterance can vary from world to world, a reading such as we saw in (30a) and (30b). But in a context which fails to provide such a  $\phi$ , the only way to get such a reading is through accommodation.

Let us assume the input state  $S$  already contains discourse marker  $d$  for the demonstration accompanying the demonstrative. Then for the reading of (31b) we are interested in, we need a state accommodating an utterance location related to that demonstration for each assignment

f. We can do this via:

$$\begin{aligned} \Delta(S) = & \text{Accom}(\text{Accom}(S, \text{demonstratum-of}, u, d), \\ & \text{location-of}, l, u) = \\ & \{ \langle w, g \rangle \mid \\ & \quad \text{There is } \langle w, f \rangle \in S \text{ and } f <_{u,l} g \\ & \quad \text{and } \langle g(l), g(u) \rangle \in w(\text{location-of}) \\ & \quad \text{and } \langle g(u), g(d) \rangle \in w(\text{demonstratum-of}) \} \end{aligned}$$

Even if  $d$  and  $u$  are rigid designators across revision worlds, the location of  $u$  may vary from revision world to revision world. Then if  $W_0$ ,  $R$ ,  $\Delta$ , and  $\llbracket \psi \rrbracket^c$  are as above and *could*<sup>BCF</sup> designates the bare counterfactual *could*,

$$(35) \quad S \llbracket \text{could}^{BCF} \psi \rrbracket^c = \{ \langle w, f \rangle \in S \mid \text{If there is } w' \text{ such that } \text{Revises}(w', w, W_0), \text{ then } \Delta(R(W_0, w, f)) \llbracket \psi \rrbracket^c \neq \emptyset \}$$

gives the desired reading for (31b).

We now turn to (31a) and (31c). On our account the indexical readings of these sentences are available without any accommodation. This is because the Utterance Condition and the Consistency Condition taken together guarantee that any information state and context that are arguments of the meaning of (31a) and (31c) provide a discourse marker for all the contextual roles; and the utterance location is one of the contextual roles, namely the one filled by **here**<sub>e</sub>.

The next question to ask is why the accommodation available for (31b) is not available for (31c). On our account, the implicit argument of *nearby* must have a corresponding discourse marker assigned to a location in the discourse. Why is it not possible to satisfy that requirement as before, by relating the implicit argument to the location of the utterance? In other words, using  $l$  again for the location and  $u$  for the utterance, why not accommodate  $l$  by way of location-of( $l, u$ )?

The answer lies in the nature of ordinary accommodation. Accommodating a definite requires relating it to an entity already given in the discourse. But there is no reason in the case of a discourse in which  $u$  has not been overtly introduced, to assume that the utterance  $u$  is given. And in uttering (31c), in, say, a context where the speaker is evaluating the aesthetic merits of the utterance location, the utterance itself has *not* been introduced; in this case there is no demonstrative forcing the introduction of a discourse marker for the utterance.

Consider on the other hand the following sentences uttered in a context in which the speaker (perhaps in wistfully addressing himself) is evaluating the aesthetic merits of the utterance location:

(36) a. There could have been a river near me.

b. There could have been a river nearby.

In this case both (36a) and (36b) have readings on which alternative locations of the speaker are considered. Note that this is quite different from considering alternative locations for the utterance, since the speaker need not be uttering (36a) in the alternative locations considered. In the case of (36a) a reading on which alternative locations of the speaker are considered is possible without accommodation. Every state supplies a discourse marker for the speaker and (36a) is about counterfactual locations of that speaker. In the case of (36b), accommodation intervenes. The location required by *nearby* can be accommodated by way of the relation location-of( $l, s$ ) where  $s$  is the speaker. Accommodating by way of a relation to the speaker is possible in any context, because speaker is one of the contextual roles of an utterance context and we require every information state to supply a discourse marker for the speaker. In contrast, the accommodation in (32) was to the utterance  $u$ , and only a prior accommodation could guarantee the required discourse marker.

The fact that, in relevant contexts, (36b) can share the non-referential reading of (36a) but not the non-referential reading of (31b) shows that something distinguishes speakers from other necessary participants of the utterance context, such as the utterance itself. It thus provides important evidence for the idea of contextual roles. Any account that automatically accommodates whatever is always in the utterance context will accommodate too much and allow the impossible reading of (36b). Any account that omits speakers will accommodate too little.

#### 4.4 Contextuals

We have argued that in dealing with the control of implicit arguments by the context of utterance we need to conceptually separate two properties, *indicativeness* and *referentiality*.

The canonical examples of indicative expressions are pronouns like  $I$  and demonstratives in their true indexical uses. The reference of an utterance of  $I$  is determined by whoever produces the utterance, but the relation of speaker and utterance is not part of the content of the sentence *I am hungry*. The reference of a true indexical use of *that* is the object pointed to, but the relation between pointer and pointed-at is not part of the content of an utterance.

Following Kaplan, we have chosen to pursue a direct reference account of the indicativeness of indexicals. This directly referential account carries over to our treatment of implicit arguments that anchor to the context of utterance.

Nunberg (1992) calls words like *local* contextuals. He defines con-

textuals as expressions that permit control by the context of utterance but whose meaning remains part of the utterance content, and points out that in cases like (37) they are controlled by the context of utterance without being referential.

- (37) a. The local scenery is getting prettier.  
b. The scenery around here is getting prettier.

Note that (37a) has a reading (37b) lacks: the discussion may be taking place on a train with the scenery moving. Here *local scenery* seems to vary with the motion of the train, but the interpretation is still controlled by the context of utterance. The fact that (37b) lacks a reading which allows *here* to vary is exactly what the direct reference account would predict, but is the quantification over locations in (37a) a problem for our analysis of implicit arguments?

We believe not. Our account of *local* allows the presuppositional requirements of the location argument to be satisfied by accommodating a location into the input information state. As in the case of (36b), that accommodated location, however, may be controlled by the context of utterance without referring directly to the location of the utterance. Suppose for all  $w$  and  $f$  the location  $x$  is accommodated by the following relation:

$$\langle f(x), \mathbf{ego}_c \rangle \in w(\text{location-of})$$

Our account now requires that  $\mathbf{ego}_c$  remain fixed, but not that the value of  $x$  remain fixed. In effect, we give this sentence the same account we would give:

- (38) The scenery around me is getting prettier.

Note that this sentence too has the reading which (37a) has and (37b) lacks.

We might also note in passing that according to Numberg's definition of contextuials, a word like *we* is also a contextual. The relevant example is Partee's:

- (39) Every time a musician comes over, we play duets.

Here the reference of *we* may vary even though *we* remains anchored to a single utterance situation (a single speaker). If  $g$  is the group-denoting variable introduced by an utterance of *we*, then  $g$  will be restricted by the condition:

$$\langle \mathbf{ego}_c, f(g) \rangle \in w(\text{member-of})$$

To sum up, an implicit argument may be controlled by the context of utterance without being referential, as in (37a), but that case involves accommodation of a location-denoting discourse marker via the  $\mathbf{ego}_c$  contextual role. In other words, that case is no different from a

description containing an indexical and does not constitute a special kind of indexicality.

## 5 Conclusion

In this paper we have provided an account of the context-dependency of implicit arguments that results in a unified treatment of their readings and an account of indexicals that captures their indicativeness and referentiality. The two accounts are independent and their interaction falls out naturally. This is a desirable property for a theory relating anaphoric elements and indexicality to have. A wide range of linguistic elements can either function anaphorically or exploit the speech situation (third person pronouns, definites, implicit arguments, demonstratives). Thus we want anaphoric dependencies to be naturally satisfiable by features of the utterance situation. The notion of the context of utterance seems to be naturally extendable, by extending the domain of the context assignment function.

For the phenomena discussed in this paper, it would have been sufficient to assume that each information state has three designated variables whose unique values are **ego**, **here**, and **now**, respectively. Instead, we have introduced a context, a special kind of information state with maximal information with respect to worlds and the variables in its domain, for two main reasons. First, utterance situations may contain additional elements, which determine the interpretation of linguistic expressions such as demonstratives. Therefore, we want a construct that can in principle provide information about any number of relevant contextual features. The second reason has to do with the logic of indexicals: in order to capture the logical properties of certain sentences containing indexicals, such as pragmatic validity, we need to relativize interpretation to a context and an information state. These are, of course, among the principal reasons that motivated Kaplan's separation of the context of utterance from other parameters of evaluation and they apply to dynamic systems of semantic interpretation as much as they applied to classical truth-conditional systems of semantic interpretation.

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## 2

## A Deductive Account of Quantification in LFG

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The relationship between Lexical-Functional Grammar (LFG) *functional structures* (f-structures) for sentences and their semantic interpretations can be expressed directly in a fragment of linear logic in a way that explains correctly the constrained interactions between quantifier scope ambiguity and bound anaphora.

The use of a deductive framework to account for the compositional properties of quantifying expressions in natural language obviates the need for additional mechanisms, such as Cooper storage, to represent the different scopes that a quantifier might take. Instead, the semantic contribution of a quantifier is recorded as an ordinary logical formula, one whose use in a proof will establish the scope of the quantifier. The properties of linear logic ensure that each quantifier is scoped exactly once.

Our analysis of quantifier scope can be seen as a recasting of Pereira's analysis (Pereira 1991), which was expressed in higher-order intuitionistic logic. But our use of LFG and linear logic provides a much more direct and computationally more flexible interpretation mechanism for at least the same range of phenomena. We have developed a

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