

Capturing Sense in Intensional Contexts

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Abstract

An account is offered of the sense of referring expressions in intensional contexts. Unlike Russell’s classic account in terms of the *de re/de dicto* distinction, this doesn’t rely on a quantifier scope ambiguity in the logical form. Instead, different senses of a referring expression are captured by the different discourse models which emerge in different contexts of use. This approach has two advantages over Russell’s. It is more general, extending to contexts which aren’t explicitly intensional. Furthermore, it doesn’t rely on proposing a spurious ambiguity in the logical form.

Keywords: sense, reference, intensional contexts, common ground, discourse models

1 Introduction

Any account of referring expressions needs to capture their behaviour in intensional contexts. (?) claimed that what matters here is the *sense* of a referring expression rather than its *reference*. This can be illustrated by the following scenario. Suppose that Mary’s sister has been found murdered. She tells a friend “The murderer is evil”. Upon being informed that Mary’s husband is in fact the murderer, this friend could faithfully report that “Mary believes the murderer is evil”, but it would be disingenuous to claim that “Mary believes *her husband* is evil”. While the *reference* is the same in both cases, one is a true report and the other is not.

We have implemented an approach to reference resolution (??) in the system of language understanding described in (??). In order to dereference a referring expression, we show that the discourse model (or *common*

ground) supports a proof that there is some entity that fits the description supplied by the referring expression, and that it does not support such a proof for more than one equally salient entity. In doing this, we rely on both the current context, represented by the discourse model, and more general background knowledge, contained in meaning postulates. This means that our approach to reference resolution cannot be divorced from the system of language understanding as a whole. In this paper we will show that a further property of this system of language understanding is that it captures the *sense* of the particular referring expression which the speaker chooses to denote the referent.

2 Background

Russell’s classic treatment of reference in intensional contexts is in terms of the *de re/de dicto* distinction (?). The *de re* interpretation of a referring expression corresponds to its referent in the world, whereas its *de dicto* interpretation corresponds, rather, to the object of the belief (or other attitude) attributed. The distinction between them is usually represented in terms of a quantifier scope ambiguity.

“Mary believes the murderer is evil.”

de re:

$$\exists X : \{murderer(X) \wedge \forall Y (murderer(Y) \leftrightarrow X = Y)\}, \\ believe(Mary, evil(X))$$

de dicto:

$$believe(Mary, \\ \exists X : \{murderer(X) \wedge \forall Y (murderer(Y) \leftrightarrow X = Y)\}, evil(X))$$

The problem with this representation is that it postulates an ambiguity where it is not at all clear that there is one. Even if there were one, it is not clear how it could possibly be resolved and successful communication achieved. It seems that the predicted ambiguity is not realised but, rather, that on the whole we have no greater problems with reference resolution in intensional than in non-intensional contexts.

3 Representation and Reference Resolution

We represent referring expressions using terms rather than quantified phrases:

$$ref(\lambda X (murderer(X)))$$

This means that, given an apparently unambiguous utterance containing a propositional attitude, we obtain a single, unambiguous logical form¹.

“Mary believes the murderer is evil.”

$believe(ref(\lambda X(named(X, Mary))), evil(ref(\lambda Y(murderer(Y))))))$

Our approach to interpretation involves constructing a discourse model D_n for utterance U_n which admits the logical form of this utterance together with the participants’ general knowledge (encapsulated as a set of meaning postulates) and the discourse model D_{n-1} that was obtained for the previous utterance. This achieved by using a tableau-like theorem prover (?; ?), but starting with the logical form itself (rather than its negation, as is usually the case with tableau-based theorem provers) and looking for an *open* branch, which will constitute a model.

As part of this process, we resolve referring expressions by showing that the common ground of the conversants supports a proof that there is something of the required kind (i.e., *existence*); and no other *equally salient* entity can be *shown* to fit the given description (i.e., *uniqueness*) (?). Note that the uniqueness part of this does *not* require us to show that there is only one item that satisfies the given description, only that there is no other (equally salient) item which can be proved to satisfy it on the basis of information that is known to be available to both participants. (?) shows that we can use this approach to cover a range of cases, including ones where the existence of such an entity is implied, but no such entity is explicitly present (as in bridging references and a number of other awkward cases).

This is the same regardless of whether the referring expression appears within an intensional context, as reference resolution concerns the conversants and as such must rely on that information which is shared in their common ground. However, in using a referring expression within an intensional context, such as the context of Mary’s beliefs, the speaker does invoke a further context. This further context can’t *actually* be Mary’s beliefs, as these are private to Mary, who might secretly know her husband is the murderer. We will suggest that the further context invoked is the common ground shared by the speaker and Mary. As the contents of this context are not in the common ground of speaker and hearer, however, our only access to this context is through the speaker. In using a referring expression in an intensional context, the speaker implies that this context shares with the common ground of speaker and hearer the information needed to dereference it.

¹This is a greatly simplified version. See Section 4.2 below for the actual logical form we obtain for “Mary believes the murderer is evil.”

4 Sense

By sticking to a single logical form, we avoid any spurious ambiguity. However, we are still able to explain how the same referring expression, “the murderer”, can have different senses in different contexts. This is because we identify different senses of a referring expression, not with different logical forms, but with different discourse models in different contexts. We take sense to be a property, not of the referring expression by itself, but of the referring expression together with the context in which it is used.

Because our approach does not rely on an ambiguity in the logical form, it applies even to contexts which are not explicitly intensional. We start by examining the senses of referring expressions used in these contexts.

4.1 Sense in the Discourse Model

Consider the following scenario. Mary’s sister has been murdered. The speaker knows that Mary’s husband is the murderer, but Mary does not. In this context, (2a) and (2b), spoken to Mary, generate different discourse models:

- (1) Hannah has been murdered.
- (2a) The murderer is evil.
- (2b) Your husband is evil.

In particular, unlike the speaker’s beliefs, the discourse model for (2b) does not contain the fact that *the murderer* is evil. Part of the discourse model we obtain from updating the discourse (1)—(2b) is shown below²:

Discourse state 0 <hr style="width: 100%;"/> <i>hearer</i> (#89) <i>named</i> (#89, <i>Mary</i>) <i>named</i> (#94, <i>Hannah</i>) <i>husband</i> (#99) <i>of</i> (#99, $\lambda A(\textit{husband}(A))$, #89) ... Discourse state 1 <hr style="width: 100%;"/> θ (#144, <i>object</i> , #94)	<i>murder</i> (#144) <i>murderer</i> (#79(#144)) ... Discourse state 2 <hr style="width: 100%;"/> <i>evil</i> (#99, #147) θ (#146, <i>pred</i> , $\lambda A(\textit{evil}(A, \#147))$) θ (#146, <i>topic</i> , #99) <i>etype</i> (#146, <i>predication</i>) ...
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²The existence of the murderer is entailed by the following meaning postulate:

$$\forall E :: \{\textit{murder}(E)\}, \exists M(\textit{murderer}(M))$$

In resolving the reference to “the murderer”, we exploit the fact that the murderer, #1040(#1071), is a function of the murder, #1071, which is in the list of forward-looking centres for Discourse State 1, as described in (?).

In a context where Mary is not aware that her husband is the murderer, the speaker cannot use (2b) to convey to Mary the sense of (2a). However, if the discourse model (1)—(2b) is further updated with (3), then the sense of (2a) will be conveyed.

- (1) Hannah has been murdered.
- (2a) The murderer is evil.
- (2b) Your husband is evil.
- (3) The murderer is your husband.

The further discourse state we obtain when we update (3) is given below:

Discourse state 3

$\theta(\#149, pred, \lambda A(A = \#99))$	$predication(\#149)$
$\theta(\#149, topic, \#79(\#144))$	$\#79(\#144) = \#99$
	...

The referent of the referring expression “Your husband” is the same in discourse model (1)—(2b)—(3) as in discourse model (1)—(2b). However, the sense of the referring expression changes. The information added to the common ground by (3) equates the referent of “your husband” with another discourse entity:

$\#79(\#144) = \#99$

The referent then takes on the sense given to this entity by the information which is predicated of it:

$murderer(\#79(\#144))$

4.2 Intensional Contexts

In the “non-intensional” case, referents are entities in the discourse model and their sense is conveyed by the information which is predicated of them in the common ground. In the intensional case, we have, not one, but two, contexts to consider, the common ground shared by the conversants and the context of the belief (or other attitude) attributed. While *reference* to entities is shared across these contexts, different information may be predicated of entities within the contexts, so that the *sense* of the referring expression varies with the context of use.

Assume a context in which the information that Mary’s husband is the murderer is shared in the common ground of the conversants. In this context, “The murderer” and “Mary’s husband” will have the same sense, and so the facts in the discourse models for (4a) and (4b) will be the same.

- (4a) The murderer is evil.
(4b) Mary's husband is evil.

However, consider (5a) and (5b) as reports of Mary's claim that (4a), given that (as far as the speaker knows) *Mary* is unaware her husband is the murderer:

- (5a) Mary believes the murderer is evil.
(5b) Mary believes her husband is evil.

In this context, (5a) is a true report of Mary's claim, but (5b) is not. In the context of Mary's beliefs, or rather in the common ground shared by the speaker and Mary, "the murderer" and "Mary's husband" do not share the same sense and so are not interchangeable. This distinction is captured in the different discourse models we obtain for (5a) and (5b).

We consider both (5a) and (5b) in the context of the same preceding discourse model, given below:

Discourse states 0 - 2

-----	$\theta(\#269, object, \#252)$
<i>named</i> (#252, <i>Hannah</i>)	<i>murder</i> (#269)
	<i>murderer</i> (#238(#269))
<i>of</i> (#257, $\lambda A(husband(A))$, #259)	#257 = #238(#269)
<i>named</i> (#259, <i>Mary</i>)	...

This discourse model contains, in particular, the knowledge shared by the conversants that Mary's husband is the murderer. The logical form we obtain for (5a), "Mary believes the murderer is evil", is given below:

$$\begin{aligned} \exists C : \{ & C \text{ is interval} \\ & \&ends_after(ref(\lambda D(speech_time(D, ref(\lambda E(cdiscourse(E)))))), C) \} \\ \exists A : \{ & aspect(simple, C, A) \} \\ & \theta(A, agent, ref(\lambda F(named(F, Mary))) \\ & \&believe(A) \\ & \&etype(A, believe) \\ & \&A \text{ is event} \\ & \&\theta(A, \\ & \quad event, \\ & \quad \wedge(\exists B : \{ B \text{ is interval} \\ & \quad \&ends_after(ref(\lambda Gspeech_time(G, ref(\lambda H(cdiscourse(H))))), \\ & \quad \quad B) \} \\ \exists I : \{ & aspect(simple, B, I) \} \\ & \theta(I, topic, ref(\lambda J(murderer(J))) \\ & \&predication(I) \\ & \&etype(I, predication) \\ & \&I \text{ is event} \\ & \&\theta(I, pred, \lambda K(\exists Levil(K, L)))) \} \end{aligned}$$

This logical form contains a nested proposition of the form \hat{P} corresponding to the belief attributed to Mary. We have extended our implementation of model building so that it constructs a nested discourse model of the form $\{P', PFACTS\}$, whenever it encounters a nested proposition, \hat{P} , in the logical form. $PFACTS$ is the discourse model for \hat{P} . P' is a logical form like \hat{P} , but anchored in the discourse context, i.e., with all referring expressions resolved to entities in the common ground. Although it is $PFACTS$ rather than P' which represents the nested discourse model, we also retain P' for use in the meaning postulates.

Reference resolution is an important part of building the discourse model. The proof that “the murderer” denotes depends on a fact in the common ground of the conversants, so the referent we obtain for this referring expression is the same as we would obtain if it appeared outside the intensional context:

murderer(#238(#269))

The further discourse state we obtain from updating the discourse model given above with (5a) is as follows:

<p>Discourse state 3</p> <hr/> <p><i>believe</i>(#273) θ(#273, <i>agent</i>, #259) θ(#273, <i>event</i>, $\{$, (<i>etype</i>(#275, <i>predication</i>) &<i>predication</i>(#275) &<i>aspect</i>(<i>simple</i>, #274, #275) &<i>evil</i>(#238(#269), #276) &θ(#275, <i>topic</i>, #238(#269)) &θ(#275, <i>pred</i>, $\lambda A(\text{evil}(A, \#276))$) &<i>ends_after</i>(#162(3), #274) &<i>type</i>(#274, <i>interval</i>)</p>	<p>&<i>type</i>(#275, <i>event</i>), [<i>etype</i>(#275, <i>predication</i>), <i>predication</i>(#275), <i>aspect</i>(<i>simple</i>, #274, #275), <i>evil</i>(#238(#269), #276), <i>static</i>(#275), θ(#275, <i>topic</i>, #238(#269)), θ(#275, <i>pred</i>, $\lambda B(\text{evil}(B, \#276))$), <i>end</i>(#164(#274), #274), <i>end</i>(#164(#275), #275), <i>ends_after</i>(#162(2), #274), <i>ends_after</i>(#162(3), #274)]]) ... </p>
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The common ground of the conversants contains the identity of Mary’s husband and the murderer:

of(#257, $\lambda A(\text{husband}(A))$, #259)
named(#259, *Mary*)
murderer(#238(#269))
#257 = #238(#269)

However, the nested context of Mary’s beliefs does not. This means that her husband’s being evil does not enter into the model of Mary’s beliefs.

Similarly, in the discourse state we obtain from updating (5b), “Mary believes her husband is evil”, the fact that the murderer is evil is not a part of Mary’s beliefs:

<p>Discourse state 3 <hr style="width: 10%; margin-left: 0;"/> <i>believe</i>(#282) θ(#282, <i>agent</i>, #259) θ(#282, <i>event</i>, {, (<i>etype</i>(#284, <i>predication</i>) &<i>predication</i>(#284) &<i>aspect</i>(<i>simple</i>, #283, #284) &<i>evil</i>(#257, #285) &θ(#284, <i>topic</i>, #257) &θ(#284, <i>pred</i>, λA(<i>evil</i>(<i>A</i>, #285))) &<i>ends_after</i>(#162(3), #283) &<i>type</i>(#283, <i>interval</i>)</p>	<p>&<i>type</i>(#284, <i>event</i>), [<i>etype</i>(#284, <i>predication</i>), <i>predication</i>(#284), <i>aspect</i>(<i>simple</i>, #283, #284), <i>evil</i>(#257, #285), <i>static</i>(#284), θ(#284, <i>topic</i>, #257), θ(#284, <i>pred</i>, λB(<i>evil</i>(<i>B</i>, #285)))</p> <p>, <i>end</i>(#164(#283), #283), <i>end</i>(#164(#284), #284), <i>ends_after</i>(#162(2), #283), <i>ends_after</i>(#162(3), #283)]]) ... </p>
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This makes (5b) untrue as a report of Mary’s claim that (4a), “The murderer is evil”. The discourse model for Mary’s beliefs we obtain from (5b) contains two kinds of discrepancies with (4a). Firstly, it is missing facts which were explicit in the model for (4a):

evil(#238(#269), #276),

Furthermore, it attributes additional beliefs to Mary which were not in the model for (4a):

evil(#257, #285),

We have noted that, even when a referring expression is used within an intensional context, it has to refer *for* the conversants and so depends on information in their common ground. In using a referring expression within an intensional context, the speaker implies that this context shares with the common ground the information need to dereference it. However, there is no implication that the common ground as a whole is shared with this context, and so referring expressions which convey the same sense in the common ground cannot be used interchangeably within the intensional context.

5 Belief and Fantasy

Our account explains a well known feature of intensional contexts, the non-substitutability of referentially equivalent expressions. However, a further feature which has been attributed to intensional contexts appears to be in

conflict with our account. (?) points out that one might truly report “Jones believes the richest debutante in Dubuque will marry him” without oneself believing that there any debutantes in Dubuque (or, indeed, that there is such a place). Yet we have suggested that such a reference depends primarily on the common ground of speaker and hearer.

There are two points to be made here. The first is that it is indeed perfectly possible to refer to entities one doesn’t believe in. What is required is that the entity referred to is in the common ground. This domain is clearly distinct from the beliefs of the conversants, as the following example illustrates:

A: “My husband bought me a Porche_i for Christmas.”

B: “I don’t believe you.”

A: “Really! He did.”

B: “What model is it_i, then?”

Here, B is able to refer to the Porsche while simultaneously expressing scepticism as to its existence. The second point concerns the common ground of speaker and hearer. Assuming Jones has told the speaker he believes the richest debutante in Dubuque will marry him, then the referent will be in the common ground shared by Jones and the speaker³. However, there is no reason to suppose that the referent is in the common ground of speaker and hearer, which is what we require for reference resolution. Showing how we deal with this example will help to elucidate some further features of our account.

$$\begin{aligned} \exists A :: \{ & A \text{ is interval} \\ & \& \text{ ends_after}(\text{ref}(\lambda(B\text{speech_time}(B, \text{ref}(\lambda C(\text{cdiscourse}(C)))))), \\ & \quad A)\} \\ \exists D :: \{ & \text{aspect}(\text{simple}, A, D)\} \\ & \text{theta}(D, \text{agent}, \text{ref}(\lambda(E\text{named}(E, \text{Jones}) \& \text{card}(E, 1)))) \\ & \& \text{believe}(D) \\ & \& \text{etype}(D, \text{believe}) \\ & \& D \text{ is event} \\ & \& \text{theta}(D, \text{event}, \\ & \quad \wedge (\exists F :: \{ F \text{ is interval} \\ & \quad \& \text{ starts_after}(\text{ref}(\lambda(G\text{speech_time}(G, \text{ref}(\lambda H(\text{cdiscourse}(H)))))), \\ & \quad \quad F)\} \\ & \quad \exists I :: \{ \text{aspect}(\text{simple}, F, I)\} \\ & \quad \text{theta}(I, \text{agent}, \\ & \quad \quad \text{ref}(\lambda J \\ & \quad \quad \quad (\text{most}(J, \lambda K \\ & \quad \quad \quad \quad (\text{rich}(K, \lambda L(\text{in}(L, \lambda M(\text{debutante}(M))), \end{aligned}$$

³The speaker may have had to *accommodate* (?) the reference in the first place.

$$\begin{aligned}
& \text{ref}(\lambda N \text{named}(N, \text{Dubuque}) \\
& \quad \& \text{card}(N, 1))))), \\
& \text{ref}(\lambda L (\text{in}(L, \lambda M (\text{debutante}(M)), \\
& \quad \text{ref}(\lambda N \text{named}(N, \text{Dubuque}) \\
& \quad \quad \& \text{card}(N, 1)))))) \\
& \quad \& \text{card}(J, 1)))))) \\
& \& \text{marry}(I) \\
& \& \text{etype}(I, \text{marry}) \\
& \& I \text{ is event} \\
& \& \text{theta}(I, \text{object}, \text{ref}(\lambda O (\text{centred}(O, \text{ref}(\lambda P (\text{cdiscourse}(P)))))) \\
& \quad \& m(O) \\
& \quad \& \text{card}(O, 1))
\end{aligned}$$

The logical form we obtain for Kripke's example contains a term corresponding to the referring expression "the richest debutante in Dubuque" which itself incorporates a reference to the set of debutantes in Dubuque. This reference in turn incorporates a further reference to Dubuque. This means that there is not one referring expression, but three, to be dereferenced. Assuming no knowledge of either the debutantes of Dubuque or Dubuque itself in the common ground, we obtain the following discourse model when we update the utterance:

Discourse state 0

named(#436, *Jones*)

...

Discourse state 1

most(#420, $\lambda A (\text{rich}(A, \lambda B (\text{in}(B, \lambda C (\text{debutante}(C)), \#452))))$), #451)

debutante(#451)

accommodated(*in*(#451, $\lambda A (\text{debutante}(A))$), #452))

named(#452, *Dubuque*)

accommodated(*named*(#452, *Dubuque*), *card*(#452, 1))

believe(#453)

θ (#453,

event,

{, (*marry*(#455)

&...),

[*marry*(#455),

debutante(#451),

accommodated(*in*(#451, $\lambda B (\text{debutante}(B))$), #452)),

accommodated(*named*(#452, *Dubuque*), *card*(#452, 1)),

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    etype(#455, marry),
    aspect(simple, #456, #455),
    named(#452, Dubuque),
    most(#420, λE(rich(E, λF(in(F, λG(debutante(G)), #452))))), #451)
    θ(#455, agent, #420),
    θ(#455, object, #436),
    ...])})
θ(#453, agent, #436)
...

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The discourse model shows that the reference to Dubuque cannot be resolved and so has to be accommodated (?). Similarly, the existence of a set of debutantes in Dubuque is not in the common ground, and so this reference is also accommodated. However, having accommodated this referent, we are then able to prove that the referring expression “the richest debutante in Dubuque” does indeed denote. This is because, given any set and any ordered property, P , such as *rich*, our meaning postulate for superlatives enables us to prove that there is a most P subset of the set⁴ (?):

$$\forall X \forall N \forall P :: \{|X| > N\}, \\ \text{exists}(Y, \text{most}(Y, P, X) \& |Y| = N)$$

We agree that the speaker doesn’t have to believe in the existence of a referent to refer to it, whether in an intensional or a “non-intensional” context. However, the referent does need to exist in the common ground of speaker or hearer. Otherwise, it needs to be the sort of referent which is easily accommodated. Dubuque and the debutantes of Dubuque are these sorts of referents, as their existence is consistent with the information already in the common ground. Not all referring expressions are equally unproblematic. Suppose that the common ground contains the fact that the hearer has no sisters. In these circumstances, the speaker’s report that “Jones believes *your sister* will marry him” will contain a reference which cannot simply be accommodated. This example illustrates that one cannot use just any referring expression in intensional contexts. Rather, whatever the context, the referring expression has to be one which can be resolved in the common ground of the conversants.

6 Belief and Ignorance

In the previous section we argued that, even when a referring expression is used in an intensional context, it needs to denote in the common ground of the conversants. Here we address the related issue of whether it also

⁴More precisely, for any specified cardinality N , there is a subset of the N most P members of the original set.

needs to denote in the common ground of speaker and addressee, as it does in our account. The kind of example which suggests the common ground of speaker and addressee doesn't matter is "Oedipus wants to marry his mother" (?). According to our account, the reason this example is true rather than misleading is that *here* there is only the single context of the conversants' common ground. The common ground of speaker and addressee is never invoked. If we consider an example clearly containing a propositional attitude, such as "Oedipus believes he will marry his mother", then this *is* misleading in exactly the same way as "Mary believes her husband is evil".

7 Conclusions

In this paper we have proposed an account of the sense of referring expressions which explains the non-substitutability of referentially equivalent expressions in intensional contexts. It is also of broader importance, explaining how a discourse entity takes on a particular sense in any kind of context. It differs from Russell's approach in that it does not rely on an ambiguity in the logical form. However, looking at our discourse models, we see that they are precisely the kinds of discourse models we would expect different logical forms to generate. The advantage of our approach is that we can explain how the different discourse models emerge in different discourse contexts without the problem of ambiguity resolution ever arising.

We construct our discourse models in the system of language understanding described in (?; ?). These contain entities introduced into the discourse, and these entities are the referents of referring expressions. Various kinds of information are predicated of these discourse entities. In choosing a referring expression, the speaker relies on as much of this information as is necessary to ensure the intended referent can be understood by the hearer. Taken as a whole, the information predicated of an entity in a particular discourse model gives it the sense that it has *in that discourse model*. Note that we are claiming that referring expressions identify referents, and that *sense is a property of the entity referred to*, in a particular discourse context.

In using a referring expression in an intensional context, the speaker still has to invoke the common ground of speaker and hearer for reference resolution to succeed. However, there are further constraints on the choice of referring expression imposed by the common ground of speaker and addressee. This is because, in using a referring expression in an intensional context, the speaker implies that the information needed to dereference the referring expression is also predicated of the referent in this context. However, as *further* information predicated of the referent in the common ground may not be present in this context, expressions which convey the same sense in the common ground may or may not be substitutable in any particular in-

tensional context. This is because the *sense* of a referring expression used in an intensional context depends on the information predicated of it, not in the common ground but, in that context.

One advantage of having an account of sense which extends to contexts which aren't explicitly intensional is that it gives us a handle on certain kinds of indirect speech acts. In a context where Mary and the speaker share the information that Mary's husband is the murderer, the speaker has the choice of saying directly to Mary "Your husband is evil" or, instead, merely implying this by saying "The murderer is evil". In contexts where there is more than one hearer, each sharing a different common ground with the speaker, the speaker can exploit the choice of referring expression to deliberately convey a different message to different hearers. For example, in a context where the information that Mary's husband is the murderer is public to the speaker and some hearer other than Mary, the speaker is able to convey one message to Mary and another to the other hearer by saying "The murderer is evil".