Chapter 3

Games and Pragmatic Interpretation

“Informants, particularly those of the ti’ye’er caste, claim this distinction to be present in their language; but when concrete evidence in support of this contention was demanded, informants invariably resorted to evasive and mystical references to context, sentence structure, collocational meaning, and the like.” (Walker 1970, p. 104)

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Chapter 3. Games and Pragmatic Interpretation

This chapter deals with applications of the IBR model. Section 3.1 first discusses how to set up and interpret context models for generic interpretation of sentences. Section 3.2 then introduces the idea of epistemic lifting of signaling games that will help us integrate sender uncertainty into the model. Section 3.3 shows how such lifted models figure in an account of free choice readings. Finally, section 3.4 places this game theoretic approach into a broader linguistic context.

3.1 Game Models Revisited

The predictions of GTP not only depend on a suitable solution concept, but also on how the game model is set up. Parameter choices in a signaling game, such as the individuation of states, the set of messages, prior probabilities, utilities and so forth should therefore be based on uniform and generally motivated principles. This crucial aspect is unfortunately not addressed with due explicitness in the bulk of the relevant literature (except maybe Benz 2009) and so we should spent some thought on the issue.

3.1.1 Interpretation Games

Epistemic Status of the Context Model. Remember that with a game we want to capture the relevant aspects of the context of utterance. In game theory, the structure of a game is usually taken to be common knowledge between players. If taken at face value, this is certainly a dubious assumption for models of natural language interpretation (cf. Clark and Marshall 1981; Sperber and Wilson 1995; Allott 2006). It would be difficult to find many naturally occurring conversational settings where it is common knowledge between interlocutors that the context is as described by a signaling game.

But we also do not have to interpret the context model this way. We should rather consider the game model as a representation such that either sender or receiver —depending on whose side we wish to focus on— believes that it is common belief that the context is like that. This way the game represents the epistemic situation of only one agent separately and we make room for the possibility of subjective error. In what follows I will make the case that signaling game models in GTP should in particular be regarded as the receiver’s conceptualization of the context after he has received a given target message whose interpretation we, as modellers, are interested in.
3.1. Game Models Revisited

Interpretation Games. From this point of view, GTP is concerned with very particularized instances of individual reasoning about language use and interpretation. Still, GTP is not exclusively about situated reasoning in a particularized context. It can also be applied to a more abstract and general setting, and indeed this is what we have done implicitly already in the previous chapters. If we wish to speak of an “implicature of a given sentence” then we would like to resort to a more abstract notion of a generic context model. The idea is that, strictly speaking, sentences as such do not have implicatures, but that utterances of sentences in context have, and that to speak of “implicatures of sentences” is to be sloppy and to refer to implicatures that a sentence has in a standard, run-of-the-mill context (see Bach 1999).

The generic context model for natural language interpretation that I favor in this thesis is that of an interpretation game. An interpretation game is a signaling game where (i) the receiver’s response actions are interpretation actions \( A = T \) that correspond one to one with the set of states and where moreover (ii) response utilities are given as:

\[
V_S(t,a) = V_R(t,a) = \begin{cases} 1 & \text{if } t = a \\ 0 & \text{otherwise.} \end{cases}
\]

If message costs apply in interpretation games, these are nominal sending costs incurred equally for all states: \( C_S(t,m) = C_S(t',m) \) (see section 2.2.4 on nominal costs). Since interpretation games aim to explain generic interpretation of sentences, these games are to be understood as representations of in particular the receiver’s conceptualization of the utterance context.

For instance, the some-all game, which has accompanied us through the last two chapters already, should be thought of as an interpretation game for a generic utterance of a sentence like (8a). It is as such a representation of a (generic) receiver belief — be that a stipulation, an implicit assumption or actual well-grounded knowledge — that it is common belief between sender and receiver that the context of utterance is as given in the some-all game.

Interpretation of Interpretation Games. Interpretation games thereby implement a number of assumptions — of the interpreter if you wish — about the utterance context, most of which are familiar from other work in linguistic pragmatics. Firstly, interpretation games assume that the receiver is interested to get to know precisely which state is actual. This is implemented by interpretation actions \( A = T \) and the receiver’s utilities that match states and actions one-to-one. In general, we should think of the receiver’s actions and
his payoffs as a fairly flexible way of representing a contextual question under discussion (see van Rooij 2003b). Receiver actions and payoffs fix what (kind of) information will be important and, indeed, relevant to the receiver.

Secondly, while the receiver’s utilities implement the question under discussion, the sender is assumed to adopt the receiver’s preferences in interpretation games. To assume that preferences of sender and receiver are aligned in the form of $V_S = V_R$ is a formal means of implementing Grice’s central assumption that conversation is a (by and large) cooperative endeavour: in our game models, it is in particular the speaker who thus tends to the hearer’s informational needs.

Thirdly, interpretation games assume that if messages are to be distinguished from one another by costs, then these costs are to be nominal. This is to implement the idea that whatever it is that makes one message more marked than another, first and foremost interlocutors strive to be understood. Only when they are otherwise indifferent would considerations of markedness of expressions play a role.¹

It is of course not necessary that these assumptions all apply for all cases of natural language interpretation. But if we want to account for the implicatures associated with utterances of certain sentences in standard contexts, these assumptions do seem feasible.

### 3.1.2 Construction of Interpretation Games

By definition, interpretation games determine the receiver’s response actions and the utilities of both sender and receiver. This still leaves other parameters of the context model underspecified. How should we interpret and specify the set of states, the prior probabilities, the set of messages, their meaning and possible message costs? I will argue in more detail below that an interpretation game for a given sentence should be constructed as follows: (i) a set of alternative forms to the given target sentence fixes the set of messages; (ii) the semantic meaning of messages is given by some suitable semantic theory; (iii) from the set of messages and their semantics, a set of state distinctions is derived; (iv) finally, prior probabilities over states are assumed flat. Let us have a closer look at these rough construction steps one by one in order to see what their respective motivations and conceptual implications are.

¹. This assumption is not very crucial. Nothing hinges on this, as far as predictions of the ibr model are concerned for the examples considered here. Still, nominal message costs are (i) conceptually defensible and (ii) easier to cope with in proofs of structural results.
Message Alternatives. It is a well-known problem in Gricean pragmatics that naïve scalar reasoning (see section 1.1.2) depends heavily on the proper specification of alternative expressions $\text{Alt}(X)$. To wit, the inference from (8a) to (8g), repeated here, hinges on the idea that the speaker would have used the semantically stronger (8d) if it had been true and relevant.

\begin{enumerate}
\item[(8a)] Some of Kiki’s friends are metalheads.
\item[(8d)] All of Kiki’s friends are metalheads.
\item[(8g)] $\leadsto$ It’s not the case that all of Kiki’s friends are metalheads.
\end{enumerate}

But by the same reasoning we could establish that (8a) implicates (24), because the speaker has not uttered the semantically stronger sentence (23) in which “some” is replaced by the expression “some but not all.”

\begin{enumerate}
\item[(23)] Some but not all of Kiki’s friends are metalheads.
\item[(24)] It’s not the case that some but not all of Kiki’s friends are metalheads.
\end{enumerate}

It is thus clear that naïve scalar reasoning crucially hinges on the set of alternatives that we take into account. This problem has been discussed centrally in Neo-Gricean pragmatics (Atlas and Levinson 1981; Horn 1989; Matsumoto 1995), and has recently been revived and dubbed symmetry problem (e.g. Fox 2007; Katzir 2007; Block 2008). Although for most cases there is usually a commonly shared understanding of which forms are a natural set of expression alternatives, it is fair to say that after all these years there is still no general consensus in the literature exactly why certain interfering expressions, like “some but not all” as an alternative to “some”, should be excluded from naïve scalar reasoning. Suggestions why this may be so range from a different degree of lexicalization (Atlas and Levinson 1981), over a difference in monotonicity properties (Horn 1989), to increased structural complexity (Katzir 2007), for instance.

It is obvious that this issue is strictly speaking orthogonal to the concerns of GTP, which is a theory of reasoning about alternative messages and not a theory of alternatives as such. In order to account for an utterance of sentence $X$, the most natural choice for GTP is to stick—as uncommitted as possible—to the most natural and hopefully uncontroversial set $\text{Alt}(X)$ in order to derive its set $M$ of speaker options. So, for instance, for a scalar implicature associated with the expression “some” we could assume that the set of alternatives are, in the vein of Horn (1989), all those semantically stronger sentences obtained from replacing “some” in the target utterance with a lexically, or otherwise, related expression. In sum, I would like to rely on a commonsense
notion of expression alternatives here, relegating the symmetry problem, as well as the question whether the present approach deals with all reasonable solutions to the symmetry problem, to another occasion.

States and Semantic Meaning. Based on a set of messages $M$ we will also have to provide a semantic denotation function $\llbracket \cdot \rrbracket$, which we assume is a function from messages to sets of states. The most natural way of thinking about this is certainly that a state $t \in T$ of an interpretation game is a “state of the world,” and that $t \in \llbracket m \rrbracket$ whenever the message $m$ is true in $t$. It should be noted, however, that we do not have to interpret semantic meaning as truth conditions in this way. I will do so for all applications in this thesis, but strictly speaking, the signaling game model is compatible with different notions of semantic meaning, as long as the meaning of a message can be reasonably expressed in set theoretic terms, in particular as a subset of $T$.

For any arbitrary semantics that we would like to feed into our $\texttt{gtp}$ model, the set of states of our interpretation game would then serve to represent all those distinctions in meaning that we would like to make based on the set $M$ for the purposes of the current application. Under my preferred interpretation of conventional meaning as truth conditions, the set of states $T$ should then be regarded as a set of disjoint sets of worlds, so as to represent all those relevant mutually exclusive states of affairs that can be expressed by the linguistic means provided by $M$.

More concretely, if we want to explain the scalar implicature associated with some (expression that we represent as) message $m^*$, then, by our conventional construction of the set $M$, it is usually the case that $m^*$ is the semantically weakest message in $M$, in the sense that all other messages in $M$ entail $m^*$. In that case it is natural to construe the set of states $T$ as a partition of the set of worlds in which $m^*$ is true so as to represent certain finer meaning distinctions as possible interpretations of the target expression $m^*$. But then, not every such partition is reasonable. Rather we should naturally consider exactly those distinctions that we can express with alternative messages beyond $m^*$ under logical conjunction and negation. Effectively, we are interested in any meaning distinctions that be expressed by formulas of the kind:
3.1. Game Models Revisited

\[ m^* \land m_1 \land \ldots \land m_i \land m_{i+1} \land \ldots \land m_{i+j} \]

\[ \vdots \]

\[ m^* \land m_1 \land \ldots \land m_i \land \neg m_{i+1} \land \ldots \land \neg m_{i+j} \]

\[ \vdots \]

\[ m^* \land \neg m_1 \land \ldots \land \neg m_i \land \neg m_{i+1} \land \ldots \land \neg m_{i+j} \]

Some of these formulas will be inconsistent and some will be equivalent. Ultimately, we would then identify the states of our interpretation games with the non-contradictory propositions, i.e., non-empty sets of possible worlds, that can be expressed by a formula of the above list.

**Prior Probabilities.** After settling on a suitable set of state distinctions for our game model, we also need to specify a prior probability distribution on these. Remember that normally in game theory the prior probabilities in a signaling game would capture the receiver’s initial beliefs about which state is actual. It is dubious, however, that this is a reasonable interpretation for applications to natural language interpretation, as I would like to argue in the following. I would also like to argue that the way prior probabilities have been used in previous approaches within \textsc{gtp} is similarly dubious. In conclusion, I suggest that we should look at prior probabilities as concise representations of the receiver’s meaning associations *ex post*.

Let us begin by briefly revisiting the standard interpretation of prior probabilities in a signaling game. Game theorists like to think of the states of a signaling game as initial chance moves by a third player, called Nature, who selects any state \( t \in T \) with probability \( \Pr(t) \), without any strategic concern of her own (cf. Harsanyi 1967, 1968a,b). In a signaling game, Nature reveals her choice to only the sender, but not the receiver. According to this interpretation, the probability distribution \( \Pr(\cdot) \) first and foremost captures the objective, frequentist probability of states actually occurring.

This standard interpretation of prior probabilities is not adequate for games as context models for natural language interpretation for two reasons: firstly, there are good arguments why objective, especially frequentist, probabilities are often not the driving force behind natural language disambiguation; secondly, it is moreover quite implausible for many linguistic applications that the receiver has any relevant probabilistic beliefs about states of affairs or
even intended speaker meanings before actually observing a message. Let me briefly enlarge on both of these points before offering an alternative view.

Consider the example (25), which is an example raised critically by Allott (2006) —borrowed from Wilson and Matsui (1998)— to argue against the use of prior probabilities in Parikh (2001)’s approach to \textsc{gtp}.

(25) John wrote a letter.

a. John wrote a letter of the alphabet.

b. John wrote a letter of correspondence.

The example demonstrates that we should not make the hearer’s initial beliefs \(\operatorname{Pr}(\cdot)\) responsible for the proper disambiguation of this sentence, as Parikh (2001) does.\(^2\) In a normal context, (25b) is the preferred interpretation, and not (25a), whereas it is equally compelling to assume that in a normal context an unbiased hearer should hold it more likely that the proposition expressed in (25a) is true than that the proposition expressed in (25b) is.\(^3\) So then if the proper disambiguation of (25) is to be achieved by modelling the context so that the state corresponding to (25b) has a higher prior probability, then obviously \(\operatorname{Pr}(\cdot)\) should not express the receiver’s initial belief which state of affairs is more likely, as derived —normatively correct— from objective chance. The example suggests that we should not conflate the receiver’s possible conjectures about actualities with his preferred interpretations of expressions.

In response to this problem, we could assume, as Parikh (2001) suggests, that the prior probabilities should be taken to represent a conjecture about the sender’s intended meaning. We could in fact take the states of the signaling game to be states that are individuated by the proposition which the speaker intends to express. This is fine for the conceptualization of states, but not necessarily for an interpretation of prior probabilities. Why would anyone have prior convictions about a speaker’s communicative intentions irrespective of an utterance before anything has been said? It thus seems that the only

\(^2\)Similar conceptual issues arise for accounts of I-implicatures (see section 1.1.3) in terms of initial probabilities, as for instance done by Franke (2008a) or Jäger (2008c) in \textsc{gtp}, or by Blutner (1998) in bidirectional optimality theory. Similar concerns to the issues raised here were also discussed in the context of bidirectional optimality theory with respect to the \textit{om/round} problem for iconic interpretation (see Zwarts 2006).

\(^3\)Please bear with the assumptions that (i) John is not proficient in any non-alphabetic writing system, such as logographic or syllabic, and that (ii) John conforms to the common practice of writing letters of correspondence which consist of more than one alphabetic letter, whenever he writes one, or alternatively that some of his writings are not letters of correspondence.
straightforward appeal to probabilities is that in some contexts one interpre-
tation of (25) is more likely than the other and in other contexts it may be the
other way around. But this is not necessarily to be expressed in the receiver’s
initial beliefs, if these are explicit beliefs the receiver holds before a message is
observed. It is also not something that we want to simply feed into the model
as a contextual parameter, or else we should not conceive of this as an account
of the disambiguation process.

It appears that in some contexts —think: out-of-the-blue utterances— the
prior beliefs of the receiver could best be regarded as merely a condensed,
systematic specification of the beliefs that the receiver holds after he receives
an utterance. It would then be reasonable to draw on information in prior
probabilities for models of disambiguation whenever it is feasible to assume
that the receiver’s posterior probabilistic beliefs effect the interpretation of
ambiguous sentences like (25). But even this may at times be dubious: some
cases of actual ambiguity are, introspectively speaking, not cases of PERCEIVED
AMBIGUITY (cf. Poesio 1996). In other words, although the model suggests oth-
erwise, the receiver might not have introspective access to the interpretation
(25a) in a given standard context at all; we might want to say here that the
receiver need not even be aware of the ambiguity.

This suggests that the prior probabilities in the game model might for
some applications be understood rather as a measure for the probability with
which certain interpretations spring to mind after a given target utterance has
been observed. Interestingly, this interpretation of prior probabilities in our
model matches a hypothesis of Tversky and Kahnemann (1983), who suggest
that subjective probability, as measured under laboratory conditions, reflects
the ease with which certain contingencies come to mind. For instance, when
judging the subjective probability with which a woman can become CEO of an
important company, we actually assess the relative ease with which examples
of female CEOS come to mind, as compared to male CEOS. Similarly, the prior
probabilities in a context model are a compact way of representing the relative
ease with which interpretations associate with given messages. Indeed, to my
mind, if prior probabilities are used in game models to differentiate between
states, this seems like the most appealing conceptualization.

What does this interpretation of prior probabilities entail for explanations
obtained from GTP, and for the way we should set up a game model for in-
terpretation? Firstly, it transpires that this conceptual reinterpretation does
not truly dispel our worry that disambiguation in terms of probabilities —
however interpreted— is not much of an explanation at all: the disambigua-
tion remains a direct function of the parameter $\Pr(\cdot)$ which is fed in by hand. One possible and, to my mind, realistic conclusion here could be that gtp does not offer a full account of all processes involved in natural language interpretation, such as example (25), or standard cases of I-implicatures. It is for this reason that this thesis does not explicitly address the interpretation of I-implicatures in game theoretic terms.\footnote{4}{Nonetheless, gtp could still do some reasonable work in cases that hinge on various degrees of association of interpretations and expressions. Even if gtp as I conceive it may not explain very well the receiver’s pragmatic inference in disambiguation of a sentence like (25) —perhaps, because there is no inference to begin with— the approach might still explain the speaker behavior: obviously, under my preferred interpretation of prior probabilities, it is rather the sender who has to reason about associations of possible utterances, than the receiver who has to reason about the likelihood of intended meanings; that means that we would predict the speaker to use less economic, more prolix formulations to increase the chance of correctly associating an utterance with the right interpretation, while in other contexts relying —successfully or not— on shorter, more economic but less specific formulations.}

The upshot of this discussion is that it is contentious whether we should use information in prior probabilities at all as an explanatory element in game models for natural language interpretation. I therefore tend to believe that interpretation games, especially when used for explanations of scalar implicatures, should not contain any prior probability distinctions whatsoever. In fact, I propose to assume flat priors in interpretation games wherever possible.\footnote{5}{Notice that the assumption of flat priors interferes with the individuation of states: for instance, in the interpretation game for an utterance such as “Some of the (three) children are dirty”, we could either assume two states, $t_{\exists\neg\forall}$ and $t_\forall$ as before, or assume that there are three states giving the number of dirty children. In the latter case the proposition that not all children are dirty has prior probability $\frac{2}{3}$ under a flat prior assumption.} Given the slack in interpretation of prior probabilities, this assumption first and foremost keeps our models simple and conceptually sober. Additionally, a flat prior assumption could also be appealed to based on empirical arguments: although the “principle of insufficient reason” may or may not be compelling from a normative point of view (see Keynes 1921, chapter 4), it is a good first shot at people’s actual probabilistic belief formation in the absence of any further information that could influence a probabilistic judgement (cf. Falk 1992; Johnson-Laird et al. 1999; Fox and Levav 2004). So, especially for generic contexts for the interpretation of scalar expressions, I will assume flat priors. Under an interpretation of prior probabilities as strength of association between meanings and forms, the assumption of flat priors in (cheap talk) interpretation games comes down to the assumption that we do not rely on any ex ante associations between meanings and forms beyond (mostly: truth-
conditional) semantic meaning, i.e., that all pragmatic enrichments merely stem from reasoning about the ‘structural properties’ of the triple $M$, $T$ and $[]=\cdot$.

**Game Construction Ex Post.** In conclusion, I propose to think of an interpretation game as basically constructed *ex post* from the to-be-interpreted target expression $X$. A set of alternatives $\text{Alt}(X)$ will naturally suggest itself, or will otherwise be supplied by a theory of salience, lexical association or the like. From this set we construct a set of states that captures the meaning distinctions that we can express with the linguistic expressions available. Generic interpretation games should moreover ideally assume flat priors in the absence of reasons to model context-specific associative biases between meanings and expressions. As a whole, the game model should be considered the receiver’s conceptualization of the context of utterance as triggered by observation of the target expression.

A number of remarks are in order concerning this model construction *ex post*. Firstly, we find that a given interpretation game, like the M-implicature game, is clearly asymmetric, in the sense that, for instance, the M-implicature game is a game for interpreting the long form $m_{\text{long}}$, but that does not necessarily mean that we would arrive at the same game model for an interpretation of the short form $m_{\text{short}}$. This is entirely intuitive: when processing an unmarked expression, we do not necessarily reason about more complex ways of saying the same thing; in other words, the interpretation of the short form in the M-implicature game may be safely thought of as a fairly direct I-implicature without comparison to a more complex expression, while only the interpretation of the long form involves reasoning about alternatives.

Secondly, constructing interpretation games from a target expression also explains why certain features are missing in the representation of the context. For example, the some-all game does not contain a state $t_{\neg \exists}$ and also no form $m_{\text{none}}$. But that does not mean that it is impossible for this state to become actual, or more crucially even, that it is impossible for the sender to use $m_{\text{none}}$. If we were to take the some-all game at face value, it may seem that we imagine a context in which the speaker could only ever make a choice between saying $m_{\text{all}}$ or $m_{\text{some}}$. But in real life speakers make much more elaborate decisions, of course: they may continue, raise or zoom in on various topics, ask questions, or keep their mouths shut. All of these alternative actions are excluded from our generic game models, for which they are considered irrelevant, because such considerations do not play a role in the generic re-
ception of sentences. Still, at particular occasions, interpreters might ponder what a speaker has meant by comparing an utterance to the speaker’s possibility of not speaking at all, or saying something entirely different (see also sections 5.2.4 and 5.3.4 on the interpretation of conditionals in context). This could easily be integrated into game models of particular utterance contexts, but in normal, generic interpretation cases this does not seem necessary. The crucial point is that particular game models for interpretation are different from generic game models for interpretations, and both may occasionally be different still from game models for production.

3.1.3 Examples: Multiple Scalar Items

Let us see how the principles of generic model construction apply to some relevant examples. In particular, let us look at examples that include multiple scalar items, once with independent scope, and once with nested scope. Examples of this kind have been addressed by Chierchia (2004) as critical for naïve scalar reasoning, but it will turn out that the \textsc{ibr} model deals with these cases effortlessly.

\textit{Independent Scope}

Consider example (26a) with its intuitively attested implicatures in (26b)–(26d).

\begin{enumerate}
\item \textit{Kai ate some of the strawberries and Hannes ate some of the carrots.} \hfill \textit{(Sauerland 2004, ex. (24))}
\item \textit{It's not the case that Kai ate all of the strawberries and Hannes ate some of the carrots.}
\item \textit{It's not the case that Kai ate some of the strawberries and Hannes ate all of the carrots.}
\item \textit{It's not the case that Kai ate all of the strawberries and Hannes ate all of the carrots.}
\end{enumerate}

For the target sentence (26a), which I will represent as $m_{\text{some|some}}$, there is not much controversy that the most natural set of alternative expressions and with it our set $M$ should consist of (26a) itself together with the obvious scalar alternatives in (27).

\begin{enumerate}
\item \textit{Kai ate some of the strawberries and Hannes ate all of the carrots.} \hfill \textit{(= $m_{\text{some|all}}$)}
\end{enumerate}
b. Kai ate all of the strawberries and Hannes ate some of the carrots.

\( (= m_{\text{all}|\text{some}}) \)

c. Kai ate all of the strawberries and Hannes ate all of the carrots.

\( (= m_{\text{all}|\text{all}}) \)

If we assume the normal truth-conditional semantics and the canonical construction procedure outlined in the previous section, we want to consult all conjunctions that contain \( m_{\text{some}|\text{some}} \) and all alternatives, either negated or not. The consistent formulas in this list will yield our state distinctions:

| \( m_{\text{some}|\text{all}} \) | \( m_{\text{all}|\text{some}} \) | \( m_{\text{all}|\text{all}} \) |
|-----------------|-----------------|-----------------|
| \( t_{\exists-\forall|\forall} \) | \checkmark | \checkmark | \checkmark |
| incons. | \checkmark | \checkmark | - |
| incons. | \checkmark | - | \checkmark |
| \( t_{\exists-\forall|\forall} \) | \checkmark | - | - |
| incons. | - | \checkmark | \checkmark |
| \( t_{\forall|\exists-\forall} \) | - | \checkmark | - |
| incons. | - | - | \checkmark |
| \( t_{\exists-\forall|\exists-\forall} \) | - | - | - |

The table lists all possible conjunctions of \( m_{\text{some}|\text{some}} \) with possibly negated stronger messages. Some of these constellations are inconsistent. Those that are not are given mnemonic state names. For example, state \( t_{\exists-\forall|\forall} \) is the set of all worlds where the target message \( m_{\text{some}|\text{some}} \) is true, where \( m_{\text{some}|\text{all}} \) is also true and where \( m_{\text{all}|\text{some}} \) and \( m_{\text{all}|\text{all}} \) are false.

In the absence of any reason to assume differences in prior probabilities or in message costs we arrive at the interpretation game in figure 3.1. This game bears no surprises for the RBR model. As is easy to verify, the unique fixed point interpretation strategy predicts the intuitively attested implicatures:

\[
R^* = \begin{cases} 
  m_{\text{some}|\text{some}} & \mapsto t_{\exists-\forall|\exists-\forall} \\
  m_{\text{some}|\text{all}} & \mapsto t_{\exists-\forall|\forall} \\
  m_{\text{all}|\text{some}} & \mapsto t_{\forall|\exists-\forall} \\
  m_{\text{all}|\text{all}} & \mapsto t_{\forall|\forall} 
\end{cases}
\]

Nested Scope

A slightly different and more interesting case is example (28a) where a scalar item occurs in the scope of another scalar item.
This example is structurally equivalent to Sauerland’s example (30), who predicts and defends the implicatures in (28b)–(28d). An example of this kind is also discussed as a problem for game theoretic accounts of Gricean communication by Rothschild (2008). What appears problematic for this example is that the most natural set of alternatives:

\[ M = \left\{ m_{\text{some|some}}, m_{\text{some|all}}, m_{\text{all|some}}, m_{\text{all|all}} \right\} \]

carves up the logical space into a partition that contains more elements than messages. It is then unclear how a theory of rational language use will assign these extra meanings to the available messages.

First things first. Let us first properly establish the set of state distinctions from our canonical construction rule. It turns out that we get all the states that we also found in the previous case with independent scope, but that there is one additional state distinction \( t_{\forall \exists \& \forall} \) possible in this case.\(^6\)

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6. Notice that I write \( \exists \) here for \( \exists \& \forall \) to maintain readability.
With these sets of states, and the usual assumptions, we then arrive at the context model in figure 3.2. For this interpretation game we predict the following interpretation for both strands of the IBR sequence:

\[
\begin{array}{ccccc}
\text{msg} & \text{msg} & \text{msg} & \text{msg} & \text{msg} \\
\hline
\text{msg} & \text{msg} & \text{msg} & \text{msg} & \text{msg} \\
\hline
\text{msg} & \text{msg} & \text{msg} & \text{msg} & \text{msg} \\
\hline
\text{msg} & \text{msg} & \text{msg} & \text{msg} & \text{msg} \\
\hline
\text{msg} & \text{msg} & \text{msg} & \text{msg} & \text{msg} \\
\hline
\end{array}
\]

The receiver does not rule out \( t_{v\exists\&v} \) as a possible interpretation for any of the messages which are true in this state, but he prefers the more specialized scalar implicature interpretations that are also intuitively attested. The additional state distinction that appeared problematic for Rothschild (2008)'s approach is not a problem for the IBR model.

Still, we should pause here for a moment and ask what exactly it is that we would call the IBR model's prediction of the receiver's interpretation. After all, the receiver’s posterior beliefs \( \mu^*(\cdot|m_{\text{some}}) \) in the fixed point do not exclude the possibility \( t_{v\exists\&v} \). But since this possibility is less likely than \( t_{v\exists} \) this is the interpretation action that the receiver chooses. That means that in some sense the IBR model does predict the attested implicatures in (28b) and (28c), and in another sense it does not. Which notion of “predicted interpretation” should we adopt, here and in general? I suggest that we should opt
for the receiver’s preferred interpretation, which shows in his choice of interpretation action. This will yield the intuitively correct predictions not only for this example, but especially in later examples where probabilistic information on states is used to model different levels of speaker expertise in models that accommodate speaker uncertainty. This is the topic that we will turn to next.

3.2 Epistemic Lifting of Signaling Games

3.2.1 The Epistemic Status of Scalar Implicatures

Where previous chapters have dealt with scalar implicatures, the treatment so far has in fact been unduly simplistic in saying that an utterance of a sentence like (29a), when an alternative sentence (29b) could have been used, conveys the implicature in (29c).

(29) a. **Assertion:** Some of Kiki’s friends are metalheads.

   b. **Alternative:** All of Kiki’s friends are metalheads.

   c. **Factual Implicature:** It’s not the case that **all** of Kiki’s friends are metalheads.

   d. **Weak Epistemic Implicature:** The speaker does not know/believe that all of Kiki’s friends are metalheads.  

\[ ¬KS(29b) / ¬BS(29b) \]
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\[ K_S(?(29b)) / B_S(?(29b)) \]

Indeed, the actual logic of Gricean reasoning does not immediately give rise to the factual implicature in (29c), but strictly speaking only allows the weak epistemic implicature in (29d) to be drawn (see Gazdar 1979; Soames 1982): from an utterance of (29a) we can conclude that the speaker, though cooperative and willing to give all relevant information, was not in a position to utter the stronger sentence (29b); but that only licenses the inference that the speaker did not know or believe that (29b) was true. This inference is also often called the primary implicature, and it has become customary in the literature to assume that the stronger secondary implicature in (29e), which is also called the strong epistemic implicature, is to be derived in a second step of reasoning from the weak epistemic implicature by the additional assumption that the speaker is competent or opinionated on the issue at hand (see Sauerland 2004; van Rooij and Schulz 2004; Schulz and van Rooij 2006; Russell 2006; Spector 2006). For the present example, to assume that the speaker is competent or opinionated in the relevant sense is to assume that she knows the truth value of sentence (29b) or at least has a decided, possibly prejudiced, belief about it:

\[ a. \text{Competence Assumption: } K_S(29b) \lor K_S(?(29b)) \]
\[ b. \text{Opinionated-Speaker Assumption: } B_S(29b) \lor B_S(?(29b)) \]

The weak epistemic implicature in (29d) and the competence assumption (30) together establish the strong epistemic implicature in (29e). The factual implicature in (29c) may then be derived from the factivity of knowledge.

In previous chapters, we have ignored the particular epistemic status of the scalar inference in the IBM model. The analysis of scalar implicature so far accounts for the strong epistemic implicature and the factual implicature; and it does so immediately, i.e., without strengthening of the weak epistemic implicature by competence. This is so because a particular sort of sender competence assumption is already integrated in the basic signaling game model of the utterance context. Remember that in a signaling game (it is common knowledge between sender and receiver that) the sender knows the true state of affairs. Therefore, the implicature that we derive using standard signaling games must be the strong epistemic implicature and also, because the speaker’s knowledge about the state of affairs is correct, the factual implicature.
But if standard signaling games incorporate sender competence as an assumption about the utterance context, that also means that there is no direct way of accounting for the weak epistemic implicature in (29d). This is indeed a shortcoming of the model as it stands, and it is, in particular, a shortcoming of our context models which are not (yet) flexible enough to accommodate the assumption that the speaker may only have partial knowledge about the relevant states of affairs. I will show presently that this shortcoming in the representation of utterance contexts obstructs proper predictions for other relevant kinds of scalar reasoning, in particular for the implicatures associated with standard uses of disjunction. Subsequently, I will present what is basically a conceptual reinterpretation of the signaling game framework which will allow us to keep the basic model as is, but nonetheless integrate a notion of speaker uncertainty into signaling games.

3.2.2 The Implicatures of Plain Disjunctions

The perhaps most prominent use of a disjunction is to express—in entirely intuitive terms—a list of epistemic possibilities not all of which are false (according to the speaker).7 For instance, an utterance of the sentence in (31a) as an answer to the possibly implicit question “Who baked this cake?” seems to give rise to two kinds of inferences: the ignorance implicature in (31b) and the scalar implicature in (31c).8

(31) a. Assertion: This cake was baked by John or Mary. \( A \lor B \)
   b. Ignorance Implicature: The speaker doesn’t know whether John baked this cake and the speaker doesn’t know whether Mary baked this cake. \( \neg K_S A \land \neg K_S \neg A \land \neg K_S B \land \neg K_S \neg B \)
   c. (Epistemic) Scalar Implicature: The Speaker knows that it’s not the case that John and Mary baked the cake together. \( K_S \neg (A \land B) \)

We would certainly like to derive both of these inferences also in the IBR model, but it is rather obvious that ignorance implicatures such as (31b)

7. There are other, less stereotypical uses of disjunctions, of course (see Culicover and Jackendoff 1997; Gómez-Txurruka 2002; Franke 2008b).

8. Whether the scalar implicature in (31c) usually arises or whether it requires a stressed or is a controversial matter. I will speak as if it ought to be derived generally. Nonetheless, the IBR model can also model the absence of this inference. Unsurprisingly, whether we derive this inference or not simply depends on whether we assume a message \( m_{A,B} \) in the signaling game model.
are going to be problematic, as long as the speaker is assumed to be competent in the strong sense that she knows the true state of affairs. To make this point entirely clear, I suggest looking at the context model in figure 3.3.

For this game both IBR sequences terminate in the same fixed point in which the critical message $m_{A,B}$ is left dangling as a surprise message that is not used by the speaker:

$$S^* = \left\{ \begin{array}{l} t_A \mapsto m_A \\
 t_B \mapsto m_B \\
 t_{AB} \mapsto m_{A,B} \end{array} \right\} \quad R^* = \left\{ \begin{array}{l} m_A \mapsto t_A \\
 m_B \mapsto t_B \\
 m_{A,B} \mapsto t_{A,B} \\
 m_{A\lor B} \mapsto t_{A,B} \end{array} \right\}.$$  

Even forward induction reasoning does not help, because the intuitive criterion does not rule out any state from the interpretation of $m_{A\lor B}$, because the sender would not gain anything in any state from sending this message compared to what she can obtain with the sending strategy $S^*$.

Hence, neither the ignorance implicature (31b), nor the scalar implicature (31c) can be accounted for in this model. The problem is clearly that with a perfectly informed speaker, i.e., a speaker who knows the truth values of propositions $A$ and $B$, there is no room to derive implicatures relating to the speaker’s epistemic uncertainty. This then calls for some amendment or extension of the standard model.

### 3.2.3 Lifted Signaling Games

The problem the IBR model is faced with is that (i) we would like to be able to derive epistemic implicatures, i.e., inferences that concern the speaker’s epistemic uncertainty but that (ii) in a standard signaling game — or rather in the standard interpretation of a signaling game — this seems impossible to achieve, because the speaker is assumed fully knowledgeable about the true relevant state — an assumption which is a part of the game structure. So it may seem that we have to turn away from signaling games in order to include
speaker uncertainty as well. But this, it turns out, is not absolutely neces-
sary. We can basically leave the model as it is but simply give an epistemic
interpretation to states; in other words, we can lift the interpretation of states
from states of the world to information states of the sender. Here is how it
works:9,10

**Information States.** To account for the ignorance implicatures associated
with an utterance of disjunction \( A \lor B \) in (31a) we would assume that the set
of states \( T \) is a set of information states. If

\[
T_{\text{plain}} = \{ t_A, t_B, t_{AB} \}
\]

are the states of the plain, unlifted signaling game for disjunction in figure 3.3,
then the set of all non-trivial information states is given as

\[
T_{\text{lifted}} = \mathcal{P}(T_{\text{plain}}) \setminus \emptyset,
\]

the set of all non-empty subsets of \( T_{\text{plain}} \) — non-empty, because we should
exclude the *absurd information state* in which the speaker does not consider
any of the plain states possible, of course. I will then write \( t_{[A,AB]} \in T_{\text{lifted}} \)
for an information state in which the sender considers it possible that only
\( t_A \) or \( t_{AB} \) might be the true (unlifted) states of affairs. In other words, \( t_{[A,AB]} \) is
alternative notation for \( \{ t_A, t_{AB} \} \).

Although the lifted states may represent the speaker’s potential uncer-
tainty, it is still feasible to maintain the assumption of standard signaling
games that the sender (but not the receiver) knows which lifted state of af-
fairs is actual: the sender simply knows which epistemic state she is in, even
if that is a state of epistemic uncertainty about the state of the world. It is
in this sense that by lifting the notion of a state to a representation of the
sender’s epistemic state we can integrate reasoning about the sender’s partial
knowledge into standard signaling games.

We then construct a lifted signaling game from the plain signaling game in
figure 3.3 as follows. In the lifted game the set of messages remains the same.
However, the interpretation of the semantic denotation function needs to be

---

9. Lifted signaling game models have also been employed by de Jager and van Rooij (2007)
   to rationalize the interpretation principle “Grice” from van Rooij and Schulz (2004). In gen-
   eral, the idea to look at the speaker’s information states in pragmatic interpretation is of
course very familiar (e.g. Gazdar 1979).
10. It needs to be stressed for clarity that the general lifting mechanism given here is strictly
grounded towards, and therefore possibly only makes sense for, interpretation games.
amended to accommodate the change in the notion of a state: in the lifted game, \([m]\) yields the set of all information states where \(m\) is believed true. A message \(m\) is believed true in an information state \(t\) —considered as a set of non-lifted states of the world— if \(m\) is true in all non-lifted states contained in \(t\). We should still treat the lifted game as an interpretation game, i.e., lifted states correspond to lifted interpretation actions and response utilities are given as \(V_{S,R}(t, m, a) = 1\) if \(t = a\), otherwise 0. This is of course to represent the hearer’s concern to understand the speaker’s epistemic state expressed by an utterance of a sentence such as (31a). Taken together, the epistemically lifted signaling game derived is the one in figure 3.4.

**Implementing Competence** There is still one feature of the lifted signaling game model left unspecified: the receiver’s prior beliefs about which epistemic state the speaker is most likely to be in. This is, I suggest, the natural place to implement a speaker competence assumption in the signaling game model similar to the one in (30), which we will need, just as previous Neo-Gricean approaches did, in order to tell, for instance, the weak and strong epistemic implicatures in (29d) and (29e) apart. I suggest that for epistemi-
cally lifted signaling games the competence assumption should take the follow-
ing simple form:\footnote{11}

\begin{equation}
(32) \textit{Competence Assumption:} \text{ If the speaker is (believed) competent, then }
\text{smaller information states are strictly more likely than larger ones.}
\end{equation}

In other terms, if (the receiver believes that) the sender is competent, (the receiver believes that) the sender is more likely to rule out more alternatives. This is then reflected in the probabilities of lifted states and, therefore, the receiver’s prior beliefs.\footnote{12}

However, the competence assumption in (32) still leaves some slack in the specification of prior probabilities. I will therefore stick to the previous considerations on flat priors in interpretation games additionally. In effect, where the sender competence assumption does not specify a difference in prior probabilities, probabilities are to be assumed equal. To be more precise, for a set of lifted states $T$ whose elements are information states which we may consider sets of possible states of affairs, we assume that for all $t, t' \in T$: \footnote{13}

(i) if the speaker is competent (alt.: an expert), then

(a) $\Pr(t) > \Pr(t')$ iff $|t| > |t'|$ and

(b) $\Pr(t) = \Pr(t')$ iff $|t| = |t'|$;

(ii) if the speaker is not competent, then $\Pr(t) = \Pr(t')$.

In the example in figure 3.4, we should thus parametrize and distinguish cases of relative expertise. Let’s set:

$$
\Pr(t) = \begin{cases} 
a & \text{if } t \text{ contains 1 element} 
b & \text{if } t \text{ contains 2 elements} 
c & \text{if } t \text{ contains 3 elements.}
\end{cases}
$$

The speaker then is competent, just in case $a > b > c$; she is not competent for parameters $a = b = c$.

\footnote{11}{Alternatively, we could also define competence as a partial order on information states in terms of set inclusion, if that seemed more natural to us. However, mapping this ordering back onto (linear) probabilities in the most natural way will result in the exact same constraint on the receiver’s prior as the notion I suggest here.}

\footnote{12}{This does not interfere with my preferred interpretation of prior probabilities of unlifted states.}

\footnote{13}{As long as $T$ is finite, the question whether there exists any $\Pr \in \Delta(T)$ that satisfies these constraints has a trivial positive answer.}
Notice that the pragmatic community is usually not concerned with assessing and systematizing intuitions about the contextual meaning of utterances under the assumption that the speaker is known to be an inexpert: most of the time, the debate about (scalar) implicatures—implicitly or explicitly—assumes expert speakers; some of the time our intuitions are questioned about readings we obtain when we do not assume that the speaker is an expert; but, as far as I am aware, there is hardly any systematic investigation into the question what we would infer from the assumption that the speaker is not an expert. When discussing predictions of the IBR model I will also only explicitly discuss the former two cases, and I will even be sloppy in my choice of expression: a ‘non-expert’ or an ‘incompetent speaker’ is a speaker who is not assumed to be competent.]

3.2.4 Examples

Disjunction $A \lor B$

With these assumptions in place the IBR model yields a unique solution for the expert and a different unique solution for the non-expert case of the signaling game in figure 3.4. For experts the fixed point of both strands of the IBR model is given by:

$$S^* = \begin{cases} 
  t[A] & \mapsto m_A \\
  t[B] & \mapsto m_B \\
  t[AB] & \mapsto m_A \land m_B \\
  t[A,AB] & \mapsto m_A, m_A \lor B \\
  t[B,AB] & \mapsto m_B, m_A \lor B \\
  t[A,B] & \mapsto m_A \lor B \\
  t[A,B,AB] & \mapsto m_A \lor B 
\end{cases}$$

$$R^* = \begin{cases} 
  m_A & \mapsto t[A] \\
  m_B & \mapsto t[B] \\
  m_A \land B & \mapsto t[AB] \\
  m_A \lor B & \mapsto t[AB] 
\end{cases}$$

Let me just briefly spell out, for illustration, the $R_0$-sequence under a competence assumption. It is easy to verify that the numeric choice for prior probabilities does not heavily affect the qualitative outcome. For $a = \frac{3}{16}$, $b = \frac{1}{8}$ and $c = \frac{1}{16}$ as parameters of the game in figure 3.4 we get:

14. Still, the IBR model in principle extends to and predicts readings also under an inexpert assumption. If we set $Pr(t) > Pr(t')$ iff $|t| < |t'|$, we derive for example that the form $m_{some}$ in the some-all game gets to be interpreted as $t_{[3-\lor \forall]}$ (for notation, see below). This seems a fine prediction for this simple case. Whether the IBR model predicts intuitively for other cases under such a strong inexpertise assumption is something I will have to leave for another occasion, especially also because I am not sure what the intuitively correct predictions should be in many of these cases.
for our naïve receiver. The competence assumption draws the receiver towards choosing the ‘smallest’ epistemic states compatible with each message’s semantic meaning. Notice that $S_1$ can then not expect to induce the proper interpretation in any state where she is truly uncertain. By TCP assumption she will then be indifferent between all messages that are true in these states, so that we get:

$S_1 = \left\{ \begin{array}{l} t[A] \mapsto m_A \\ t[B] \mapsto m_B \\ t[AB] \mapsto t[AB] \\ t[A,AB] \mapsto m_A, m_{A\land B} \\ t[B,AB] \mapsto m_B, m_{A\land B} \\ t[A,B] \mapsto m_{A\lor B} \\ t[A,B,AB] \mapsto m_{A\lor B} \end{array} \right\}$

The following best response of $R_2$ is again straightforward:

$R_2 = \left\{ \begin{array}{l} m_A \mapsto t[A] \\ m_B \mapsto t[B] \\ m_{A\land B} \mapsto t[AB] \\ m_{A\lor B} \mapsto t[A,B] \end{array} \right\}$
To this the sender best responds with the above strategy \( S_1 = S^* \) and a fixed point is reached.

Turning to the non-expert case, here both strands of the IBR model reach a fixed point in the following strategies:

\[
S^* = \begin{cases} 
    t_{[A]} & \mapsto m_A \\
    t_{[B]} & \mapsto m_B \\
    t_{[AB]} & \mapsto m_{A \land B} \\
    t_{[A,AB]} & \mapsto m_A \\
    t_{[B,AB]} & \mapsto m_B \\
    t_{[A,B]} & \mapsto m_{A \lor B} \\
    t_{[A,B,AB]} & \mapsto m_{A \lor B}
\end{cases}
\]

\[
R^* = \begin{cases} 
    m_A & \mapsto t_{[A],t_{[A,AB]}} \\
    m_B & \mapsto t_{[B],t_{[B,AB]}} \\
    m_{A \land B} & \mapsto t_{[AB]} \\
    m_{A \lor B} & \mapsto t_{[A,B],t_{[A,B,AB]}}
\end{cases}
\]

The calculation of this result is straightforward and I will refrain from giving details.\(^{15}\) Suffice it to say that the ignorance implicature in (31b) that the speaker does not know of either disjunct that it is true is predicted for both experts and non-experts. However, the strong epistemic version of the scalar implicature in (31c) that the speaker knows that the disjuncts are not both true is derived only for the expert case; for non-experts we only derive a weak epistemic implicature that the speaker does not know whether both disjuncts are true at the same time.

I find these predictions intuitive and they also match the implicatures generally associated with standard informative uses of disjunctions in the literature. It should be stressed also that we did not have to assume any increased costs for the disjunctive form to obtain this result.

**Scalar Implicatures**

This pattern of explanation reoccurs in a straightforward lifting of the scalar implicature example (29a). We would like to account for both the weak and the strong epistemic implicature in (29d) and (29e) respectively. Lifting the standard signaling game for scalar implicature given in figure 1.3 in section 1.2.2, we obtain the signaling game model in figure 3.5. The notation for lifted states is as before: \( t_{[\exists \land \forall,\forall]} \) is an information state representing speaker uncertainty comprising the unlifted states \( t_{[\exists \land \forall]} \) and \( t_{[\forall]} \). For experts we assume \( a > b \) and for non-experts we assume \( a = b \).

---

\(^{15}\) Results reported here are backed up by a computer implementation of the IBR model, which was obtained by amending code kindly provided by Gerhard Jäger who has been implementing his own version of IBR reasoning. In the text, I will preferably only give the ‘analytical highlights’ the first time they arise.
Again the IBR model predicts a unique solution for both the expert and non-expert cases. The interested reader will find it easy to verify for herself that for expert senders the fixed point strategy pair is:

\[
S^* = \begin{cases} 
    t_{[\exists \neg \forall]} & \mapsto m_{\text{some}} \\
    t_{[\forall]} & \mapsto m_{\text{all}} \\
    t_{[\exists \neg \forall, \forall]} & \mapsto m_{\text{some}} 
\end{cases} \\
R^* = \begin{cases} 
    m_{\text{some}} & \mapsto t_{[\exists \neg \forall]} \\
    m_{\text{all}} & \mapsto t_{[\forall]} 
\end{cases}.
\]

For non-experts we obtain:

\[
S^* = \begin{cases} 
    t_{[\exists \neg \forall]} & \mapsto m_{\text{some}} \\
    t_{[\forall]} & \mapsto m_{\text{all}} \\
    t_{[\exists \neg \forall, \forall]} & \mapsto m_{\text{some}} 
\end{cases} \\
R^* = \begin{cases} 
    m_{\text{some}} & \mapsto t_{[\exists \neg \forall], t_{[\exists \neg \forall, \forall]}} \\
    m_{\text{all}} & \mapsto t_{[\forall]} 
\end{cases}.
\]

This is the intuitively correct prediction.

**McCawley-Chierchia Problem**

Let us briefly venture into a less trivial example, which the IBR model solves effortlessly with the notion of epistemic lifting. The example in (33a) has been dubbed Chierchia’s puzzle by Fox (2007) to credit the observation by Chierchia (2004) that an example like (33a) with scalar “some” in one of the disjuncts of a disjunction gives rise to a problem for naïve scalar reasoning, but a structurally parallel case has already been raised by McCawley (1981).

\[ (33) \]

a. Kai had the broccoli or some of the peas.

b. *Ignorance Implicature:* S doesn’t know whether Kai had broccoli.

c. *Ignorance Implicature:* S doesn’t know whether Kai had some of the peas.

d. *Scalar Implicature 1:* S knows that Kai didn’t have both broccoli and some of the peas.

e. *Scalar Implicature 2:* S knows that Kai didn’t have all of the peas.
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f. *Unattested Scalar Implicature:* $S$ knows that Kai didn’t have the broccoli.

Intuitively, sentence (33a) implicates (33b)–(33e), but *not* (33f), contrary to the predictions of naive scalar reasoning. The misprediction arises, because the sentence (34) *is* a stronger alternative to the target sentence in (33a), but a negation of (34) actually entails the unattested inference in (33f).

(34)  Kai had the broccoli or all of the peas.

$m_{B \lor \text{all}}$

This example has been important in the recent literature on Gricean pragmatics, and this is why we should address it and see whether we get it right. The example was used as an argument against Neo-Gricean accounts of implicatures by Chierchia (2004) in order to support his view of local implicature calculation in the syntax. Responding to Chierchia’s challenge, Sauerland (2004) subsequently defended a Neo-Gricean account.

The ibr model solves the McCawley-Chierchia problem without any complications. The correct predictions can be derived immediately after lifting a properly set-up context model. Next to the target sentence (33a) and the problematic alternative in (34), we should clearly include the messages in (35) as the set of alternative messages.

(35)  a. Kai had the broccoli and some of the peas. $m_{B \land \text{some}}$

b. Kai had the broccoli and all of the peas. $m_{B \land \text{all}}$

c. Kai had the broccoli or all of the peas. $m_{B \lor \text{all}}$

d. Kai had the broccoli. $m_B$

e. Kai had some of the peas. $m_{\text{some}}$

f. Kai had all of the peas. $m_{\text{all}}$

This set of alternatives gives rise to the set of states

$$T = \{ t_{B \land \text{some}}, t_{B \land \text{all}}, t_{B \lor \text{all}}, t_{\neg B}, t_{\text{some}}, t_{\text{all}} \}$$

and leads straightforwardly to the obvious interpretation game. Lifting this game we derive the following fixed point interpretation strategy for the re-
This prediction seems to exceed intuition in detail and precision, but a quick check validates that the attested implicatures in (33b)–(33e) still hold and that the unattested implicature in (33f) still does not follow from the interpretation of $m_{B,V,some}$. To see that (33f) does not follow, for instance, notice that each
information state associated with $m_{B \rightarrow \text{some}}$ has the sender uncertain whether Kai had broccoli. Without going into the details of the derivation, suffice it to say that the Ibr model does not run into the same problem as naïve scalar reasoning with a negation of (34) because it integrates the epistemic implicatures also associated with (34), namely that the speaker is uncertain between disjuncts, when comparing alternative forms.

**Disjunctions Revisited**

It remains to be checked whether the Ibr model can also deal with disjunctions with more than two logically independent disjuncts, and with disjunctions of logically dependent disjuncts.\(^16\)

**Generalized Disjunctions.** Consider the case of disjunction $A \lor B \lor C$ with three logically independent disjuncts. The construction of the context model will be a mere automatism once we have settled on the correct set of alternatives to our target message $m_{A \lor B \lor C}$. If we assume that a three-placed disjunction has no further hierarchical structure in its logical form, it is plausible to assume that at least the disjuncts $m_A$, $m_B$ and $m_C$ are alternatives (cf. Sauerland 2004). With these messages our rules for canonical state construction will identify seven states:

$$T = \{t_A, t_B, t_C, t_{AB}, t_{AC}, t_{BC}, t_{ABC}\}$$

where notation $t_{AB}$, for instance, represents a state where propositions $A$ and $B$ are true, while $C$ is not true. Consider a signaling game with this set of states and only the four messages above. Then, lifting the signaling game and assuming an expert sender, the forms $m_A$, $m_B$ and $m_C$ will be associated with singleton information states $t[A]$, $t[B]$, and $t[C]$, as we would expect, but the target form $m_{A \lor B \lor C}$ will be associated with all remaining information states because there is nothing else to express these with. That means that for proper predictions under the Ibr model, the set of alternatives should include additional messages that can take away, so to speak, undesirable meanings from our target form. For the time being, let us assume that the set of alternatives for interpretation of $m_{A \lor B \lor C}$ includes all the conjunctions of single disjuncts, as well as all disjunctions thereof (see below for discussion):

$$M = \{m_A, m_B, m_C, m_{AB}, m_{AC}, m_{BC}, m_{ABC}, m_{A,B}, m_{A,C}, m_{C,B}, m_{A,B,C}\}$$

\(^16\) Two propositions $A$ and $B$ are logically independent iff for all $X \in \{A, \overline{A}\}$, $Y \in \{B, \overline{B}\}$ we have $X \cap Y \neq \emptyset$. 
where notation $m_{AB}$ stands for “$A$ and $B$” and $m_{A,B}$ for “$A$ or $B$.”

With these alternatives, the construction of the lifted and unlifted context models is nothing out of the ordinary. The model predicts that for expert senders the receiver’s interpretation strategy has a unique fixed point in:

$$R^* = \begin{align*}
    m_A &\mapsto t[A] \\
    m_B &\mapsto t[B] \\
    m_C &\mapsto t[C] \\
    m_{AB} &\mapsto t[AB] \\
    m_{AC} &\mapsto t[AC] \\
    m_{BC} &\mapsto t[BC] \\
    m_{ABC} &\mapsto t[ABC] \\
    m_{A,B} &\mapsto t[A,B] \\
    m_{A,C} &\mapsto t[A,C] \\
    m_{B,C} &\mapsto t[B,C] \\
    m_{A,B,C} &\mapsto t[A,B,C]
\end{align*}$$

This is exactly as it should be. The preferred interpretation $t_{[A,B,C]}$ of our target form represents an information state of the sender in which she consider it possible that either disjunct is true alone, and in which she can exclude all further possibilities.

Similarly, the predictions for the non-expert sender case are appealing, but not very perspicuous, which is why I omit obvious permutations:

$$R^* = \begin{align*}
    m_A &\mapsto t[A], t_{[A,AB]}, t_{[A,AC]}, t_{[AB,AC]}, t_{[A,AB,AC]}, t_{[AB,AC,ABC]} \\
    m_{AB} &\mapsto t_{[AB]}, t_{[AB,AC]} \\
    m_{ABC} &\mapsto t_{[ABC]} \\
    m_{A,B} &\mapsto t_{[B]}, t_{[A,B,AB]}, t_{[A,B,AC]}, t_{[A,B,AB,AC]}, t_{[A,B,AC,ABC]} \\
    m_{A,C} &\mapsto t_{[AC]} \\
    m_{B,C} &\mapsto t_{[BC]} \\
    m_{A,B,C} &\mapsto t_{[ABC]} \\
    m_{A,B,C} &\mapsto t_{[ABC]} \\
    m_{A,B,C} &\mapsto t_{[ABC]} \\
    m_{A,B,C} &\mapsto t_{[ABC]}
\end{align*}$$
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Our target form is interpreted as conveying that the sender is in an epistemic state in which she considers it possible that \( A, B, \) and \( C \) are all true alone, and that she might consider further alternatives possible, but that she does not have any more concrete knowledge beyond that.

The predictions based on the above set \( M \) are flawless, but the question remains whether the set \( M \) itself is defensible. Conceptually, \( M \) is just what we would obtain from an application of, for instance, Sauerland’s (2004) construction of alternatives to disjunction, where we neglect any internal binary structure of disjunction and treat it as flat, at least on the level of logical form.

Moreover, we do not necessarily need exactly this set of alternatives, if we are only interested in the interpretation of the target form. More concretely, the situation for the \( \text{ibr} \) model is this. We could in principle assume a smaller set of alternatives, namely

\[
M' = \{ m_A, m_B, m_C, m_{A,B}, m_{A,C}, m_{C,B}, m_{A,B,C} \}
\]

and still the predictions for the target message \( m_{A,B,C} \) would be the exact same: only for the non-expert case would the predictions for non-target disjunctive messages\( m_{A,B} \) change to include more possible interpretations that could otherwise be expressed by more specific conjunctions. Similarly, we could also take a much larger set, namely the smallest set including \( m_A, m_B \) and \( m_C \) which is closed under disjunction and conjunction. Again, the prediction for the target message alone will be flawless, but non-target messages, in particular, disjunctions with entailing disjuncts of the form “\( A \) or \( (A \text{ and } B) \)” are not assigned intuitive interpretations. This is a separate problem that I will be dealing with presently. As far as the interpretation of disjunctions with more than two mutually exclusive disjuncts is concerned, we should conclude that the \( \text{ibr} \) model can deal with those under several possible specifications of alternative sets.

The principles of model specification discussed here for three-place disjunctions with mutually exclusive disjuncts should generalize to disjunctions with an arbitrary number of disjuncts. The predictions discussed here are based on simulation, but it would be desirable to offer an analytic result stating the predictions of the \( \text{ibr} \) model for any arbitrary disjunction. Unfortunately, this interesting issue has to be left for future research.

ENTAILING DISJUNCTS. A problem of interpretation may arise under truth-conditional semantics for disjunctions of the form “\( A \) or \( (A \text{ and } B) \)”, or more generally whenever one disjunct entails another. The problem is that, as far as
truth-conditions carry us, the sentence “A or (A and B)” is equivalent to the sentence “A.” But, intuitively, these forms are to be interpreted differently, at least in certain contexts and if we assume that the speaker is an expert on the topic at hand. Compare the answers (37a) and (38a) to a question (36).

(36) Who (of John and Mary) came to the party?
(37) a. John did.
    b. ¬ The speaker knows that John came and that Mary did not.
(38) a. John or (John and Mary).
    b. ¬ The speaker knows that John came and considers it possible that Mary came too.

Though semantically equivalent, the implicatures associated with these answers, (37b) and (38b) respectively, are clearly different. This problem palpably affects pretty much all global Neo-Gricean accounts that rely on truth-conditional semantics, and it is thus interesting to see what the present GTP perspective can add to this puzzle.

Let us therefore derive a canonical context model from the target expression “A or (A and B).” Following the construction of alternatives for disjunction from before, we take all individual disjuncts occurring in the target expression, $m_A$ and $m_{AB}$, and also all conjunctions and disjunctions thereof. That way we obtain a set of alternatives:

$$M = \{m_A, m_B, m_{A \lor AB}, m_{A \land AB}\}.$$  

These alternatives yield only a binary state distinction, differentiating a state $t_A$, where only $A$ is true, from a state $t_{AB}$, where $A$ and $B$ are both true:

$$T = \{t_A, t_{AB}\}.$$  

Obviously, on this simple set of states not only is $m_{A \lor AB}$ equivalent to $m_A$, but also $m_{A \land AB}$ is equivalent to $m_B$. If we stick to truth-conditional meaning only, it is impossible to distinguish between either of these linguistic forms in the model based on their meaning. If we nonetheless want to include a non-semantic distinction, the most obvious idea is to assume that the syntactically more complex forms are more costly than their semantically equivalent correspondences: I suggest that nominal message costs should be brought in whenever there is an obvious morpho-syntactic difference between two semantically equivalent forms (compare also M-implicatures).
Feeding this assumption into the canonical interpretation game, and lifting the model, the expert case yields the fixed point interpretation:

\[ R^* = \begin{cases} 
  m_A & \mapsto t_{[A]} \\
  m_{AB} & \mapsto t_{[AB]} \\
  m_{A\lor AB} & \mapsto t_{[A,AB]} \\
  m_{A\land AB} & \mapsto \text{surprise} 
\end{cases} \]

This is exactly how we would want it to be. Only the interpretation of the non-expert case calls for careful thought:

\[ R^* = \begin{cases} 
  m_A & \mapsto t_{[A], t_{[A,AB]}} \\
  m_{AB} & \mapsto t_{[AB]} \\
  m_{A\lor AB} & \mapsto \text{surprise} \\
  m_{A\land AB} & \mapsto \text{surprise} 
\end{cases} \]

The prediction here is that the target message comes as a surprise. This is not at all unreasonable, because associating \(t_{[A,AB]}\) with \(m_A\) is crucially what an interpretation of \(m_A\) under an inexpert assumption entails. Extrapolating from this, we predict that the costly form \(m_{A\lor AB}\) could be optimal for an inexpert sender, for instance, if she believed that the receiver incorrectly assumed her to be an expert. (This kind of speaker uncertainty about the receiver’s assumption about speaker expertise is not modelled explicitly, but it is easy to see how it could be.)

**Summary.** Taking stock, in this section I have suggested that the basic signaling game model, in which the sender knows the true state of the world, can accommodate the speaker’s partial information by a conceptual reinterpretation of the notion of a state. In order to derive epistemic implicatures, as I have called them, we should:

(i) lift the interpretation of states in the game model from states of the world to information states of the sender;

(ii) lift the notion of semantic meaning captured in \([\cdot]\) from “being true in a state of the world” to “believed true in an information state”;

(iii) implement a speaker competence assumption in \(\Pr(\cdot)\) such that smaller, i.e., more specific, information states are more probable if the speaker is assumed to be an expert;

(iv) stick to an interpretation game with \(T = A\) and corresponding payoffs.
I showed how this basic set-up deals with the epistemic implicatures of disjunctions and also with the McCawley-Chierchia problem. In the following, I will show how the IGR model, if applied to lifted signaling games, also copes with free choice inferences.

3.3 Free Choice Inferences

A linguistically very interesting case concerning the meaning and use of English disjunction is its interaction with deontic modals such as in (39a) and (40a) for which we obtain the free-choice readings (fc-reading) in (39b) and (40b).

(39)  
  a. You may take an apple or a pear.  \( \Diamond(A \lor B) \)
  b. Free Choice Implicature: You may take an apple and you may take a pear.  \( \Diamond(A) \land \Diamond(B) \)
  c. Scalar Implicature: You may not take both.  \( \neg \Diamond(A \land B) \)

(40)  
  a. You must take an apple or a pear.  \( \Box(A \lor B) \)
  b. Free Choice Implicature: You may take an apple and you may take a pear.  \( \Diamond(A) \land \Diamond(B) \)
  c. Scalar Implicature: You need not take both.  \( \neg \Box(A \land B) \)

The basic observation (see Kamp 1973, 1978) is that, contrary to what we might expect from a standard logical semantics of modals and disjunction, sentences like (39a) and (40a) give rise to the conjunctive reading in (39b) and (40b) under the scope of the deontic modals, and the strengthened exclusive readings in (39c) and (40c). In the following, I am especially concerned with the former fc-readings, but I will also deal with the latter exclusive readings on the side. I will adopt the mainstream conviction in the linguistic literature that both aspects of meaning are not part of the standard semantic meaning of sentences (39a) and (40a), and should rather be accounted for as conversational implicatures. Let us briefly revise the relevant arguments behind the mainstream conviction.

A standard possible-worlds interpretation of deontic modals renders \( \Diamond A \) (\( \Box A \)) true in a pointed model \( \langle W, R, w \rangle \), with a deontic accessibility relation \( R \subseteq W \times W \), if some (all) worlds accessible from \( w \) via \( R \) make the proposition \( A \) true. Under these semantics, \( \Diamond(A \lor B) \) is true in a pointed model \( \langle W, R, w \rangle \) iff some worlds R-accessible from \( w \) make the disjunction \( A \lor B \)
true. In particular then, the standard semantics renders (39a) and (40a) true in pointed models in which the intuitively attested inferences (39b) and (39c), respectively (40b) and (40c), do not hold. To see this, both \( \Diamond (A \lor B) \) and \( \Box (A \lor B) \) are true in a pointed model in which \( A \) and only \( A \) is true for all accessible worlds. In these pointed models however the \( \text{fc} \)-reading (39b) and (40b) that the hearer may choose between alternatives \( A \) and \( B \) is not true. Similarly, both \( \Diamond (A \lor B) \) and \( \Box (A \lor B) \) are true in a pointed model in which both \( A \) and \( B \) are true for all accessible worlds. In these pointed models, the exclusive readings in (39c) and (40c) are not true. Taken together, both the \( \text{fc} \)-reading and the exclusive readings would require a strengthening of the standard semantics of modals and disjunction.

**Reassessing Disjunction.** Of course, one may argue that the standard semantics is wrong and that it needs to be strengthened accordingly. Alternative semantics for disjunction that do exactly that have been suggested by Zimmermann (2000), Geurts (2005) and Simons (2005). Against an amendment of the semantics of disjunction, other authors have argued that the intuitive readings we are after should rather be accounted for as conversational implicatures (Kratzer and Shimoyama 2002; Alonso-Ovalle 2005; Schulz 2005). One argument voiced in favor of this position is that the attested \( \text{fc} \)-reading does not (necessarily) arise in downward entailing contexts such as (41).

(41) No one is allowed to take an apple or a pear.

Another argument in favor of an implicature-based analysis of \( \text{fc} \)-readings is the observation that the \( \text{fc} \)-inferences in (39b) and (40b) seem to rest on the contextual assumption that the speaker is, in a sense, an authority about the deontic modality in question. If this assumption is not warranted or explicitly suspended as in the following example (42a) we do not get the \( \text{fc} \)-implicature. We rather get the *ignorance implicature* (42b) similar to the one we got for a plain disjunction. Additionally, the epistemic ignorance reading of \( \Diamond (A \lor B) \) forced in (42a) may still convey an (epistemic) scalar implicature as in (42c).

(42) a. You may take an apple or a pear, but I don’t know which.

b. *Ignorance Implicature*: The speaker doesn’t know whether the hearer may take an apple and the speaker does not know whether the hearer may take a pear. 
\[ \neg K_S (\Diamond A) \land \neg K_S (\Diamond B) \]

c. *Scalar Implicature*: The speaker knows that the receiver may not take both. 
\[ K_S \neg (\Diamond (A \land B)) \]
Reassessing Deontic Modals. A similarly non-classical approach to fc-readings might reconsider the analysis of deontic modals. In this camp, we find the earliest contribution on the subject (Kamp 1973), and thereafter Merin (1992) and van Rooij (2000) who all have favored a performative analysis of the deontic modals in fc-environments. A general conceptual problem for a performative analysis is that fc-readings also arise for modals which are clearly not performatively used. Whence that all else being equal a uniform analysis should be preferred (see Schulz 2005, for this line of argument).17

Taken together, the intuitively attested fc-readings pose a problem for standard semantics of disjunction and deontic modals. Deviations from the classical, logical analyses are on the market, but obviously the preferred Gricean analysis would adhere to the standards and give a rationalistic account of the readings in question.

3.3.1 Free Choice from Anti-Exhaustivity

Unfortunately, fc-inferences cannot be derived by naïve scalar reasoning unless we buy into additional and perhaps seemingly ad hoc assumptions about the nature of the relevant alternative forms to reason with. To see this, consider the set $M_1$ which I and others take to be the most natural set of alternatives to a disjunctive permission $\Diamond (A \lor B)$ (see Kratzer and Shimoyama 2002; Chierchia 2004; Alonso-Ovalle 2005; Fox 2007; Chierchia et al. 2008):18

$$M_1 = \{m_{\Diamond A}, m_{\Diamond B}, m_{\Diamond (A \lor B)}, m_{\Diamond (A \land B)}\},$$

which consists of the sentences in (43).

(43) 

a. You may take an apple. $m_{\Diamond A}$

b. You may take a pear. $m_{\Diamond B}$

c. You may take an apple or a pear. $m_{\Diamond (A \lor B)}$

d. You may take an apple and a pear. $m_{\Diamond (A \land B)}$
It is not difficult to see how things go wrong for naïve scalar reasoning based on the set $M_1$. If we assume that an assertion of a form $X$ implicates that all stronger alternatives for $X$ from the relevant set of candidate forms are false, we derive that an utterance of $\Diamond (A \lor B)$ implicates $\neg \Diamond A$ and $\neg \Diamond B$, which is clearly too strong, and even incompatible in conjunction with the semantic meaning of the asserted sentence.\footnote{For concreteness’ sake, let me mention that an epistemic version of this problem arises for instance for Sauerland (2004)’s improved Neo-Gricean model of implicature calculation. As Fox (2007) notes critically, Sauerland (2004) predicts that an utterance of $\Diamond (A \lor B)$ implicates that the speaker does not know that $\Diamond A / \Diamond B$. This is indeed too strong a prediction for the attested fc-reading (although it is the correct prediction for the epistemic reading in (42a)).} So, given these allegedly natural alternatives a naïve account cannot derive the fc-reading.

**Other Alternatives.** The mistake may be sought in the set of featured alternatives, of course. And indeed, other authors have featured other alternatives. For instance, Schulz (2005) and Aloni and van Rooij (2007) use the following set of alternatives:

$$M_2 = \{ m_{\Diamond A}, m_{\Diamond B}, m_{\Diamond (\neg A)}, m_{\Diamond (\neg B)} \}$$

and derive the desired fc-inference. It’s clear however that this choice of alternatives stands in need of justification; at least more so than did the previous. All else being equal, I believe, we would prefer an account that derives fc-readings as implicatures from the set $M_1$ rather than from the set $M_2$.

**Anti-Exhaustivity.** This seems indeed possible, as an interesting observation by Kratzer and Shimoyama (2002) suggests: Kratzer and Shimoyama hypothesize that one reason why $m_{\Diamond (A \lor B)}$ may be used instead of $m_{\Diamond A}$ and $m_{\Diamond B}$ is so as to prevent an exhaustive interpretation of the latter forms.\footnote{More concretely, Kratzer and Shimoyama (2002) offer a pragmatic account of the use of German existential ‘irgendein’ which they analyze as introducing domain widening. Domain widening under an existential modal can then be rationalized parallel to the use of disjunction.} Since, in other words, on this account the purpose of using $m_{\Diamond (A \lor B)}$ is to negate an exhaustive inference, the term **anti-exhaustivity** has caught hold in the community to describe Kratzer and Shimoyama’s idea.

The desired prediction of free choice follows from naïve scalar reasoning if we assume that the alternative forms $m_{\Diamond A}$ and $m_{\Diamond B}$ in $M_1$ should be interpreted exhaustively, i.e., basically as in (44a) and (44b) respectively.
(44) a. You may take an apple but you may not take a pear. $m_{\Diamond A \land \neg \Diamond B}$
b. You may take a pear but you may not take an apple. $m_{\Diamond B \land \neg \Diamond A}$

Effectively, this amounts to replacing the set of alternatives $M_1$ with the set:

$$M_1^* = \left\{ m_{\Diamond A \land \neg \Diamond B}, m_{\Diamond B \land \neg \Diamond A}, m_{\Diamond (A \lor B)}, m_{\Diamond (A \land B)} \right\}.$$ If we now apply the standard Neo-Gricean mechanism of implicature calculation, we derive that an utterance of $\Diamond (A \lor B)$ implicates that all stronger alternatives in $M_1^*$ are false, i.e., we derive the implicatures in (45).

(45) a. It’s not the case that the hearer may take an apple but not a pear.
b. It’s not the case that the hearer may take a pear but not an apple.

Truth of $\Diamond (A \lor B)$ in conjunction with the implicatures in (45) derives the $fc$-reading, as the interested reader will quickly be able to verify.

**Hidden Exhaustive Operators.** So far, so good. The desired $fc$-readings follow from anti-exhaustivity, but where does anti-exhaustivity itself find its legitimation? Chierchia (2004), Fox (2007) and Chierchia et al. (2008) answer this question by appeal to their general theory of local implicature calculation *in the syntax*: the gist of the idea is that a hidden exhaustivity operator —akin to the meaning of “only”— applies in the syntax, if necessary multiple times, to supply the proper readings of alternatives and target forms. Without going into the details of any individual account, suffice it to note that this grammatical approach sticks with the original set of alternatives $M_1$ from which it derives $M_1^*$ by insertion of hidden exhaustivity operators at the required places in the syntactic derivation of (39a). Further applications of exhaustivity operators —higher up in the syntactic derivation— would then feed on the alternative set $M_1^*$ and derive the $fc$-reading along the lines spelled out above.

The reader will find this latter localist account of $fc$-inferences appealing to the extent that she is open towards the somewhat iconoclastic idea of relegating basic pragmatic mechanisms to syntax; conversely, she will dislike the suggested solution proportional to her sense that reiterations of hidden syntactic operators not only create heavy theoretical overload, but also seem rather unwieldy and arbitrary, at least compared to the strong folk-psychologicl appeal of the Gricean rationalistic programme. But the ball is in the field of the classical Griceans to meet the challenge posed by the syntax-enthusiasts who write:
We believe this logic [i.e., the logic of anti-exhaustivity] is basically correct, but we don’t see a way to derive it from basic principles of communication (Maxims). […] In conclusion, we have sketched reasons to believe that free choice effects can be explained in a principled way as meta- (or higher order) implicatures. If this is anywhere close to the mark, then clearly implicatures must be part of grammar.”

(Chierchia et al. 2008, p. 36)

In the following I would like to rise to this challenge and show how the IBR model can account for the FC-readings of (39a) based on the alternatives in $M_1$ pretty much by deriving anti-exhaustivity from iteration: peeking ahead, it will turn out that early iteration steps derive exhaustive readings of forms $m_{\Diamond A}$ and $m_{\Diamond B}$; later iterations will then compare $m_{\Diamond(A \lor B)}$ with the exhaustive interpretations of $m_{\Diamond A}$ and $m_{\Diamond B}$. Iteration thus implements the logic of anti-exhaustivity, and explains FC-readings in rationalistic terms without relegating implicatures to syntax.

3.3.2 Anti-Exhaustivity from Iteration

In this section I would like to spell out how FC-readings and also ignorance readings can be derived in the IBR model. Vital for my account is a proper defense of the assumptions feeding the construction of a reasonable signaling game model. The present account does not require any special assumptions beyond the general principles for the construction of interpretation games that I defended in section 3.1.1. The only thing that deserves motivation is my use of non-lifted and lifted models to account for FC-readings and ignorance readings respectively. This is what I will do first.

Authorities and Experts

A sentence like (39a) basically allows for two kinds of readings: the FC-reading in (39b), and the ignorance reading in (42b). (This is similar for the universal deontic modal in (40a), of course.) There is a strong intuition that the reading we obtain depends on how well-informed we take the speaker to be: where it is the speaker herself who is the relevant authority responsible for granting or withholding permission, FC-readings arise; where the speaker appears at best a possibly underinformed reporter on the deontic state of affairs, ignorance readings arise.

To make this intuition bite in the game theoretic context model I will distinguish terminologically (deontic) authorities from (epistemic) experts. Authorities
are (assumed) infallible informants who cannot err when describing the relevant deontic states of affairs.\textsuperscript{21} Experts, on the other hand, may also happen to be perfectly informed, but they are not the ultimate authority so that error is at least in principle conceivable. In a nutshell: experts on deontic matters may be mistaken, authorities cannot.

Consequently, I propose to model the context of utterance either as a non-lifted or as a lifted signaling game. If the speaker is (assumed to be) an authority, the context model will be a normal, i.e., non-lifted signaling game where it is common belief that the sender knows the true state of the world. The states of the unlifted game model fix which of the actions $A$ (taking an apple) and $B$ (taking a pear) are feasible or allowed actions for the hearer. In contrast, if the speaker is not an absolute authority, the context model will be an epistemically lifted signaling game in which the sender may (or may not) have imperfect information about the deontic state of affairs. The states in the lifted game are thus information states representing the speaker’s information concerning what obligations and permissions obtain. Unlike in the non-lifted game, the sender is not assumed to necessarily be perfectly informed.

Both context models, basic and lifted, are games with interpretation actions, so as to clearly model the pragmatic inferences about the meaning of the sentences involved.\textsuperscript{22} Based on this, the next section will show how the basic, non-lifted models should derive FC-readings for both “may” and “must.” The subsequent section covers the ignorance readings for both modals.

\textit{Deriving FC-Readings}

**Existential Modals.** As for the case “may(A or B),” I suggest to adopt the following non-lifted model from which the lifted model will be derived later on. We would like to stick to the arguably most natural set of alternatives, as discussed in section 3.3.1:

\[
M = \left\{ m_{\Diamond A}, m_{\Diamond B}, m_{\Diamond (A \lor B)}, m_{\Diamond (A \land B)} \right\}.
\]

\textsuperscript{21} Notice that I still adhere to a descriptive approach: authorities still describe the deontic states of affairs; they do not performatively create, remove or change obligations by sending messages.

\textsuperscript{22} If we assume that an interpretation game is played on this set of states, we are basically construing the context of utterance for (39a) as one in which the (implicit) question under discussion is: “which combination of actions out of \{A, B\} may I (the receiver) perform so as to please you (the sender)?” Alternatively, we could have the receiver respond by performing the concrete actions $A$ and $B$. I stick to the interpretation framework for continuity with previous and subsequent cases.
3.3. Free Choice Inferences

<table>
<thead>
<tr>
<th>Pr(t)</th>
<th>t_0</th>
<th>t_0B</th>
<th>t_0AB</th>
<th>t_0A|B</th>
<th>m_0</th>
<th>m_0B</th>
<th>m_0(A\lor B)</th>
<th>m_0(A\land B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>1,1</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>√</td>
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<td>√</td>
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<td>0,0</td>
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<td>√</td>
<td>√</td>
<td>√</td>
<td>−</td>
</tr>
</tbody>
</table>

Figure 3.6: Unlifted signaling game for free choice “may(A or B)”

By our general construction rule, we then derive four states of the signaling game model under a standard possible worlds semantics:

<table>
<thead>
<tr>
<th>m_0</th>
<th>m_0B</th>
<th>m_0(A\land B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_0AB</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>t_0A|B</td>
<td>√</td>
<td>−</td>
</tr>
<tr>
<td>in cons.</td>
<td>√</td>
<td>−</td>
</tr>
<tr>
<td>t_0A</td>
<td>√</td>
<td>−</td>
</tr>
<tr>
<td>in cons.</td>
<td>−</td>
<td>√</td>
</tr>
<tr>
<td>t_0B</td>
<td>−</td>
<td>√</td>
</tr>
<tr>
<td>in cons.</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>in cons.</td>
<td>−</td>
<td>−</td>
</tr>
</tbody>
</table>

The state t_0AB, for instance, is one where the receiver is allowed to take both an apple and a pear. The state t_0A\|B, on the other hand, is one where the receiver may take either an apple or a pear but not both. With our usual assumptions of flat priors and cheap talk, we thus arrive at the signaling game in figure 3.6.

For this game, the IBR model predicts a unique fixed point interpretation behavior of the receiver for both strands of reasoning:

$$R^* = \left\{ \begin{array}{c}
    m_0 \iff t_0A \\
    m_0B \iff t_0B \\
    m_0(A\lor B) \iff t_0A\|B \\
    m_0(A\land B) \iff t_0AB
  \end{array} \right\}.$$  

This is the desired prediction for interpretation of m_0(A\lor B). In order to show how in particular iteration of best response reasoning accounts for anti-exhaustivity, let me spell out and comment on the R_0-sequence for illustration.
Chapter 3. Games and Pragmatic Interpretation

Under the assumed semantics the naïve receiver behavior is:

\[
R_0 = \begin{cases} 
  m_A & \mapsto t_A, t_{AB}, t_{A|B} \\
  m_B & \mapsto t_B, t_{AB}, t_{A|B} \\
  m_{A\lor B} & \mapsto T \\
  m_{A\land B} & \mapsto t_{AB} 
\end{cases}
\]

Based on this, the optimal strategy for the sender is:

\[
S_1 = \begin{cases} 
  t_A & \mapsto m_A \\
  t_B & \mapsto m_B \\
  t_{AB} & \mapsto m_{(A\land B)} \\
  t_{A|B} & \mapsto m_{A, m_B} 
\end{cases}
\]

It is noteworthy here that \(m_A\) and \(m_B\) are the best sender choices in \(t_{A|B}\), because under \(R_0\)'s interpretation these messages yield a chance of \(\frac{1}{3}\) of successful communication, as opposed to a chance of \(\frac{1}{4}\) when sending \(m_{(A\lor B)}\).

Our target form will therefore be a surprise message to \(R_2\):

\[
R_2 = \begin{cases} 
  m_A & \mapsto t_A \\
  m_B & \mapsto t_B \\
  m_{A\lor B} & \mapsto \text{surprise} \\
  m_{A\land B} & \mapsto t_{AB} 
\end{cases}
\]

Under the vanilla model, without forward induction assumption, \(R_2\) would respond to \(m_{(A\lor B)}\) with any action in \(T\). This interpretation will settle on the desired outcome eventually, as the interested reader will happily verify. Still, we can also use a shortcut, for the sake of exposition, and notice that our target message \(m_{(A\lor B)}\) is actually weakly 2-dominated in all states except \(t_{A|B}\): intuitively speaking, all other states already have a message which expresses these states at that point. So, by forward induction reasoning, \(R_2\) may arrive at the interpretation \(R_2(m_{(A\lor B)}) = \{t_{A|B}\}\), which yields the fixed point of this reasoning sequence.

Let me stress again for clarity that the predictions of the model do not hinge on forward induction. The reasoning with weak \(k\)-dominance is merely more compact, and eases exposition and helps focus on localizing the formal counterpart of the “anti-exhaustivity reasoning” in the model. Anti-exhaustivity occurs, so to speak, because \(R_2\) interprets the forms \(m_A\) and \(m_B\) exhaustively as denoting states \(t_A\) and \(t_B\) respectively, and because \(R_2\)
compares this exhaustive interpretation to the target expression. This is so
even though both forms also get sent in $t_{\Diamond A|B}$ by $S_1$, since by proper sophis-
ticated updating, the posterior probability of $t_{\Diamond A}$ after observing $m_{\Diamond A}$ is twice as
high as that of $t_{\Diamond A|B}$. In effect, the IBR model derives the intuitively appealing
logic of anti-exhaustivity by a two-step iteration process: first we derive the
exhaustive interpretation of $m_{\Diamond A}$ and $m_{\Diamond B}$, and from that arrive at the attested
fc-reading. (Similar remarks apply to the $S_0$-sequence.)

**Universal Modals.** The present account of fc-readings carries over to uni-
versal modals without any further complications. If we assume the set of
speaker alternatives:

$$M = \{ m_{\Diamond A}, m_{\Diamond B}, m_{\Diamond (A \lor B)}, m_{\Diamond (A \land B)} \} $$

we derive four possible state distinctions:

<table>
<thead>
<tr>
<th>$m_{\Diamond A}$</th>
<th>$m_{\Diamond B}$</th>
<th>$m_{\Diamond (A \lor B)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{\Diamond AB}$</td>
<td>$\checkmark$</td>
<td>$\checkmark$</td>
</tr>
<tr>
<td>incons.</td>
<td>$\checkmark$</td>
<td>$\checkmark$</td>
</tr>
<tr>
<td>incons.</td>
<td>$\checkmark$</td>
<td>$-$</td>
</tr>
<tr>
<td>$t_{\Diamond A}$</td>
<td>$\checkmark$</td>
<td>$-$</td>
</tr>
<tr>
<td>incons.</td>
<td>$-$</td>
<td>$\checkmark$</td>
</tr>
<tr>
<td>$t_{\Diamond B}$</td>
<td>$-$</td>
<td>$\checkmark$</td>
</tr>
<tr>
<td>incons.</td>
<td>$-$</td>
<td>$-$</td>
</tr>
<tr>
<td>$t_{\Diamond A</td>
<td>B}$</td>
<td>$-$</td>
</tr>
</tbody>
</table>

Here the state $t_{\Diamond AB}$, for instance, is one where the receiver has to take both an
apple and a pear. The state $t_{\Diamond A|B}$, on the other hand, is one where the receiver
has to take an apple or a pear but may choose which one. This yields the
unlifted cheap talk signaling game in figure 3.7.

For this game, the IBR model again predicts a single unique receiver inter-
pretation strategy for both strands of reasoning:

$$R^* = \{ m_{\Diamond A} \mapsto t_{\Diamond A}, m_{\Diamond B} \mapsto t_{\Diamond B}, m_{\Diamond (A \lor B)} \mapsto t_{\Diamond A|B}, m_{\Diamond (A \land B)} \mapsto t_{\Diamond AB} \} .$$

The target expression receives the interpretation that the receiver need not
take an apple, and that he need not take a pear, just as intuition demands.
REFLECTION. Taken together, an account of \textit{fc}-readings is rather straightforward in the \textit{ibr} model. Once we have settled on an acceptable set of alternative forms, we do not have to assume message costs or any particular ordering on states to derive the \textit{fc}-readings. This is what sets the present approach apart from previous accounts, such as in terms of bidirectional optimality theory (Aloni 2007; Pauw 2008), or “minimal models” (Schulz 2005) or “default interpretations” (Asher and Bonevac 2005). The key to the success of \textit{ibr} is, in a manner of speaking, the proper exploitation of semantic structure by sophisticated updating (as given in an assumed set of alternatives): previous accounts have not drawn on the full ‘proportional information’ given, so to speak, when comparing the meaning of expressions; therefore previous accounts had to rely on additional ordering assumptions.

\textit{Deriving Ignorance Implicatures}

Thus far we have derived the \textit{fc}-implicatures of sentences (39a) and (40a). In order to do so, we have set up a context model that modeled the deontic authority of the speaker in terms of an unlifted signaling game in which the sender cannot possibly be mistaken about the actually obtaining deontic state of affairs. Turning to the epistemic inferences associated with a situation where the speaker may in principle fail to be the absolute authority, we should try lifting the basic models. Epistemic lifting of these context models is a plain execution of the principles set out in section 3.2.

\textit{Existential Modals.} Lifting the basic signaling game in figure 3.6, we receive a total of fifteen epistemic states:

\[
T = \{ t_{\Diamond A} , t_{\Diamond B} , t_{\Diamond A \Diamond B} , t_{\Diamond A \Diamond A \Diamond B} , t_{\Diamond A \Diamond B \Diamond A \Diamond B} , t_{\Diamond A \Diamond B \Diamond B} , t_{\Diamond A \Diamond B \Diamond A \Diamond B} ,
\]

\[
t_{\Diamond A \Diamond A \Diamond B} , t_{\Diamond A \Diamond B \Diamond B} , t_{\Diamond A \Diamond B \Diamond A \Diamond B} \).
\]
3.3. Free Choice Inferences

The notation here is as before: commas in brackets separate unlifted states as epistemic possibilities not ruled out in an epistemic state. For example, the state \( t_{[OA,OB]} \) contains the unlifted states \( t_{OA} \) and \( t_{OB} \). It thus represents the sender’s epistemic state in which she considers two possibilities, namely that the receiver may take only an apple, and that the receiver may take only a pear. With this both strands of the IBR model arrive at the same unique fixed point for epistemic experts (3.1) and for non-experts (3.2):

\[
R^* = \left\{ \begin{array}{c}
m_{OA} \quad \mapsto \quad t_{[OA]} \\
m_{OB} \quad \mapsto \quad t_{[OB]} \\
m_{(A \vee B)} \quad \mapsto \quad t_{[OA,OB]} \\
m_{(A \wedge B)} \quad \mapsto \quad t_{[OA,OB]} \end{array} \right\} \quad (3.1)
\]

\[
R^* = \left\{ \begin{array}{c}
m_{OA} \quad \mapsto \quad t_{[OA]} \\
m_{OB} \quad \mapsto \quad t_{[OB]} \\
m_{(A \vee B)} \quad \mapsto \quad t_{[OA,OB]} \\
m_{(A \wedge B)} \quad \mapsto \quad t_{[OA,OB]} \end{array} \right\} \quad (3.2)
\]

Universal Modals. Similarly, we would hope that ignorance readings of an utterance of the universal modal statement \( \square (A \vee B) \) should fall out of the lifted model straightforwardly. But this is not quite so. When lifting the signaling game in figure 3.7, we again obtain fifteen epistemic states:

\[
T = \{ t_{[A]}, t_{[B]}, t_{[A,B]}, t_{[A\wedge B]}, t_{[A\vee B]}, t_{[A,B,A\wedge B]}, t_{[A,B,A\vee B]}, t_{[A,B,A\wedge B,A\vee B]}, t_{[A,B,A\wedge B,A\vee B]}, t_{[A,B,A\wedge B,A\vee B]} \}.
\]

But here, of course, the unlifted states have to be interpreted slightly differently. So, the state \( t_{[OA,OB]} \) is now an epistemic state of the sender where she considers only two possibilities, namely the unlifted state \( t_{OA} \) where the receiver has to take an apple (while being allowed not to take a pear), and the unlifted state \( t_{OB} \) where the receiver has to take a pear (while being allowed not to take an apple). For this model, the both the \( S_0 \)-sequence as well as the \( R_0 \)-sequence derive the same fixed point. For epistemic experts we get:

\[
R^* = \left\{ \begin{array}{c}
m_{OA} \quad \mapsto \quad t_{[OA]} \\
m_{OB} \quad \mapsto \quad t_{[OB]} \\
m_{(A \vee B)} \quad \mapsto \quad t_{[OA,B]} \\
m_{(A \wedge B)} \quad \mapsto \quad t_{[OA,B]} \end{array} \right\} \quad (3.3)
\]
while for non-experts we get:

\[
R^* = \begin{cases}
    m_{\Box A} & \mapsto t[\Box A], t[\Box A, \Box AB] \\
    m_{\Box B} & \mapsto t[\Box B], t[\Box B, \Box AB] \\
    m_{\Box (A \lor B)} & \mapsto t[\Box A, \Box B], t[\Box A \lor B], t[\Box A, \Box AB], t[\Box B, \Box AB] \\
    m_{\Box (A \land B)} & \mapsto t[\Box AB]
\end{cases}
\] (3.4)

These predictions are not correct. For expert senders, the target form \( m_{\Box (A \lor B)} \) should be interpreted as \( t[\Box A, \Box B] \) instead, because in a context where the sender is not an absolute authority, a sentence like (46a) should implicate both (46b) and (46c).

(46) a. You must take an apple or a pear, but I don’t know which.

b. \( \sim \) The speaker considers it possible that the hearer must take an apple (a pear).

c. \( \sim \) The speaker considers it possible that the hearer need not take an apple (a pear).

Unfortunately, the IBR model only predicts (46c) and not (46b). As a matter of fact, the IBR model predicts the expert sender to be too much of an expert. This problem did not arise under existential modals because there the alternative forms \( m_{\Diamond A} \) and \( m_{\Diamond B} \) were true in the corresponding state \( t[\Diamond A, \Diamond B] \). Under universal modals, however, the only message that is true in \( t[\Diamond A \lor B] \) is the target message \( m_{\Diamond (A \lor B)} \). This way, when the IBR model looks for the most informed sender state where \( m_{\Diamond (A \lor B)} \) is true, it finds a too specific state \( t[\Diamond A \lor B] \), instead of the intuitively correct \( t[\Diamond A, \Diamond B] \).

Reprensibility. This problem could perhaps be solved by arguing for a different set of alternatives to \( m_{\Diamond (A \lor B)} \). Another, to my mind more interesting, strategy is to assume an adequate order on the set of states. This is what many alternative accounts of FC- and ignorance implicatures rely on, and it is already astonishing enough that the IBR model derives FC-readings for both existential and universal modals, as well as ignorance readings for existential modals, without such extra ordering information. A plain but appealing first shot at characterizing minimality of a deontic state based on a set of relevant propositions \( P \) is to say that a state \( t \) is more restricted in its permissions than another state \( t' \) iff \( t' \) makes more sentences of the form \( \Diamond p \) for \( p \in P \) true.
than \( t \) does (cf. van Fraassen 1973; Kratzer 1981; Lewis 1981). Analogously, a state \( t \) is more restricted in its obligations than another state \( t' \) iff \( t' \) makes more sentences of the form \( \Box p \) for \( p \in P \) true than \( t \) does. In a signaling game context, the minimality of models could be translated into an assumption about the prior probabilities of states: more minimal models are a priori more likely because these are the stereotypical interpretations that first spring to mind. For the signaling game in figure 3.7, this latter notion would induce an ordering on prior probabilities as follows:

\[
Pr(t_{\Box A|B}) > Pr(t_{\Box A}) = Pr(t_{\Box B}) > Pr(t_{\Box AB})
\]

If we allow this ordering information—which, by the way, does not disturb predictions for the unlifted game—to take precedence over the ordering information on epistemic states from speaker expertise, the model predicts the intuitively correct outcome also for ignorance implicatures under universal modals. Whether this is a generally and conceptually satisfactory solution, I will have to leave for another occasion.

### 3.3.3 Simplification of Disjunctive Antecedents

Although we will come back in detail to questions concerning the interpretation of conditionals in chapter 5, I would like to round off the discussion of \( \text{fc} \)-inferences by a brief look at conditionals with a disjunctive antecedent like in (47a).

(47)  
\begin{align*}
\text{a.} & \quad \text{If you eat an apple or a pear, you will feel better.} \quad (A \lor B) > C \\
\text{b.} & \quad \sim A \quad \text{If you eat an apple, you will feel better.} \quad A > C \\
\text{c.} & \quad \sim B \quad \text{If you eat a pear, you will feel better.} \quad B > C
\end{align*}

(48)  
\begin{align*}
\text{a.} & \quad \text{If you’d eaten an apple or a pear, you’d feel better.} \quad (A \lor B) > C \\
\text{b.} & \quad \sim A \quad \text{If you’d eaten an apple, you’d feel better.} \quad A > C \\
\text{c.} & \quad \sim B \quad \text{If you’d eaten a pear, you’d feel better.} \quad B > C
\end{align*}

Intuitively, the indicative (47a) seems to convey both (47b) and (47c), and similarly the counterfactual (48a) seems to convey both (48b) and (48c). In general, the inference from \( (A \lor B) > C \) to \( A > C \) (or \( B > C \)) is known as simplification of disjunctive antecedents, henceforth \( \text{sda} \).

Although \( \text{sda} \) is a valid inference under a material implication analysis of conditionals, standard possible-worlds semantics in the vein of Stalnaker
(1968) and Lewis (1973) do not necessarily make sda valid. This has been held as a problem case against in particular Lewis’s (1973) theory of counterfactuals (see Nute 1975; Fine 1975), but the case would equally apply to indicatives under like-minded semantic theories.

Still, there are good arguments not to want sda to be a semantically valid inference pattern. Warmbröd (1981) gives one argument in favor of this position. He argues that if a conditional semantics makes sda valid, and if we otherwise stick to standard truth-functional interpretation of disjunction, we can also derive that inferences like that from (49a) to (49b) are generally valid, which intuitively should not be the case.

(49) a. If you eat an apple, you will feel better. \( A > C \)

b. If you eat an apple and a rock, you’ll feel better. \((A \land B) > C\)

Another argument against a semantic validation of sda comes from examples such as the following (cf. McKay and van Inwagen 1977):

(50) a. If John had taken an apple or a pear, he would have taken an apple.

b. \( \not \rightarrow \) If John had taken a pear, he would have taken an apple.

If sda was semantically valid then (50a) would imply (50b), but this is of course nonsense. Together, this suggests loosely that sda should perhaps be thought of as a pragmatic inference on top of a standard semantics.

A pragmatic account is moreover also made plausible by the observation that sda is structurally very similar to fc-readings (see Klinedinst 2006; van Rooij 2006a). Asher and Bonevac (2005) even analyze permission statements of the form “you may do \( A \)” as, roughly, a conditional statement “if you do \( A \), it is okay.” This is also very plausible given the fact that an English question like

(51) Is it okay if I take an apple?

is an expression frequently used to ask for permission. Moreover, lacking a clear equivalent to English modal “may”, in Japanese a standard construction for permission giving is the conditional construction “-te mo” which generally translates as “even if” (see McClure 2000, p. 180):

23. I will not enlarge on semantic theories of conditionals here. Readers unfamiliar with this topic may want to skip ahead and consult section 5.1.

24. Formally, this is because if sda is generally valid, we can infer from \( A > C \) and the fact that \((A \land B) \lor (A \land \neg B)\) is a truth-functionally equivalent to \( A \) that \(((A \land B) \lor (A \land \neg B)) > C\). Then, by sda, we derive \((A \land B) > C\) for arbitrary \( B \).
A final parallel between SDA and FC is the observation that we can force epistemic ignorance readings also for conditionals with disjunctive antecedents (see Klinedinst 2006):

\[(A \lor B) > C\]

a. If you eat an apple or a pear, you will feel better, but I don’t know which.

b. ~ The speaker considers \(A > C\) possible, but not necessary.

c. ~ The speaker considers \(B > C\) possible, but not necessary.

In a context like (53a) that marks the speaker’s epistemic uncertainty we do not derive from \((A \lor B) > C\) that the speaker knows that \(A > C\) and \(B > C\) are both true, as full-fledged SDA would have it. Rather, if we take the speaker to be maximally knowledgeable despite her expressed uncertainty, we only infer that the speaker considers exactly one of the sentence \(A > C\) and \(B > C\) true, but not both.

For these reasons, we should try and see whether SDA can be derived as a pragmatic inference similar to FC-readings in the IR model. It seems that the exact same approach that we used for FC-readings and ignorance readings above should apply also for SDA and ignorance readings such as in (53). In particular, it may be suspected that SDA as in (47) and (48) can be explained as a general pragmatic inference associated with conditionals \((A \lor B) > C\) in standard unlifted signaling games. The ignorance readings in a context which forces us to assume speaker uncertainty, like in (53), should also be explicable, as before, in terms of lifted signaling games. If we could thus explain SDA as an inference by iterated pragmatic reasoning this would also rebut the claim of localists Levinson (2000) and Chierchia et al. (2008) that sequences like (54) force Gricean reasoning to penetrate into syntax so that an embedded implicature is calculated under the scope of the antecedent operator.

\[(54)\] If you take an apple or a pear, that’s fine. But if you take both, that’s not okay.

**Context Model.** Following our general principles for construction of context models, we should start with a suitable set of expression alternatives to
the target expression $m_{(A \lor B) > C}$. In line with the previous treatment of disjunction it is safe to assume three further alternative expressions, namely $m_{A > C}$, $m_{B > C}$ and $m_{(A \land B) > C}$ with the obvious intended meanings. The question then is which semantics we should adopt for conditional sentences. Let me defer more in-depth discussion of conditional semantics to chapter 5, and confine myself here to just stating the abstract semantic scheme that I will endorse in this thesis for both indicatives and counterfactuals.

Let each possible world $w$ be associated with a modal structure $\langle R_w, \preceq_w \rangle$ that is suitable for interpreting the conditional that we are interested in. Generally, $R_w$ is a set of possible worlds and $\preceq_w$ is a well-founded ordering on $R_w$. Many reasonable constraints on the nature of this ordering could be given to instantiate certain influential theories of conditionals (think of: Stalnaker 1968; Lewis 1973; Kratzer 1981; Lewis 1981; Veltman 1985). For the present pragmatic purpose we should remain noncommittal and not take on any particular constraints on modal structures. We then simply define

$$\text{Min}(R_w, \preceq_w, A) = \{ v \in R_w \cap A \mid \neg \exists v' \in R_w \cap A : v' \prec_w v \}$$

and say that an indicative or counterfactual conditional

$$A > C \text{ is true in } w \text{ iff } \text{Min}(R_w, \preceq_w, A) \subseteq C.$$

To derive the states of our signaling game, we should then look at the eight conjunctive combinations of alternative forms in the following table and ask which of these combinations are consistent:

<table>
<thead>
<tr>
<th></th>
<th>$m_{A &gt; C}$</th>
<th>$m_{B &gt; C}$</th>
<th>$m_{(A \land B) &gt; C}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_1$</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>$t_2$</td>
<td>√</td>
<td>√</td>
<td>−</td>
</tr>
<tr>
<td>$t_3$</td>
<td>√</td>
<td>−</td>
<td>√</td>
</tr>
<tr>
<td>$t_4$</td>
<td>√</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>$t_5$</td>
<td>−</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>$t_6$</td>
<td>−</td>
<td>√</td>
<td>−</td>
</tr>
<tr>
<td>$t_7$</td>
<td>−</td>
<td>−</td>
<td>√</td>
</tr>
<tr>
<td>$t_8$</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
</tbody>
</table>

As $(A \lor B) > C$ implies $(A > C) \lor (B > C)$ under the assumed general semantics, states $t_7$ and $t_8$ are inconsistent. All other combinations are possible and non-redundant, and so we end up with six possible states in the context model given in figure 3.8.
### Free Choice Inferences

**Table 3.8:** Unlifted context model for sda

<table>
<thead>
<tr>
<th>Pr(t)</th>
<th>t1</th>
<th>t2</th>
<th>t3</th>
<th>t4</th>
<th>t5</th>
<th>t6</th>
</tr>
</thead>
<tbody>
<tr>
<td>t1</td>
<td>1/6</td>
<td>1,1</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
</tr>
<tr>
<td>t2</td>
<td>1/6</td>
<td>0,0</td>
<td>1,1</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
</tr>
<tr>
<td>t3</td>
<td>1/6</td>
<td>0,0</td>
<td>0,0</td>
<td>1,1</td>
<td>0,0</td>
<td>0,0</td>
</tr>
<tr>
<td>t4</td>
<td>1/6</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>1,1</td>
<td>0,0</td>
</tr>
<tr>
<td>t5</td>
<td>1/6</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>1,1</td>
</tr>
<tr>
<td>t6</td>
<td>1/6</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>0,0</td>
<td>1,1</td>
</tr>
</tbody>
</table>

**Predictions.** The iBR model predicts a slightly different fixed point for each iBR sequence. The interpretation of the target message, however, is the exact same in both fixed points. Let us first look at the predictions for unlifted games. For the R₀-sequence, we obtain

$$R^* = \begin{cases} 
  m_{A>C} & \rightarrow t_4 \\
  m_{B>C} & \rightarrow t_6 \\
  m_{(A\land B)>C} & \rightarrow t_1,t_3,t_5 \\
  m_{(A\lor B)>C} & \rightarrow t_2 
\end{cases}$$

as fixed-point interpretation behavior. For the S₀-sequence, on the other hand, we obtain the same, except that

$$R^*(m_{(A\land B)>C}) = \{t_3,t_5\} .$$

Still, the interpretation of our target message $m_{(A\lor B)>C}$ is exactly as it should be in accordance with sda. The state $t_2$ is indeed one where both $A > C$ and $B > C$ are true but where $(A \land B) > C$ is false.\(^{25}\) I am content with this result

---

\(^{25}\) As before for the derivation of fc-readings, it may be contestable that $(A \land B) > C$ is derived to be false. As before this inference may require some emphatic stress or more contextual relevance of the conjunction alternative. Without the conjunctive alternative the
but admit that the diverging interpretation of $m_{(A \land B) > C}$ between \textsc{ibr} sequences is a minor oddity of the model.\footnote{signaling game model is fairly trivial and predictions are unremarkable: $\textsc{dsa}$ is derived from the unlifted model with the same fixed point for both sequences, and the lifted models also derive the obvious intuitive results.}

As for the lifted models, the situation is similar. Assuming epistemic experts, the $R_0$-sequence reaches a fixed point in the interpretation strategy

$$R^* = \begin{cases} m_{A > C} & \mapsto t_{[4]} \\ m_{B > C} & \mapsto t_{[6]} \\ m_{(A \land B) > C} & \mapsto t_{[1], t_{[3]}, t_{[5]}} \\ m_{(A \lor B) > C} & \mapsto t_{[4,5], t_{[3,6]}, t_{[4,6]}} \end{cases}$$

while the interpretation fixed point of the $S_0$-sequence differs only in the interpretation of the conjunctive alternative:

$$R^*(m_{(A \land B) > C}) = \{ t_{[3,5]} \}.$$ 

We derive the intuitively attested epistemic readings for a case like (53): the sender is taken to believe that exactly one out of $A > C$ and $B > C$ is true, while being uncertain which one that is.

For completeness, let me also give the predictions of the model for the inexpert case, at least for our target message. Predictions are the same here for both \textsc{ibr} sequences:

$$R^*(m_{(A \lor B) > C}) = \begin{cases} t_{[2,3,5]} & t_{[1,2,3,5]} & t_{[4,5]} & t_{[1,4,5]} & t_{[2,4,5]} & t_{[1,2,4,5]} \\ t_{[3,4,5]} & t_{[1,3,4,5]} & t_{[2,3,4,5]} & t_{[1,2,3,4,5]} & t_{[3,6]} & t_{[1,3,6]} \\ t_{[2,3,6]} & t_{[1,2,3,6]} & t_{[4,6]} & t_{[1,4,6]} & t_{[2,4,6]} & t_{[1,2,4,6]} \\ t_{[3,4,6]} & t_{[1,3,4,6]} & t_{[2,3,4,6]} & t_{[1,2,3,4,6]} & t_{[3,5,6]} & t_{[1,3,5,6]} \\ t_{[2,3,5,6]} & t_{[1,2,3,5,6]} & t_{[4,5,6]} & t_{[1,4,5,6]} & t_{[2,4,5,6]} & t_{[1,2,4,5,6]} \\ t_{[3,4,5,6]} & t_{[1,3,4,5,6]} & t_{[2,3,4,5,6]} & t_{[1,2,3,4,5,6]} & t_{[4,6]} & t_{[1,4,6]} \end{cases}.$$ 

Although unwieldy, these results are intuitive, as is easy to check. We predict the inference attested in (53) that the sender considers both $A > C$ and $B > C$ possible but does not have enough information to believe any one true. Unlike for epistemic experts we now no longer obtain that the sender believes...
that only one of these conditionals is true; there are epistemic states associated with our target message that contain \( t_1 \) or \( t_2 \), i.e., there are states in the interpretation of \( m_{(A \lor B) > C} \) where the sender considers it possible that \( A > C \) and \( B > C \) are both true at the same time.

**Summary.** The \( \text{ibr} \) model offers a parallel solution for free-choice readings of disjunctions under modals, and also for the related \( \text{sda} \)-inferences if we consult unlifted signaling games. Lifted game models naturally account for the epistemic readings associated with both types of constructions.

### 3.4 Games at the Semantics-Pragmatics Interface

As the true philosopher that Grice was, he managed to inspire by raising the right questions rather than by providing fully resolving answers. To fill in the details of the Gricean programme was left to a community of philosophers and linguists, and more recently also psycholinguists. The issues debated in connection with Grice’s notion of implicature, and linguistic and speaker meaning are still very much alive. After having detailed the \( \text{ibr} \) model and shown some of its applications, it is time to place game theoretic pragmatics in its current variety on the map by showing its position in some of the relevant controversies about the interface between semantics and pragmatics.

**Global or Local.** A first issue that should be addressed because it has recently been vividly debated is whether conversational implicatures are to be computed globally or locally. To see what is at stake, take again the case (54), repeated here, that we have just looked at in section 3.3.3.

(54) If you take an apple or a pear, that’s fine. But if you take both, that’s not okay.

Intuitively speaking, the scalar inference associated with “or” seems to take scope under the meaning of “if” and that may suggest that whenever scalar items fall into the scope of other operators, the scalar inference should be computed locally within the narrow scoping. A strong local view would therefore require that implicatures be computed as part of syntax (cf. Levinson 2000; Chierchia 2004; Fox 2007; Chierchia et al. 2008). In contrast, a scalar inference is computed globally if it is derived by comparing alternatives to a target
scalar item in the full linguistic context of its occurrence, e.g., by comparing the whole conditional in (54) to other alternative conditionals without a disjunctive antecedent.

As many of the previous examples showed, the IBR model clearly takes and supports a global approach to scalar implicature calculation (cf. van Rooij and Schulz 2004; Schulz and van Rooij 2006; Russell 2006). A major contribution of in particular this chapter is the proof that many allegedly local scalar inferences can be accounted for, especially if iteration of optimality considerations is taken into account. Indeed, as far as scalar inferences are concerned, I fully endorse the view of Geurts (2009) who argues that only very few marked cases seem to resist a global treatment.

Pragmatic Intrusion and the Gazdarian Picture. But although I would preferably apply the IBR model as a globalist reasoning scheme when it comes to scalar inferences, that does not mean that the IBR model is actually committed to a rigid modular architecture in which all pragmatic inference takes place based on fully spelled out truth-conditional semantics. To appreciate this point fully, let us briefly take a step back and recapitulate some of the basic ideas about the relation between semantics and pragmatics.

Grice himself had suggested that conversational implicatures should be derivable from “what was said” together with the Cooperative Principle and the Maxims of Conversation. But there is still an ongoing debate about a clear demarcation between semantic meaning and “what was said” on the one hand, and conversational implicatures and “what was meant” on the other. On one end of the (multidimensional) spectrum, we find positions like Gerald Gazdar’s who holds that utterance meaning is computed globally and modularly: according to Gazdar, Gricean inference takes semantic meaning, which is truth-conditional meaning unmediated by pragmatic processes, as a starting point (Gazdar 1979). Opposed to this strictly modular picture, others have acknowledged the role of Gricean inferences already in establishing the truth-conditional meaning of an utterance, such as for instance in expanding (55a) or completing (55b) a proposition (see Carston 1988; Recanati 1989; Bach 1994; Levinson 2000; Recanati 2004).

(55)  a. You are are not going to die.
      ~ You are not going to die from this.

   b. Keisuke was too late.
      ~ Keisuke was too late for pie.
Contrary to superficial impression, the \textbf{ibr} model is not committed to a strict Gazdarian conception, but is entirely compatible with the idea that certain pragmatic inferences feed the specification of sentence meaning, based on which the \textbf{ibr} model may kick in and do its work. Although I have assumed that messages in the game model have traditional truth-conditional semantics, this is—as I have already mentioned in section 3.1—not at all necessary. The \textbf{ibr} model could equally well deal with fairly weak conceptions of semantic meaning (see Borg 2004; Recanati 2004; Cappelen and Lepore 2005), as long as we may assume that (the interpreter assumes that) a semantic meaning uniquely exists that is shared and commonly accessible. The \textbf{ibr} model thus seems incompatible with only the most extreme ‘anything goes’ theories of conventional meaning (such as found, for instance, in a strong reading of Davidson 1986).

**Generalized or Particularized Inferences.** Grice distinguished generalized conversational implicatures that seem to occur for some given lexical material with a certain predictable regularity from particularized conversational implicatures that arise for seemingly arbitrary lexical material and only under special contextual constellations. The inferences associated with scalar items like “some” or “possibly” are prime examples of generalized implicatures. But scalar inferences also occur for more ad hoc comparisons between possible utterances: if we went shopping together and you know that we bought Gouda and Emmentaler cheese, then if I say

\begin{equation}
(56) \quad \text{I ate the Emmentaler.}
\end{equation}

you may take this to mean that I did not eat the Gouda. But clearly an out-of-the-blue utterance of (56) would not trigger this inference. This is then a clear example of a particularized implicature.

On the face of it, the present game theoretic approach treats all pragmatic inferences as reasoning about language use in a given context and consequently mainly accounts for particularized implicatures that arise from particular hearer beliefs about the concrete utterance context. However, by reference to interpretation games as representations of generic contexts of sentence interpretation, the present approach nonetheless also covers generalized implicatures as those inferences associated with utterances of sentences in an out-of-the-blue context. A similar contextualist view underlies not only game theoretic approaches (Benz and van Rooij (2007) are very outspoken on this issue) but also relevance theory (Sperber and Wilson 1995; Carston 1998) and
Neo-Gricean approaches with a clear affinity towards rational choice models of utterance contexts (see van Rooij and Schulz 2004, 2006; Schulz and van Rooij 2006).

This contextualist view is opposed to the idea that generalized implicatures have a special default status, a theory that is supported by, for instance, Levinson (2000) and Chierchia (2004). But there are good empirical arguments against the idea that generalized implicatures are special and/or computed as a default (see Noveck and Sperber 2004; Katsos 2008b, for overview on experimental approaches to pragmatics). Experimental data offers evidence that only if a scalar implicature arises in context its computation does take time (Noveck and Posada 2003; Bott and Noveck 2004). This clearly speaks against a default approach which would predict the reverse pattern. Other studies similarly stress the importance of context in computation of implicatures (see Breheny et al. 2006; Katsos 2008b). Specifically, there is compelling evidence that whether a scalar inference arises or not crucially hinges on the contextual question under discussion (see Zondervan 2006). Finally, both young language learners as well as adults seem to reason just as proficiently, if not even better, with contextualized ad hoc alternatives of the variety in (56) as with generalized lexical alternatives (see Katsos and Bishop 2009). All of this taken together supports the view that implicatures are contextualized, in line with the present approach.

On top of empirical arguments, there are also conceptual arguments in favor of the contextualist position. The main advantage of the present game theoretic approach in this respect is that we have very rich and explicit context models. Obviously, games can model very fine distinctions both in the beliefs of interlocutors as well as in the preferences of individual agents. This can be relevant for linguistic interpretation in diverse ways. For instance, under normal circumstances the answer to a question like in (57) is interpreted exhaustively as implicating that Bill did not come, but the answer to a question like that in (58) is not.

(57)  a. Who, of John, Bill and Mary, came to the party?
   b. John and Mary did.
   c. \(\sim\) Bill did not.

(58)  a. Where can I get an Italian newspaper?
   b. At the reception.
   c. \(\not\sim\) Not at the airport.
The reason for this difference in interpretation of answers intuitively lies in the relevance that certain information has for the questioner based on a practical decision he faces (see van Rooij 2003b). To account for the structural commonalities and differences of cases (57) and (58), models that represent an agent’s individual preferences in a goal-oriented setting are advantageous if not necessary. A detailed representation of individual preferences thus pins down what exactly is relevant for the conversationalists, independent of lexicalized scales (cf. Benz 2007). The crucial point is that rational choice models not only always incorporate a notion of relevance, but also reduce it in a natural way to individual preferences.\footnote{A further advantage of this is that a preference for informativity, as postulated in Grice’s Maxim of Quantity and upheld by the Neo-Griceans, falls out as a special case in preference-based approaches, just as it should. This argument is presented by Bernardo (1979) in the abstract, and by van Rooij (2004c) in the context of natural language interpretation.}

Moreover, games as context models not only include the preferences of single agents, but crucially those of all discourse participants. This lets us model different levels of partial alignment or divergence of preferences of multiple agents. Grice’s assumption of cooperation in conversation is easily integrated as a special case, but it is clear that the representative power of games provides much more generality. Game models let us represent arbitrary constellations of partially cooperative, partially adversary discourses. Predictions are not confined to cooperation only—as in traditional Gricean approaches—or to argumentation only—as for instance in the work of Ducrot (1973), Anscombe and Ducrot (1983) and Merin (1999)—and this makes gtp of the current variety much more general and systematically applicable than other approaches (see also van Rooij 2004a; Benz 2006; Franke et al. to appear, as well as section 2.5).

In sum, the present gtp approach is a very flexible, but nonetheless rigorous, contextualist approach to pragmatic inferences. Both on-the-fly context-dependent reasoning as well as sentence interpretation in generic contexts can be accommodated in a uniform theory that is backed up by both empirical evidence as well as conceptual considerations.

**Naturalistic or Normative.** A final issue, squarely related to the distinction between default and contextual accounts, is whether the present approach understands itself as a naturalistic description of actual reasoning about language or rather as a normative prescription of how we ought to reason. At first glance, the ibr model has elements of both, and which interpretation is
most plausible may seem to depend on the intended application.

My preferred view on the matter certainly showed in the way I have applied the model so far. I take it that the IBR model aims to explain actual linguistic competence and not necessarily performance with all conceivable interferences factored in. Still, I would like to think of the IBR model as a descriptive, not a prescriptive approach. This is because I tend to think of the model as an account of idealized reasoning behavior, rather than as a full-fledged performance model, despite the fact that the IBR model as such includes certain natural restrictions on reasoning competence, such as the focality of conventional meaning or a tendency towards unbiased belief formation. The IBR model thus seeks to balance a formally rigorous and predictive approach in the vein of the Neo-Griceans with the cognitive realism advocated by relevance theorists: it tries to explain pragmatic competence as rational inference given further psychologically plausible assumptions about the cognitive architecture of reasoners.

This is also to say that I vehemently reject any commitment to the absurd notion that every time a proficient speaker of English grasps, say, a free choice inference, she has gone consciously through exactly the calculation the IBR model offers for this inference. In particular, although in derivations of implicatures I have mostly consulted the limit prediction of the IBR model, I am only committed to the idea that proficient language users are in principle able to carry out such intricate higher-order theory of mind reasoning steps, not that they actually perform these as a conscious reasoning process every time anew. Empirical research suggests that in certain domains and under certain conditions taking other people’s perspective into account may happen immediately and automatically (cf. Hanna et al. 2003; Heller et al. 2008), but such processes also seem costly (Keysar et al. 2003). So the IBR model may better be conceived of as a model of perhaps subconscious optimization in production and interpretation that requires competence of higher-order theory of mind reasoning, but not necessarily repeated execution thereof once a piece of pragmatic competence is mastered. The next chapter also furthermore addresses issues of perspective-taking in language use and moreover the acquisition of pragmatic competencies in language learners whose TOM capabilities might not yet match adult competence.