Inquisitive Semantics and Pragmatics

Jeroen Groenendijk & Floris Roelofsen

ILLC/Department of Philosophy
Universiteit van Amsterdam
http://www.illc.uva.nl/inquisitive-semantics

Abstract. This paper starts with an informal introduction to inquisitive semantics. After that, we present a formal definition of the semantics, and introduce the basic semantic notions of inquisitiveness and informativeness, in terms of wich we define the semantic categories of questions, assertions, and hybrid sentences.

The focus of this paper will be on the logical pragmatical notions that the semantics gives rise to. We introduce and motivate inquisitive versions of principles of cooperation, which direct a conversation towards enhancement of the common ground. We define a notion of compliance, which judges relatedness of one utterance to another, and a notion of homogeneity, which enables quantitative comparison of compliant moves. We end the paper with an illustration of the cooperative way in which implicatures are established, or cancelled, in inquisitive pragmatics.

Keywords: inquisitiveness, informativeness, common ground, compliance.

1 Mission Statement

Traditionally, the meaning of a sentence is identified with its informative content. In inquisitive semantics, a sentence is not only associated with the information it provides, but also with the issues it raises. The notion of meaning embodied by inquisitive semantics directly reflects that the primary use of language is communication: the exchange of information in a cooperative process of raising and resolving issues.

The way in which inquisitive semantics enriches the notion of meaning also changes our perspective on logic. In the logic that comes with the semantics, the central notion is the notion of compliance. Compliance is concerned with what the utterance of a sentence contributes to a conversation, how it is related to what was said before. Just as the standard logical notion of entailment rules the validity of argumentation, the logical notion of compliance rules the coherence of dialogue.

The way in which inquisitive semantics enriches the notion of meaning will also change our perspective on pragmatics. The main objective of Gricean pragmatics is to explain aspects of interpretation which are not directly dictated by semantic content, in terms of general features of rational human behaviour. Since inquisitive semantics changes the notion of semantic content, pragmatics will change with it. Implicatures will not only arise from the informative content of a sentence, but also from its inquisitive content.

2   Getting the Picture

The primary aim of inquisitive semantics is to develop a notion of meaning which directly reflects that the primary use of language lies in the interactive process of exchanging information in a cooperative conversation.

The classical notion of meaning embodies the informative content of sentences, and thereby reflects the descriptive function of language. Stalnaker (1978) gave this informative notion a dynamic and conversational twist by taking the meaning of a sentence to be its potential to change the common ground, where the common ground is viewed as a body of shared information as it has been established in a conversation.

What is implicit in the picture of meaning that resulted from this 'dynamic turn' is that the goal of cooperative informative discourse is to enhance the common ground. And one can view this against the background of the human need for a common ground to be able to perform coordinated action.Thus, the *active* use of language in *changing* information is reflected in the dynamic notion of meaning. However, what it does not yet capture is the *interactive* use of *exchanging* information. This requires yet another turn, an 'inquisitive turn', leading to a notion of meaning that directly reflects the nature of informative dialogue as a cooperative process of raising and resolving issues.

2.1   Propositions as Proposals

We follow the standard practice of referring to the meaning of a sentence as the proposition that it expresses. The classical logical-semantical picture of a proposition is a set of possible worlds, those worlds that are compatible with the information that the sentence provides. The common ground is also standardly pictured as a set of worlds, those worlds that are compatible with the conversational participants' common beliefs and assumptions. The communicative effect of a sentence, then, is to enhance the common ground by excluding certain worlds, namely those worlds in the common ground that are not included in the proposition expressed by the sentence.

Of course, this picture is limited in several ways. First, it only applies to sentences which are used exclusively to provide information. Even in a typical informative dialogue, utterances may serve different purposes as well. Second, the given picture does not take into account that enhancing the common ground is a cooperative process. One speech participant cannot simply change the common ground all by herself. All she can do is *propose* a certain change. Other speech participants may react to such a proposal in several ways. These reactions play a crucial role in the dynamics of conversation.

In order to overcome these limitations, inquisitive semantics starts with an altogether different picture. It views propositions as proposals to enhance the common ground. These proposals do not always specify just one way of changing the common ground. They may suggest alternative ways of doing so, among which the responder is then invited to choose.

Formally, a proposition consists of one or more *possibilities*. Each possibility is a set of possible worlds—a set of *indices*, as we will call them—and embodies a possible way to change the common ground. If a proposition consists of two or more possibilities, it is *inquisitive*: it invites the other participants to respond in a way that will lead to a cooperative choice between the proposed alternatives. In this sense, inquisitive propositions raise an issue. They give direction to a dialogue. Purely informative non-inquisitive propositions do not invite other participants to choose between different alternatives. But still, they are proposals. They do not automatically establish a change of the common ground.

Thus, the notion of meaning in inquisitive semantics is directly related to the interactive proces of exchanging information. Propositions, conceived of as proposals, give direction to this process. Changes of the common ground come about by mutual agreement among speech participants.

2.2   Two Possibilities for Disjunction

An inquisitive semantics for the language of propositional logic has been specified and studied in detail (cf. Groenendijk, 2008b; Mascarenhas, 2009; Ciardelli and Roelofsen, 2009). The crucial aspect of this semantics is the interpretation of *disjunction*. To see how the inquisitive treatment of disjunction differs from the classical treatment, consider figure 1 below.
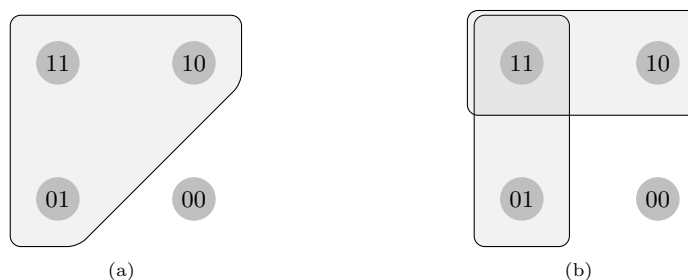

Fig. 1. (a) the traditional and (b) the inquisitive picture of $p \vee q$

Figure 1(a) depicts the traditional proposition associated with $p \vee q$, consisting of all indices in which either p or q, or both, are true (in the picture, 11 is the index in which both p and q are true, 10 is the index in which only p is true, etcetera). Figure 1(b) depicts the proposition associated with $p \vee q$ in inquisitive semantics. It consists of two possibilities. One possibility is made up of all indices in which p is true, and the other of all indices in which q is true.

Thus, $p \vee q$ is inquisitive. It invites a response which is directed at chosing between two alternatives. On the other hand, $p \vee q$ also proposes to exclude one index, namely the index in which both p and q are false. This illustrates two things: first, that $p \vee q$ is informative, just as in the classical analysis, and

second, that, unlike in the classical analysis, sentences can be informative and inquisitive at the same time. We call such sentences *hybrid* sentences.

2.3   Non-inquisitive Closure and Negation

The classical proposition in figure 1(a) is non-inquisitive: it consists of a single possibility, which is the union of the two possibilities in the inquisitive proposition in figure 1(b). In general, the non-inquisitive proposition that is classically expressed by a sentence φ is expressed in inquisitive semantics by the *non-inquisitive closure* $!\varphi$ of φ. The proposition expressed by $!\varphi$ always consists of a single possibility, which is the union of the possibilities for φ. In particular, the proposition depicted in figure 1(a) is expressed by $!(p \vee q)$.

The non-inquisitive closure operator, $!$, is not a basic operator in the language, but is defined in terms of negation. The propositon expressed by a negation $\neg\varphi$ is taken to contain (at most) one possibility, which consists of all the indices that are not in any of the possibilities for φ, i.e., the indices that are not in the union of the possibilities for φ. Hence the proposition expressed by $\neg\neg\varphi$ will always contain (at most) one possiblity, consisting exactly of the indices that are in the union of the possibilities for φ. Thus, $!\varphi$ can be defined as $\neg\neg\varphi$.

Notice that it follows from this analysis of negation that $\neg\neg\varphi$ and φ are not fully equivalent. They are from a purely informative perspective in that $\neg\neg\varphi$ and φ always exclude the same possibility, but whereas φ can be inquisitive, $\neg\neg\varphi$ never is. That is why $!\varphi$ is called the non-inquisitive closure of φ.

2.4   Questions

As a consequence of the inquisitive treatment of disjunction, a classical tautology like $p \vee \neg p$ is associated with two possibilities as well: the possibility that p and the possibility that $\neg p$. This means that in inquisitive semantics, $p \vee \neg p$ can be taken to express the polar question *whether p*. It turns out that this observation does not only apply to atomic sentences, but also to more complex sentences. So, in general, a non-informative sentence $\varphi \vee \neg\varphi$ can express a question, adding the possibility that $\neg\varphi$ as an alternative to the possibility or possibilities for φ, and is therefore abbreviated as $?\varphi$.

One important empirical issue that has partly driven the development of inquisitive semantics so far is the analysis of *conditional* questions (e.g., *If Alf comes to the party, will Bea come as well?*). It is problematic for classical analyses of questions (Hamblin, 1973; Karttunen, 1977; Groenendijk and Stokhof, 1984) to predict that the answers to a conditional question $p \rightarrow ?q$ are $p \rightarrow q$ (*yes, if Alf comes, Bea will come as well*) and $p \rightarrow \neg q$ (*no, if Alf comes, Bea won't come*) (cf. Velissaratou, 2000; Isaacs and Rawlins, 2008). In inquisitive semantics, this prediction is straightforwardly obtained by the interaction of the inquisitive interpretation of disjunction and the interpretation assigned to conditional sentences. Figure 2 depicts the inquisitive treatment of a polar question, $?p$, and a conditional question, $p \rightarrow ?q$.
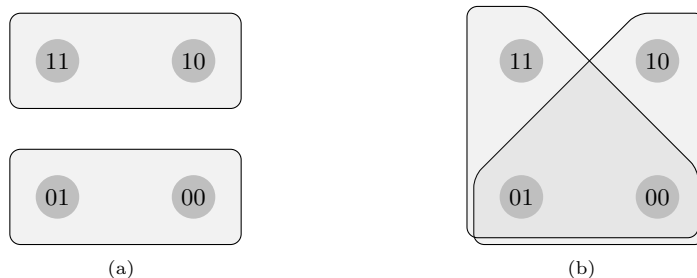
Fig. 2. (a) the polar question $?p$ and (b) the conditional question $p \rightarrow ?q$

2.5 Alternatives

Inquisitive propositions are taken to be sets of *alternative* possibilities. The significance of alternatives is widely recognized in semantics and pragmatics. For instance, sets of alternatives have been argued to play a crucial role in the analysis of focus (cf. Rooth, 1985), and in the treatment of indefinites and disjunction (cf. Kratzer and Shimoyama, 2002; Alonso-Ovalle, 2006).

What is new about inquisitive semantics is that it puts the inquisitive aspect of meaning directly at the heart of the notion of semantic content, and does not treat it as a collateral feature. The new conception of propositions as proposals, and the shift to a conversation oriented logic that it brings along, provide philosophical and mathematical foundations for research in the above-mentioned linguistic traditions, and may pave the way for more extensive applications.

2.6 A Hierarchy of Alternativehood

A question that has played a fundamental role in the development of inquisitive semantics is when two or more possibilities should count as alternatives. We have moved from a very strict notion of alternatives as sets of mutually exclusive possibilities (blocks in a partition), via intermediate notions, to a rather weak notion where a set of possibilities counts as a set of alternatives iff it is not the case that one of the possibilities is included in another. This means, in particular, that alternative possibilities may overlap in quite dramatic ways. For instance, not only the possibilities in figure 1 and figure 2 above count as alternatives, but also those in figure 3 below.

In the order in which these pictures are presented in figure 2 and 3, they exemplify increasingly weaker notions of alternativehood. This 'hierarchy' of alternativehood appears to be relevant in several respects. First, as propositions correspond to weaker alternatives, they are less straightforwardly expressible in natural language. Second, a process of 'alternative strengthening' seems to play an important role in a range of semantic and pragmatic phenomena. Informal observations of this kind have been made in the literature from time to time (cf. Zimmermann, 2000). Inquisitive semantics might provide a principled explanation of these phenomena.
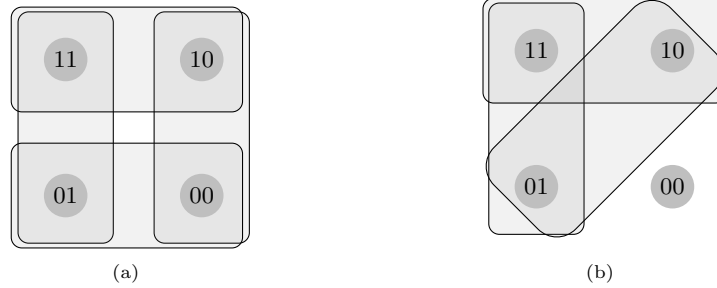
Fig. 3. Alternative possibilities with a high degree of overlap.

3 Inquisitive Semantics

In this section we define an inquisitive semantics for a propositional language, which is based on a finite set of propositional variables, and has $\neg$, $\wedge$, $\vee$, and $\to$ as its basic logical operators. We add two non-standard operators: ! and ?. $!\varphi$ is defined as $\neg\neg\varphi$, and $?\varphi$ is defined as $\varphi \vee \neg\varphi$. $!\varphi$ is called the *non-inquisitive closure* of φ, and $?\varphi$ is called the *non-informative closure* of φ.

3.1 Indices, Possibilities, and Propositions

The basic ingredients for the semantics are *indices* and *possibilities*. An index is a binary valuation for the atomic sentences in the language. A possibility is a non-empty set of indices. We use v as a variable ranging over indices, and denote the set of all indices by ω. We use α, β as variables ranging over possibilities, and $\mathcal{P}$ as a variable ranging over sets of possibilities. Note that since α and β are always non-empty, $\alpha \subseteq \beta$ implies that α is a non-empty subset of β.

The sentences of the language are interpreted as sets of *alternative possibilities*. Two possibilities count as alternatives if the one is not properly included in the other.

Definition 1 (Propositions).
$\mathcal{P}$ *is a* proposition *iff for all $\alpha \in \mathcal{P}$, there is no $\beta \in \mathcal{P}$ such that $\alpha \subset \beta$.*

We introduce as an auxiliary notion a function ALT which has as its domain all sets of possibilities, and as its range the set of propositions. ALT restricts a set of possibilities $\mathcal{P}$ to those possibilities in $\mathcal{P}$ that are not included in any other possibility in $\mathcal{P}$. This yields a set of alternative possibilities, i.e., a proposition.

Definition 2 (Alternative Closure).
ALT $\mathcal{P} = \{\alpha \in \mathcal{P} \mid$ *for no $\beta \in \mathcal{P}$: $\alpha \subset \beta\}$*

The notion of the proposition expressed by a sentence φ is denoted by $\lfloor \varphi \rfloor$, and is recursively defined as follows.

Definition 3 (Propositional Inquisitive Semantics).

1. $\lfloor p \rfloor = \text{ALT}\,\{\alpha \subseteq \omega \mid \forall v \in \alpha \colon v(p) = 1\}$
2. $\lfloor \neg\varphi \rfloor = \text{ALT}\{\alpha \subseteq \omega \mid \forall \beta \in \lfloor \varphi \rfloor : \alpha \cap \beta = \emptyset\}$
3. $\lfloor \varphi \vee \psi \rfloor = \text{ALT}\,\{\alpha \subseteq \omega \mid \exists \beta \in \lfloor \varphi \rfloor \colon \alpha \subseteq \beta \ or \ \exists \beta \in \lfloor \psi \rfloor \colon \alpha \subseteq \beta\}$
4. $\lfloor \varphi \wedge \psi \rfloor = \text{ALT}\,\{\alpha \subseteq \omega \mid \exists \beta \in \lfloor \varphi \rfloor \colon \alpha \subseteq \beta \ and \ \exists \beta \in \lfloor \psi \rfloor \colon \alpha \subseteq \beta\}$
5. $\lfloor \varphi \to \psi \rfloor = \text{ALT}\,\{\alpha \subseteq \omega \mid \forall \beta \in \lfloor \varphi \rfloor \colon \exists \gamma \in \lfloor \psi \rfloor \colon \alpha \cap \beta \subseteq \gamma\}$

This definition assures that $\lfloor \varphi \rfloor$ is always a set of alternative possibilities, i.e., a proposition. We call the possibilities in $\lfloor \varphi \rfloor$ the possibilities *for* φ. If $\lfloor \varphi \rfloor = \emptyset$, we say that there is no possibility for φ. Furthermore, we make a distinction between *classical* and *inquisitive* sentences.

Definition 4 (Classical and Inquisitive Sentences).

1. φ is classical *iff $\lfloor \varphi \rfloor$ contains at most one possibility;*
2. φ is inquisitive *iff $\lfloor \varphi \rfloor$ contains at least two possibilities.*

We will now consider the clauses of definition 3 one by one. We will see that inquisitive semantics is a natural generalization of the classical semantics of propositional logic. The examples displayed in figure 4—most of which were already discussed informally in section 2—will be used to illustrate the behavior of some of the logical operators.

Atoms. To determine the proposition expressed by an atomic sentence p, we first collect all the possibilities $\alpha \subseteq \omega$ which only contain indices that make p true. Then we apply ALT to turn this set of possibilities into a proposition. This will always yield a set containing just *one* possibility: the possibility consisting of *all* indices that make p true. So an atomic sentence is always classical.

Negation. To determine the proposition expressed by $\neg\varphi$, we first collect all possibilities that do not overlap with any possibility for φ. Then we apply ALT again, to turn this set of possibilities into a proposition. If $\lfloor \varphi \rfloor$ covers the whole logical space ω, then $\lfloor \neg\varphi \rfloor$ will be empty: there will be no possibilities that do not overlap with any possibility for φ. If $\lfloor \varphi \rfloor$ does *not* cover ω, then $\lfloor \neg\varphi \rfloor$ will contain exactly one possibility, consisting of all indices that do not belong to any possibility for φ. So negated sentences, like atomic sentences, are always classical.

Disjunction. To determine the proposition expressed by a disjunction $\varphi \vee \psi$ we first collect all possibilities that are contained in some possibility for φ or in some possibility for ψ, and then apply ALT to turn this set of possibilities into a proposition. This procedure always yields a proposition consisting of all possibilities for φ that are not contained in any possibility for ψ, plus all possibilities for ψ that are not contained in any possibility for φ.

Disjunctions are typically inquisitive. Figure 4(a)–4(c) give some examples: a simple disjunction of two atomic sentences $p \vee q$, a polar questions $?p$ (recall that $?p$ is defined as $p \vee \neg p$), and the disjunction of two polar questions $?p \vee ?q$.
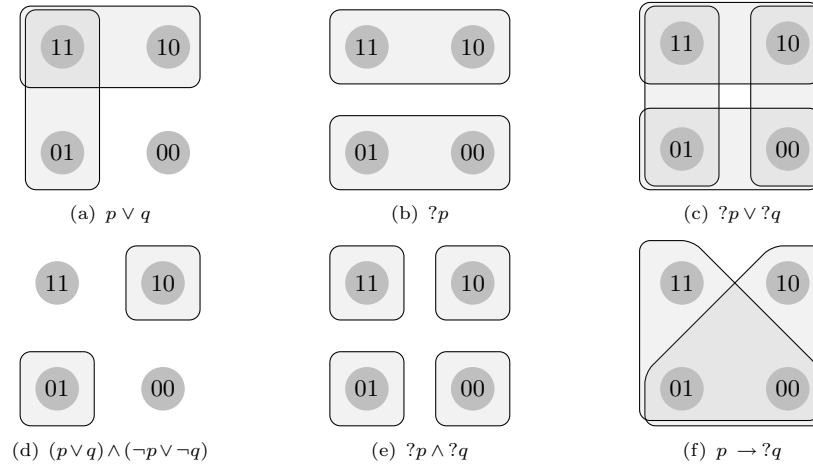
Fig. 4. Some examples of inquisitive sentences.

Conjunction. To determine the proposition expressed by a conjunction $\varphi \wedge \psi$ we first collect all possibilities that are contained in some possibility for φ and also in some possibility for ψ, and then apply ALT to turn this set of possibilities into a proposition. If φ and ψ are both classical, then conjunction amounts to intersection, just as in the classical setting. If φ and/or ψ are inquisitive, then conjunction amounts to pair-wise intersection (plus an application of ALT). Figure 4(d) and 4(e) illustrate how this works for the conjunction of two disjunctions $(p \vee q) \wedge (\neg p \vee \neg q)$ and for the conjunction of two polar questions $?p \wedge ?q$.[1]

Implication. To determine the proposition expressed by $\varphi \to \psi$, we first collect all possibilities α such that the intersection of α with any possibility for φ is contained in some possibility for ψ. Then we apply ALT to turn this set of possibilities into a proposition. If the consequent ψ is classical, then $\varphi \to \psi$ behaves just as it does in the classical setting: in this case, $\lfloor \varphi \to \psi \rfloor$ contains a single possibility, consisting of all indices that make ψ true or φ false.

If the consequent ψ is inquisitive, then $\varphi \to \psi$ may be inquisitive as well. Figure 4(f) shows what this amounts to for a conditional question $p \to ?q$. When φ and ψ are both inquisitive, then unlike in case the consequent is classical,

---

[1] The clauses for disjunction and conjunction could also be formulated as follows:

$$\lfloor \varphi \vee \psi \rfloor = \text{ALT}\,(\lfloor \varphi \rfloor \cup \lfloor \psi \rfloor)$$
$$\lfloor \varphi \wedge \psi \rfloor = \text{ALT}\,\{\alpha \cap \beta \mid \alpha \in \lfloor \varphi \rfloor \text{ and } \beta \in \lfloor \psi \rfloor\}$$

We used the slightly more complex formulation in definition 3 in order to show that disjunction and conjunction can be defined in a parallel fashion. These alternative formulations, however, show that there is also a difference between the two: disjunction simply involves taking the union of the propositions expressed by the two disjuncts, while conjunction involves taking the *pair-wise* intersection of the propositions expressed by the two conjuncts.

inquisitiveness of the antecedent may have effect on the interpretation of the implication as a whole. For example, whereas $!(p \vee q) \rightarrow ?r$ is a polar conditional question for which there are two possibilities corresponding to $(p \vee q) \rightarrow r$ and $(p \vee q) \rightarrow \neg r$, the proposition expressed by $(p \vee q) \rightarrow ?r$ contains two more possibilities which correspond to $(p \rightarrow r) \wedge (q \rightarrow \neg r)$ and $(p \rightarrow \neg r) \wedge (q \rightarrow r)$. There is more to say about implication, but that would take us too far astray from the central concern of this paper (see, for instance, Groenendijk, 2009).

3.2 Truth-sets and Excluded Possibilities

The *truth set* of φ, denoted $|\varphi|$, is the set of indices where φ is classically true. The proposition expressed by φ can be thought of as the meaning of φ in an inquisitive setting, while the truth-set of φ is what is taken to be the meaning of φ in a classical setting. Notice that $|\varphi|$ is always identical to the *union* of all the possibilities in $\lfloor\varphi\rfloor$ (if there are any; otherwise $|\varphi| = \lfloor\varphi\rfloor = \emptyset$). Thus, as in the classical setting, $|\varphi|$ embodies the informative content of φ: someone who utters φ proposes to eliminate all indices that are not in $|\varphi|$ from the common ground. This brings us to the notion of a possibility that is *excluded* by a sentence φ.

Definition 5 (Excluded Possibilities).

1. φ excludes a possibility α iff $\alpha \cap |\varphi| = \emptyset$
2. $\lceil\varphi\rceil = \text{ALT}\{\alpha \subseteq \omega \mid \alpha \cap |\varphi| = \emptyset\}$

If $\lfloor\varphi\rfloor$ covers the whole logical space, then $|\varphi| = \omega$. In this case, φ does not exclude any possibility, $\lceil\varphi\rceil = \emptyset$. If $\lfloor\varphi\rfloor$ does *not* cover the whole logical space, then $|\varphi| \neq \omega$. In this case, $\lceil\varphi\rceil$ always contains exactly one possibility, consisting of all indices that are not in $|\varphi|$. So $\lceil\varphi\rceil$, like $\lfloor\varphi\rfloor$ and unlike $|\varphi|$, is not a single possibility but a *set* of possibilities. However, unlike $\lfloor\varphi\rfloor$, $\lceil\varphi\rceil$ contains *at most one* possibility.

The semantics for $\neg$, $?$, and $!$ can be stated in a transparent way in terms of excluded possibilities (recall that $!\varphi$ was defined as $\neg\neg\varphi$ and $?\varphi$ as $\varphi \vee \neg\varphi$).

Fact 1 ($\neg$, $?$, and $!$ in terms of Exclusion).

1. $\lfloor\neg\varphi\rfloor = \lceil\varphi\rceil$
2. $\lfloor!\varphi\rfloor \ = \lceil\neg\varphi\rceil$
3. $\lfloor?\varphi\rfloor = \lfloor\varphi\rfloor \cup \lceil\varphi\rceil$

Notice that $\lfloor\varphi\rfloor \cup \lceil\varphi\rceil$ is always a proposition, i.e., a set of *alternative* possibilities: if there is a possibility $\alpha \in \lceil\varphi\rceil$, it must be disjoint from any possibility $\beta \in \lfloor\varphi\rfloor$.

3.3 Questions, Assertions, and Hybrids

We already defined a sentence φ to be inquisitive just in case $\lfloor\varphi\rfloor$ contains at least two possibilities. Uttering an inquisitive sentence is one way of making a significant contribution to a conversation. The other way in which a significant contribution can be made is by uttering an *informative* sentence.

Definition 6 (Informative Sentences).
φ is informative iff there is a possibility for φ and a possibility that φ excludes.

In terms of whether a sentence is inquisitive and/or informative or not, we characterize the following four semantic categories:

	informative	inquisitive
question	–	+
assertion	+	–
hybrid	+	+
insignificant	–	–

A *question* is inquisitive and not informative, an *assertion* is informative and not inquisitive, a *hybrid* sentence is both informative and inquisitive, and an *insignificant* sentence is neither informative nor inquisitive. Some examples are provided in figure 5.
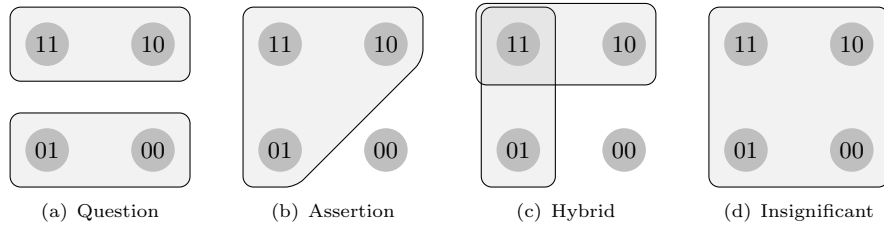

(a) Question   (b) Assertion   (c) Hybrid   (d) Insignificant

Fig. 5. One example for each of the four semantic categories.

It is a major feature of inquisitive semantics that questions and assertions are not distinguished syntactically, but are characterized semantically, next to hybrids. There is a single syntactic category of sentences in the language. In forming the disjunction of two sentences the semantic category of the resulting sentence can be different from the semantic category of either disjunct. Disjunction can turn two classical sentences into an inquisitive sentence. Negation has the opposite effect, it turns any sentence into a classical sentence.

3.4 Inquisitive Entailment

Classically, φ entails ψ iff the proposition expressed by φ is contained in the proposition expressed by ψ. In inquisitive semantics, every possibility for φ must be contained in some possibility for ψ.

Definition 7 (Entailment). $\varphi \models \psi \quad iff \quad \forall \alpha \in \lfloor \varphi \rfloor : \exists \beta \in \lfloor \psi \rfloor : \alpha \subseteq \beta$

It is immediately clear from the definition of entailment and the interpretation of implication that the two notions are, as usual, closely related:

Fact 2 (Entailment and Implication). $\varphi \models \psi \quad iff \quad \models \varphi \rightarrow \psi$

If φ and ψ are both classical sentences, then the entailment relation boils down to classical entailment. In fact it is not so difficult to see that this even holds when the antecedent of the implication is inquisitive:

Fact 3. *If ψ is classical, then $\quad \varphi \models \psi$ iff φ classically entails ψ.*

If ψ is classical, then there is at most a single possibility for ψ, which equals $|\psi|$. Then, φ entails ψ iff every possibility for φ is included in $|\psi|$. This is the case iff the union of all the possibilities for φ is included in $|\psi|$, that is, iff $|\varphi| \subseteq |\psi|$.

Fact 4. *For every sentence φ, $\quad \varphi \models !\varphi$.*

Every possibility for φ is included in the single possibility for $!\varphi$. The reverse, however, does not always hold. In particular, it does not hold if φ is inquisitive. For instance, the hybrid disjunction $p \vee q$ entails its non-inquisitive closure $!(p \vee q)$, but the reverse does not hold (this can easily be seen by inspecting figure 1).

Fact 5. *For every sentence φ, $\quad \varphi \models ?\varphi$ and $\neg\varphi \models ?\varphi$.*

The non-informative closure $?\varphi$ of a sentence φ is entailed by φ itself, by its negation $\neg\varphi$, and therefore also by its non-inquisitive closure $!\varphi$. But, whereas classically *any* sentence ψ entails $?\varphi$ (that is, $\varphi \vee \neg\varphi$), this does not hold inquisitively. For instance, $p \not\models ?q$.

If an assertion $!\varphi$ entails a question $?\psi$, then $!\varphi$ completely resolves the issue raised by $?\psi$. To some extent this means that $!\varphi \models ?\psi$ characterizes answerhood. We say to some extent since it only characterizes complete and not partial answerhood, and it is not very 'precise' in characterizing complete answerhood in that it allows for over-informative answers: if $!\varphi \models ?\psi$ and $!\chi \models !\varphi$, then also $!\chi \models ?\psi$.

For some questions, but not for all, we can characterize precise and partial answerhood in terms of entailment by saying that $!\varphi$ is an answer to $?\psi$ iff $?\psi \models ?!\varphi$. The intuition here is that $!\varphi$ is an answer to $?\psi$ just in case the polar question $?!\varphi$ behind $!\varphi$ is a subquestion of $?\psi$.

This characterization gives correct results as long as we are dealing with sentences that satisfy the strong notion of alternativehood where every two possibilities mutually exclude each other. However, given the weak notion of alternativehood adopted in inquisitive semantics, $?\psi \models ?!\varphi$ does not give us a general characterization of answerhood, and neither does $?\varphi \models ?\psi$ give us a general characterization of subquestionhood.

Problems arise as soon as we consider questions with *overlapping* possibilities. Conditional questions and alternative questions are questions of this kind. First, consider a conditional question $p \rightarrow ?q$ (*If Alf goes to the party, will Bea go as well?*). We certainly want $p \rightarrow q$ to count as an answer to this question, but $p \rightarrow ?q \not\models ?(p \rightarrow q)$. This can easily be seen by inspecting the propositions expressed by $p \rightarrow ?q$ and $?(p \rightarrow q)$, depicted in figure 6(a) and 6(b). In fact, entailment goes in the other way in this case: $?(p \rightarrow q) \models p \rightarrow ?q$.
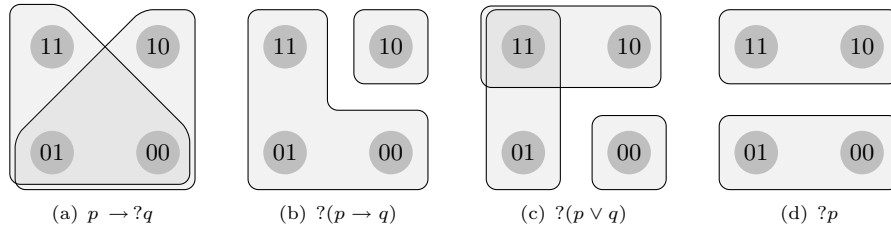
(a) $p \to ?q$ (b) $?(p \to q)$ (c) $?(p \vee q)$ (d) $?p$

Fig. 6. Questions with overlapping possibilities are problematic for characterizations of answerhood and subquestionhood in terms of entailment.

Similarly, we certainly want p to count as an answer to the alternative question $?(p \vee q)$ (*Does* ALF *or* BEA *go to the party?*). But $?(p \vee q) \not\models ?p$, as can be seen by comparing figure 6(c) and 6(d).

This does not mean that there is anything wrong with the entailment relation as such. It does what it should do: provide a characterization of meaning-inclusion. As noted above, entailment between an assertion and a question means that the assertion fully resolves the issue raised by the question, and entailment between two questions $?\varphi$ and $?\psi$ means that the issue raised by $?\psi$ is fully resolved whenever the issue raised by $?\varphi$ is.

At the same time, given that entailment does not lead to a general notion of answerhood and subquestionhood, we surely are in need of a logical notion that does characterize these relations. The notion of *compliance*, to be defined in section 5, will—among other things—fulfil this role.

4   Inquisitive Information Exchange

The previous two sections were concerned with inquisitive semantics. We now turn to pragmatics. The present section offers an informal analysis of the regulative principles that underlie human behavior in conversation. Section 5 will develop the logical tools that are necessary to capture these principles, and section 6 will illustrate how inquisitive pragmatics can be used to explain certain well-known, but ill-understood pragmatic inferences.

It will be clear that our analysis is very much in the spirit of (Grice, 1975). However, there are also important differences between our framework and that of Grice. Inquisitiveness is, of course, the main source of these differences.

4.1   Maintain Your Information State!

One primary use of language—and the only one we are interested in here—is to exchange information through conversation. To analyze this process in more detail, we first of all assign an *information state* to each conversational participant. The simplest and most standard way to model such a state is as a set of indices, where each index represents a possible way the world may be

according to the participant. So, states are of the same nature as possibilities, and as we did for possibilities, we take states to be *non-empty* sets of indices. That is, we assume information states to be consistent.

We think of the information state of each participant as embodying what that participant *takes himself to know*,[2] and we assume that every participant is *aware* of what he takes himself to know.

To *update* a state with new information is to *eliminate indices* from it. The amount of information increases as the number of indices in a state decreases.

We assume that, in the process of exchanging information, all participants in a conversation make sure to *maintain their own information state*, and assume each other to do so.

Each participant makes sure that, at all times, his information state does indeed embody what he takes himself to know. This means, in particular, that he may not update his state with information that is inconsistent with what he already takes himself to know. Doing so would eliminate all indices from his information state. This should never happen. Every participant must be sure to maintain a consistent state.

4.2   Trust and be Truthful!

When entering a conversation with the purpose of exchanging information, you should be prepared to *trust* the quality of the information communicated by others, although you are aware of the fact that just like your own information, the information of others might eventually turn out to be incorrect. Adopting new information might deteriorate your state. But that's all in the game of information exchange. Don't enter the game if you don't dare to take a risk.

We will not, and cannot, set limits to how far trust should go, except that the requirement to maintain your own information state dictates that you will never go as far as to trust information that goes against what you already take yourself to know.

For a proper balance between the threat of deterioration and the prospect of enhancement of your state, your trust should be met by *truthfulness* on part of the others. That is, you should be able to expect that other participants only communicate information that they take themselves to know.

Fortunately, this delicate balance holds for everyone involved in a conversation. So, to make a long story short, in the end, to trust and be truthful is the only rational thing for everyone to do (cf. Lewis, 1969).

---

[2] One important simplification here is that we do not distinguish between different types of information, such as *direct information* obtained by observation, *indirect information* obtained by reasoning, *information from hearsay*, obtained by conversation, etc. The significance of these distinctions is reflected by the fact that in many languages, sentences are obligatorily marked by so-called *evidentials* in order to communicate what kind of information is involved (cf. Murray, 2009).

4.3 Maintain the Common Ground!

In line with standard practices, we take the *common ground of a conversation* to be the body of information that has been established by the conversation so far (cf. Stalnaker, 1978). The common ground is modeled as an information state, only it is not *private* to one of the participants, but *public* to all of them.

The *initial* common ground of a conversation is ω, the state in which no information has been established yet. Every time an informative sentence is uttered, the common ground is updated with the information provided, unless one of the participants objects to this update (for instance, because the given information is inconsistent with his own information state). In this way, the common ground gradually comes to embody more and more information.

The information embodied by the common ground is supposed to be *common information*. That is, if some piece of information is supported by the common ground, then it should also be supported by the state of every individual participant. In terms of indices, if an index has been eliminated from the common ground, then it should also be absent from each individual information state. Certainly, this is true for the initial common ground ω. It is the common responsibility of all participants that it remains true throughout the conversation.

It follows from this requirement that all participants should be truthful. If one participant would untruthfully convey some piece of information, and none of the other participants would protest, then the common ground would be updated with the information provided, which is not supported by the state of the untruthful participant. Hence, the common ground would no longer embody common information. Some indices would be removed from the common ground, but remain present in the information state of the untruthful participant.[3]

If all participants are required to maintain the common ground, it also follows that, if one participant conveys a certain piece of information, then every other participant should either update his own state with the information provided, or publicly announce that he is not willing to do so. For suppose that one participant would not update his state with the information provided, and would also refrain from publicly announcing his unwillingness to do so. Then the common ground would be updated with the given piece of information, but the state of the unwilling participant would not be. As a result, the common ground would no longer embody common information. Some indices would be eliminated from the common ground, but remain present in the information state of the unwilling participant.

In particular, this means that if the information provided by one participant is inconsistent with the state of another participant, then that other participant should publicly announce that he is unwilling to update with the information provided (updating would force him to give up his state).

---

[3] Note that the untruthful participant cannot update his state with the given information, because if he did, the state would no longer be in accordance with what he takes himself to know. This breaches the maxim *Maintain your Information State!*.

4.4 The Internal Common Ground

We will sometimes refer to the common ground of a conversation as the *external* common ground, in order to explicitly distinguish it from another notion of common information which we will refer to as the *internal* common ground. The internal common ground is the *union* of all the individual information states. Thus, the internal common ground is itself a state, embodying what every participant in the conversation takes himself to know.[4]

The internal common ground differs from the external common ground in that it usually contains common information of which the participants are *not aware* that they have it in common. Such 'unconscious' common information is rather useless in that, for instance, it cannot form a basis for coordinated action. On the other hand, the common information that is embodied by the external common ground has been established by the conversation. Every participant will therefore be aware that this information is indeed common information.

Figure 7 illustrates how the external common ground, the internal common ground, and the individual participants' information states are related. If the external common ground is carefully maintained, then every individual state will be contained in it. In this case, the internal common ground, which is the union of all individual states, will also be contained in the external common ground. Each individual participant is aware of the boundaries of his own information state and those of the external common ground. In general, however, he will be in the dark about the information states of the other participants and about the internal common ground.

external common ground

internal common ground
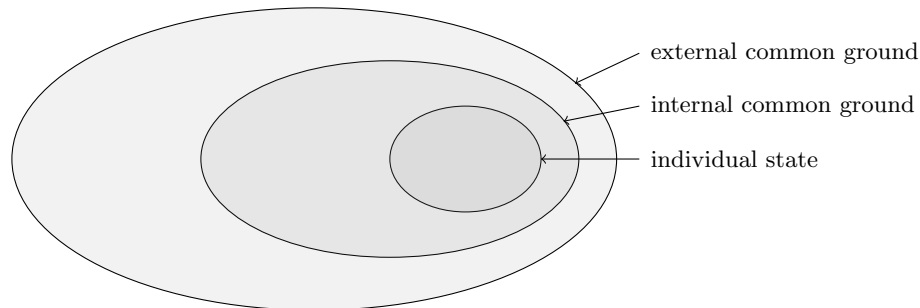
individual state

Fig. 7. An individual information state, the internal, and the external common ground.

---

[4] Gerbrandy (1999) discusses the distinction between the external and internal common ground in detail. He shows that the two notions can only be appropriately connected if (i) information states do not contain 'higher order information', that is, information of one participant about the information states of others; and (ii) operations on states do not involve revision of information.

4.5 Enhance the Common Ground!

The main purpose of a conversation—at least, of the type of conversation we are interested in here—is to exchange information, typically in order to (i) satisfy the informational needs of some of the individual participants, and/or (ii) to establish common information that is needed for coordinated action. Whatever the external goals of the conversation may be (personal information needs and/or a basis for coordinated action), the participants will always have to cooperatively *enhance the common ground* in order to achieve these goals.

Ideally, each conversational move either sets a new goal, or contributes to achieving goals that have been set previously. To set a new goal is to raise a new issue. Any move that does not set a new goal should contribute to enhancing the common ground in such a way that at least one of the existing issues may be resolved. One way to do so is to directly provide information that (partially) resolves one of the issues. If this is not possible, however, a conversational move may still make a significant contribution, namely by replacing one of the existing issues by an easier to answer sub-issue. That is, one way to contribute to achieving a given goal is to set an appropriate sub-goal.

In order to achieve a basis for coordinated action, it is not only necessary to establish common information, but also to ascertain that all participants are *aware* that this information is indeed common information. This can only be achieved by enhancing the external common ground.

In order to satisfy the personal information needs of some particular participant, it would in principle suffice to enhance the information state of that participant. However, in order to achieve this in a coordinated fashion, it is again crucial that the external common ground is enhanced. This is the only information state that is publicly accessible and manipulable by all participants.

The maxims discussed above are all subservient to the general desire to enhance the common ground. Clearly, the common ground cannot be enhanced if it is not maintained properly, and we have already seen that maintainance requires truthfulness. Trust is also essential, because if the participants refuse to trust each other, enhancement of the common ground is clearly impossible. Finally, a minimal requirement for cooperative information exchange is that every participant maintains his own information state. Thus, the fundamental driving force behind all these maxims is the joint desire to enhance the common ground.

5 Inquisitive Logic and Conversation

The previous section provided an informal analysis of the regulative principles underlying human behavior in conversation. We now turn to the central logical notions of inquisitive pragmatics, which are intended to capture the essential features of these regulative principles.

5.1 Basic Logical Notions

The first step to take is to relativize propositions to information states. The proposition expressed by a sentence φ relative to a state σ is denoted by $\sigma\lfloor\varphi\rfloor$.

It is obtained by *restricting* each possibility for φ to σ, and then applying ALT in order to obtain a proposition. Parallel to $\sigma\lfloor\varphi\rfloor$ we also define $\sigma\lceil\varphi\rceil$.

Definition 8 (Relative Propositions and Exlusion-Sets).

1. $\sigma\lfloor\varphi\rfloor = \text{ALT}\,\{\alpha \subseteq \omega \mid \exists\beta \in \lfloor\varphi\rfloor : \alpha = \sigma \cap \beta\}$
2. $\sigma\lceil\varphi\rceil = \text{ALT}\,\{\alpha \subseteq \omega \mid \exists\beta \in \lceil\varphi\rceil : \alpha = \sigma \cap \beta\}$

Notice that the restriction of a possibility β to a state σ amounts to taking the intersection $\sigma \cap \beta$. Recall that α ranges over possibilities, i.e., non-empty sets of indices. Therefore, it can only be the case that $\alpha = \sigma \cap \beta$ if $\sigma \cap \beta$ is non-empty. This ensures that $\sigma\lfloor\varphi\rfloor$ and $\sigma\lceil\varphi\rceil$ are always sets of possibilities.

Next, we define relative notions of inquisitiveness and informativeness (the corresponding 'absolute' notions were already introduced in section 3).

Definition 9 (Relative Inquisitiveness and Informativeness).

1. φ is inquisitive in σ *iff there are at least two possibilities for φ in σ;*
2. φ is informative in σ *iff there is a possibility for φ in σ and a possibility is excluded by φ in σ.*

When we take the notions of informativeness and inquisitiveness defined here relative to ω, they coincide with the absolute notions defined in section 3.

Apart from inquisitiveness and informativeness, we distinguish the following properties that a sentence φ may have relative to a state σ:

If $\sigma\lfloor\varphi\rfloor = \{\sigma\}$, then φ embodies a proposal that is *void* in σ. In this case we say that φ is *supported* by σ.[5] The other extreme occurs when $\sigma\lfloor\varphi\rfloor = \emptyset$. This means that φ embodies a proposal that is *inconsistent* with σ. In this case, we say that φ is *unacceptable* in σ. Finally, we distinguish between sentences that *exclude* a possibility in σ and sentences that do not. If φ excludes a possibility in σ, we say that it is *eliminative* in σ.

Definition 10 (Support, Acceptability, and Eliminativity).

1. φ is supported by σ *iff the only possibility for φ in σ is σ itself;*
2. φ is unacceptable in σ *iff there is no possibility for φ in σ;*
3. φ is eliminative in σ *iff φ excludes a possibility in σ;*

---

[5] Incidentally, the notion of support is often taken to be the basic notion in inquisitive semantics. In (Groenendijk, 2008b) and (Ciardelli and Roelofsen, 2009) for instance, support is defined recursively, and the proposition expressed by φ is then defined indirectly, as the set of $\subseteq$-maximal possibilities supporting φ. In the present paper we approach things from the other direction. We recursively defined the proposition expressed by a sentence, and now define support in terms of that. Both strategies have their advantages.

Taking the notions of support and acceptability relative to ω allows us to distinguish two kinds of insignificant sentences: *contradictions*, sentences that are unacceptable in ω, and *tautologies*, sentences that are supported by ω.

The notion of support can also be formulated in terms of inquisitiveness and eliminativity.

Fact 6 (Support, Inquisitiveness, and Eliminativity).
φ is supported by σ iff φ is neither inquisitive in σ nor eliminative in σ.

Similarly, informativeness can be formulated in terms of acceptability and eliminativity.

Fact 7 (Informativeness, Acceptability, and Eliminativity).
φ is informative in σ iff φ is acceptable in σ and eliminative in σ.

Having established these basic logical notions, we are now ready to formulate a number of conversational maxims. Like Grice, we distinguish between maxims of Quality, Quantity, and Relation.

5.2   Quality: Be Significant and Sincere!

The Quality maxim concerns the minimal conditions for the beholder of a state ς to maintain and potentially enhance the common ground σ in proposing φ.

Informative and inquisitive quality. That we relate Quality to maintaining the common ground is motivated by the fact that the standard notion of Quality corresponds to truthfulness, which serves the requirement to maintain the common ground. Truthfulness pertains to the informative aspect of meaning. For the beholder of a state ς to be truthful in proposing φ means that φ is not eliminative in ς.

As for the inquisitive aspect of meaning, the intuition is that Quality requires that an inquisitive sentence should be inquisitive in the state of the speaker. The argument we will put forward to support this intuition concerns the prospects of enhancing the common ground. This being so, we let Quality in general concern both maintaining and potentially enhancing the common ground.

Potential enhancement of the common ground. When a sentence φ is supported by a state ς, we take this to mean that the beholder of ς takes himself to know φ. If the common ground σ has been properly maintained, and for every participant in the conversation, his state ς has remained included in the common ground, then the information in the common ground is common information, and issues resolved in the common ground are commonly resolved.

Fact 8 (Common Ground). *If σ supports φ, then for all $\varsigma \subseteq \sigma$: ς supports φ.*

This fact implies that, for a sentence φ to possibly enhance the common ground σ, it is minimally required that φ is *not* supported by σ, i.e., that φ is inquisitive or eliminative in σ. We incorporate this requirement in the Quality maxim.

Note that this element of the maxim does not mention a participant, but only a sentence φ and the common ground σ, but since any participant is expected to be aware of the common ground, to adhere to it is under control of the participants.

Non-support of φ by the common ground σ, as such allows that φ is not acceptable in σ, but since Quality also involves that φ is not eliminative in state ς of the speaker, under the assumption that the common ground has been maintained, and $\varsigma \subseteq \sigma$, it must be the case that φ is acceptable in σ. So, these two elements of Quality together imply that φ is inquisitive or informative in σ.

Potential enhancement and inquisitiveness. Turning to the Quality requirement that φ has to be inquisitive in the state of the speaker, if φ is an inquisitive sentence, it might be thought that inquisitiveness in the common ground as such would suffice for φ to have the potential to lead to enhancement of the common ground. Note that inquisitiveness in the state of some participant implies inquisitiveness in the common ground. Let us assume for the sake of the argument that φ is inquisitive and not informative, i.e., that it is a question $?\varphi$.

A question $?\varphi$ will never have the direct effect to enhance the common ground, but only indirectly via a response ψ that resolves the issue $?\varphi$ poses.[6] It is in this sense that questions have the potential to enhance the common ground. For this to be possible, in the sense that the *internal* common ground is enhanced, it is minimally required that there are two participants in states ς and ϱ such that $?\varphi$ is not inquisitive in ς and $?\varphi$ is inquisitive in ϱ.

If it is the speaker who is in the state ς where $?\varphi$ is not inquisitive, then everything depends on there being another participant in state ϱ where $?\varphi$ is inquisitive. The fact that $?\varphi$ is inquisitive in the common ground σ makes this *possible*, but it is by no means guaranteed. It depends on the internal common ground, on what the states of the other participants are, of which we are largely unaware.

Furthermore, since φ is not inquisitive in ς, the beholder of state ς could just as well have uttered an informative sentence ψ that corresponds to his own answer to $?\varphi$. That would have been a much more straightforward way to potentially enhance the common ground. Put all this together, add, if you like, a bit of sincerity, and there is every reason from the perspective of the potential to enhance the common ground to require an inquisitive and non-informative sentence to be inquisitive in the state of the speaker.

Having thus motivated 'inquisitive sincerity' to be an element of Quality, we arrive at the following three elements for a speaker oriented Quality maxim:

Definition 11 (Maxim of Quality).

1. *φ is inquisitive or eliminative in the common ground.*

2. *φ is not eliminative in the state of the speaker.*

3. *φ is inquisitive in the state of the speaker, if φ is inquisitive.*

---

[6] We simplify things a bit here, because a partial resolution would already suffice to enhance the common ground.

Besides this speaker oriented maxim directed towards maintaining the common ground and to potentially enhance the common ground, there is also the hearer oriented Quality maxim which says that unacceptability of a proposal is to be publicly announced, upon which the proposal is not absorbed in the common ground; and that if no such announcement is made every participant is to absorb the prososal in his state, and the proposal is absorbed in the common ground. To implement this formally would require us to develop a common ground mainte- nance system which records changes in the common ground. This is beyond the scope of the present paper, see (Groenendijk, 2008a) for a proto-type system.

5.3 Quantity: Say More, Ask Less!

In this section we introduce the notion of homogeneity, which is the inquisitive pragmatic version of the Gricean maxim of Quantity. As is foretold by the title of this section, the main point in this section will be that preferences for informative and inquisitive Quantity run in opposite directions. This is also reflected by the following definition of comparative informativeness and inquisitiveness.

Definition 12 (Comparative Informativeness and Inquisitiveness).

1. *φ is at least as informative as ψ iff in every state where ψ is eliminative, φ is eliminative as well.*

2. *φ is at most as inquisitive as ψ iff in every state where ψ is not inquisitive, φ is not inquisitive either.*

Note that although the first clause deals with comparative informativeness, it is (and should be) formulated in terms of eliminativity. If it were formulated in terms of informativity, it would give very counter-intuitive results. Suppose that we defined φ to be at least as informative as ψ iff in every state where ψ is informative, φ is informative as well. Then, for instance, $p \wedge q$ would not count as more informative than p. To see this consider the state $|\neg q|$. In this state, p is informative, but $p \wedge q$ is *not*, because it is *unacceptable* in $|\neg q|$. More generally, for any non-tautological sentence χ, it would be impossible to find a formula that is more informative than χ. This is clearly very undesirable. Thus, in order to measure comparative informativeness, the acceptability aspect of informativeness must be left out of consideration—the only relevant feature is eliminativity.

Potential enhancement. Next, we introduce two basic logical facts that play a leading role in our motivation for the notion of homogeneity. The first fact expresses that if a sentence φ is informative in the common ground σ, then it cannot fail to be the case that it is possible that there is a participant with state ς where φ is eliminative, and also a participant with state ϱ where φ is *not* eliminative. The point is that, if there actually are two such participants with states ς and ϱ in a conversation with common ground σ, an utterance of φ has the potential to enhance the common ground. The second fact is similar, except that it deals with inquisitiveness.

Fact 9 (Information Exchange Potential).

1. If φ is informative in σ, then for some $\varsigma \subset \sigma$: φ is not eliminative in ς, and for some $\varrho \subseteq \sigma$: φ is eliminative in ϱ.

2. If φ is inquisitive in σ, then for some $\varsigma \subseteq \sigma$: φ is inquisitive in ς, and for some $\varrho \subset \sigma$: φ is not inquisitive in ϱ.

What the first fact amounts to is that if you happen to be an actual participant in a conversation, and you are in a state ς where φ is not eliminative, and you are aware of the fact that φ is informative in the common ground σ, then, first of all, your utterance of φ meets the quality maxim and you can propose φ, and secondly, *there is a chance* that there is another participant in state ϱ where φ is eliminative. If the latter actually happens to be the case, and if, hopefully, φ is not only eliminative in ϱ, but also acceptable, i.e., φ is informative in ϱ, then your utterance of φ will lead to an enhancement of the common ground. (Only a third participant for whom φ is not acceptable can still disturb this.)

The second fact has a similar effect but then for the situation where you happen to be a participant in a state ς where, like in the common ground σ, φ is inquisitive. You are qualitatively entitled to propose φ, and *there is a chance* that your inquisitive sentence meets a response from another participant who can resolve the issue φ embodies in your state, in which case your state is enhanced, and hence, so is the internal common ground. Here, too, there is still a chance of failure. If there are more than two possibilities for φ relative to the common ground, one of which is not a possibility for φ relative to your state, the response might just happen to pick out the 'wrong' possibility, and you are unable to accept it. Also, in this case, a third participant might find a response unacceptable, that is acceptable to you, that would disturb things as well.

In case there are only two possibilities for φ in the common ground, and hence also in your state, it would be very odd for you to not accept an informative response to your issue. When you ask a question, trust on your part towards a proposed answer is much more strongly required, than in case information is provided you didn't ask for yourself. However, if the reponse is over-informative in relation to your question, and hence (also) provides information you did not ask for, the situation is different (we will return to this when discussing compliance in section 5.4).

Quantity and potential enhancement. Returning to the main line of the story, the point is that purely on a logical basis, your awareness of the common ground and your own state, assuming the common ground has been maintained properly, allows you to draw conclusions, be it defeasible ones, about chances there are to enhance the internal common ground, of which you are only very partially aware.

Furthermore, these facts also give a clear indication about preferred informative and inquisitive quantity. We have stressed the fact that when you are qualitatively entitled to propose an informative sentence φ, there is a chance that in the state of another participant φ is eliminative, which could lead to an

enhancement of the internal common ground. Your chances to meet this situation are the better the more informative your utterance is. So, other things being equal, informative quantity prefers more informative sentences.

With respect to inquisitiveness, the situation is reversed. When you are qualitatively entitled to propose an inquisitive sentence, there is a chance that in the state of another participant φ is not inquisitive, which could lead to an enhancement of the internal common ground. Your chances to meet this situation are the better the less inquisitive your utterance is. So, other things being equal, inquisitive quantity prefers less inquisitive sentences.

These logical observations concerning the opposed tendencies for informative and inquisitive quantity are captured by the notion of homogeneity.

Definition 13 (Homogeneity).

> φ is at least as homogeneous as ψ, $\varphi \succeq \psi$ iff φ is at least as informative and at most as inquisitive as ψ.

The most essential features of homogeneity, and its relation with entailment, are summed up in fact 10:

Fact 10 (Homogeneity).

1. *If $\varphi \succeq \psi$, then $!\varphi \models !\psi$*
2. *$!\varphi \succeq !\psi$ iff $!\varphi \models !\psi$*
3. *If $!\varphi \equiv !\psi$, then $\varphi \succeq \psi$ iff $?\psi \models ?\varphi$*
4. *$?\varphi \succeq ?\psi$ iff $?\psi \models ?\varphi$*
5. *$!\varphi \succeq ?\psi$*
6. *$\bot \succeq \varphi$*
7. *$\top \succeq ?\varphi$*

We can look upon homogeneity as specifying the preferred general direction of a conversation with the purpose to exchange information, to enhance the common ground. First and foremost, the direction is towards establishing more common information. Propositions which exclude more possibilities are preferred. Among sentences which exclude the same possibilities, or no possibilities at all, the preferred general direction is towards less inquisitiveness.

5.4   Relation: Be Compliant!

Although homogeneity determines the *general* direction that an inquisitive dialogue strives for, as is particularly clear from the fact that *any* assertion is at least as homogeneous as *any* question (item 5 in the list above), we need some more specific directions that tell us, e.g., *which* assertions are proper responses to *which* questions. This is accomplished by the logical notion of *compliance*. Just as entailment traditionally judges whether an argument is valid, compliance judges whether a certain dialogue move is coherent with respect to previous moves.

Basic compliance intuitions. Before stating the definition of compliance, we first discuss the basic logico-pragmatical intuitions behind it. Consider a situation where a sentence φ is a *response* to an *initiative* ψ. We are mainly interested in the case where the initiative ψ is inquisitive, and hence proposes several alternatives. In this case, φ is an optimally compliant response just in case it picks out exactly one of the alternatives proposed by ψ. Such an optimally compliant response is an assertion φ such that the possibility α for φ equals one of the possibilities for ψ: $\lfloor\varphi\rfloor = \{\alpha\}$ and $\alpha \in \lfloor\psi\rfloor$. Of course, the responder is not supposed to choose randomly, but in accordance with the maxim of Quality, which means that his state ς must be included in the alternative α: $\varsigma \subseteq \alpha$.

If the state of the responder is not included in any of the alternatives proposed by ψ, such an optimally compliant response is not possible. However, it may still be possible in this case to give a compliant informative response, not by picking out *one* of the alternatives proposed by ψ, but by selecting some of them, and excluding others. The informative content of such a response must correspond with the union of some but not all of the alternatives proposed by ψ. That is, $|\varphi|$ must coincide with the union of a proper non-empty subset of $\lfloor\psi\rfloor$.

If such an informative compliant response cannot be given without breaching the maxim of Quality, it may still be possible to make a significant compliant move, namely by responding with an inquisitive sentence, replacing the issue raised by ψ with an easier to answer sub-issue. The rationale behind such an inquisitive move is that, if part of the original issue posed by ψ were resolved, it might become possible to subsequently resolve the remaining issue as well.

Summing up, there are basically two ways in which φ may be compliant with ψ:

(a) φ may partially *resolve* the issue raised by ψ;
(b) φ may *replace* the issue raised by ψ by an easier to answer sub-issue.

Combinations are also possible: φ may partially resolve the issue raised by ψ and at the same time replace the remaining issue with an easier to answer sub-issue. What is important is that φ should do nothing *more* than this: it should not provide information that is not related to the given issue, and it should not raise issues that are not related to the given issue, or that are more difficult to answer.

Compliance and homogeneity. Partly, these logical intuitions about compliance are in line with our observations concerning homogeneity, but partly these two notions are, as it were, 'opposing forces'. To see this, consider two assertions φ and χ as possible responses to an initiative ψ, where the unique possibility for φ coincides with one of the possibilities for ψ, and the unique possibility for χ is properly included in the one for φ. In this case, χ is more informative, and therefore more homogeneous than φ. Still, our notion of compliance will regard φ as an optimally compliant response to ψ, and χ as not compliant at all. χ is discarded because it is over-informative. So, compliance sets an upperbound to homogeneity.

Compliance and enhancement of the common ground. The fact that compliance discards over-informative responses may seem arbitrary at first sight,

but from the perspective of our general conversational principles quite the opposite is true. In the scenario just considered, φ and χ both have the potential to enhance the common ground in such a way that the issue raised by ψ is resolved. However, χ, by being over-informative, runs a higher risk of being unacceptable in the information state of one of the participants, and therefore of being rejected. This higher risk is completely unnecessary, given that the information provided by φ is sufficient to resolve the current issue.

These considerations lead to the following definition

Definition 14 (Compliance). *φ is compliant with ψ, $\varphi \propto \psi$, iff*

1. *every possibility in $\lfloor \varphi \rfloor$ is the union of a set of possibilities in $\lfloor \psi \rfloor$*
2. *every possibility in $\lfloor \psi \rfloor$ restricted to $|\varphi|$ is contained in a possibility in $\lfloor \varphi \rfloor$*

To explain the workings of the definition, we will consider the case where ψ is an insignificant sentence, an assertion, a question, and a hybrid one by one.

If ψ is a contradiction, the first clause can only be met if φ is a contradiction as well. The second clause is trivially met in this case. Similarly, if ψ is a tautology, the first clause can only be met if φ is a tautology as well, and the second clause is also satisfied in this case. Thus, if ψ is insignificant, φ is compliant with ψ just in case φ and ψ are equivalent.

Fact 11. *If ψ is insignificant, then $\varphi \propto \psi$ iff $\lfloor \varphi \rfloor = \lfloor \psi \rfloor$.*

Next, consider the case where ψ is an assertion. The first clause implies that for φ to be compliant with ψ, φ should be least as informative as ψ. If every possibility for φ is to be the union of a set of possibilities for ψ, then we must have that $|\varphi| \subseteq |\psi|$. This means, in particular, that questions can only be compliant with questions. The first clause also implies that hybrids cannot be compliant with assertions. Only assertions can be compliant with assertions.

Hence, if ψ is an assertion, any compliant response must be an assertion, and in fact, it even follows from the first clause that any compliant response should be *equivalent* with ψ. In this case, the second clause is trivially met. Thus, the only way to compliantly respond to an assertion is to confirm it.[7]

Fact 12. *If ψ is an assertion, then $\varphi \propto \psi$ iff $\lfloor \varphi \rfloor = \lfloor \psi \rfloor$.*

If ψ is a question and φ is an assertion, then the first clause in the definition of compliance requires that $|\varphi|$ coincides with the union of a set of possibilities for ψ. The second clause is trivially met in this case. Such an assertion provides information that is fully dedicated to partially resolving the issue raised by the question, and does not provide any information that is not directly related to the

---

[7] Recall that common ground maintenance requires a dialogue participant to explicitly reject an assertion ψ in case it is unacceptable in his own information state. Such a move is strictly speaking not compliant. However, it *is* compliant with 'the question behind ψ', which is, in the simplest case, $?\psi$. For detailed discussion of this issue, see (Groenendijk, 2008a).

issue. Recall that at the end of section 3 we criticized the notion of entailment for not delivering a notion of 'precise' (partial) answerhood. This is precisely what compliance of assertions to questions characterizes.

Fact 13. *If ψ is a question and φ an assertion, then $\varphi \propto \psi$ iff $|\varphi|$ coincides with the union of a set of possibilities for ψ.*

If φ and ψ are both questions, then the first clause requires that φ is related to ψ in the sense that every complete answer to φ is at least a partial answer to ψ. In this case the second clause has work to do as well. However, since φ is assumed to be a question, and since questions are not informative, the second clause can be simplified in this case: the restriction of the possibilities for ψ to $|\varphi|$ does not have any effect, because $|\varphi| = \omega$. Hence,the second clause simply requires that every possibility for ψ is contained in a possibility for φ. This constraint prevents φ from being more difficult to answer than ψ.

We illustrate this with an example. Consider the case where $\psi \equiv \, ?p \vee ?q$ and $\varphi \equiv \, ?p$. The propositions expressed by these sentences are depicted in figure 8.
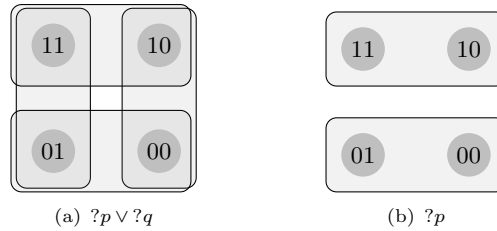

(a) $?p \vee ?q$ (b) $?p$

Fig. 8. $?p$ is not compliant with $?p \vee ?q$.

Intuitively, $?p \vee ?q$ is a *choice question*. To resolve it, one may either provide an answer to the question $?p$ or to the question $?q$. Thus, there are four possibilities, each corresponding to an optimally compliant response: p, $\neg p$, q and $\neg q$. The question $?p$ is more demanding: there are only two possibilities and thus only two optimally compliant responses, p and $\neg p$. Hence, $?p$ is more difficult to answer than $?p \vee ?q$, and should therefore not count as compliant with it. This is not taken care of by the first clause in the definition of compliance, since every possibility for $?p$ is also a possibility for $?p \vee ?q$. So the second clause is essential in this case: it says that $?p$ is not compliant with $?p \vee ?q$ because two of the possibilities for $?p \vee ?q$ are not contained in any possibility for $?p$. The fact that these possibilities are, as it were, 'ignored' by $?p$ is the reason that $?p$ is more difficult to answer than $?p \vee ?q$.

Recall that at the end of section 2, we criticized the notion of entailment for not delivering a satisfactory notion of subquestionhood. The difference with compliance, which does give the right characterization, lies in the first clause of the definition, which requires that the two questions are *related*. Entailment only covers the (simplified version of the) second clause in the definition of compliance.

Fact 14. *If both ψ and φ are questions, then $\varphi \propto \psi$ iff*

1. *every possibility in $\lfloor\varphi\rfloor$ is the union of a set of possibilities in $\lfloor\psi\rfloor$*
2. *every possibility in $\lfloor\psi\rfloor$ is contained in a possibility in $\lfloor\varphi\rfloor$*

The second clause only plays a role in case both φ and ψ are inquisitive. Moreover, the restriction of the possibilities for ψ to $|\varphi|$ can only play a role if φ is more informative than ψ. Thus, the restriction can only play a role in case φ is hybrid. If φ is hybrid, just as when φ is a question, the second clause forbids that a possibility for ψ is ignored by φ. But now it also applies to cases where a possibility for ψ is partly excluded by φ. The part that remains should then be fully included in one of the possibilities for φ.

As an example where this condition applies, consider $p \vee q$ as a response to $p \vee q \vee r$. One of the possibilities for $p \vee q \vee r$, namely $|r|$, is ignored by $p \vee q$: the restriction of $|r|$ to $|p \vee q|$ is not contained in any possibility for $p \vee q$. Again, this reflects the fact that the issue raised by $p \vee q$ is more difficult to resolve than the issue raised by $p \vee q \vee r$.

A general characterization of what the second clause says, then, is that φ may only remove possibilities for ψ by providing information.

A possibility for ψ must either be excluded altogether, or it must be preserved: its restriction to $|\varphi|$ must be contained in some possibility for φ.

The notion of compliance gives rise to the following maxim.

Definition 15 (Maxim of Relation).
If φ is a response to an initiative ψ, then φ should be compliant with ψ.

Our maxims, like the Gricean maxims, are regulative principles that guide behavior in a conversation. They are not hard rules that people adhere to without exception. In calling our notion of relatedness *compliance*, we wanted to stress this point: sometimes you can't be or even shouldn't be compliant. To give one example: in response to the question *Will Alf go to the party?*, the counter-question *Will Bea go?* is not compliant. But it may be the best thing to do in case a positive answer to your counter-question makes it possible for you to come back with *Then Alf goes as well*.

5.5 Quantity Revisited: Compliance and Homogeneity

There may be several non-equivalent compliant responses possible to an intiative. Then Quantity matters. Among compliant responses more homogeneous ones are preferred. But first we note that compliance as such already implies homogeneity.

Fact 15 (Compliance Implies Homogeneity).
If φ is compliant with ψ, then φ is at least as homogeneous as ψ.

Proof. Suppose that φ is compliant with ψ. We have already seen that the second clause of the definition of compliance implies that φ must be at least as

informative as ψ in this case. It remains to be shown that φ is also at most as inquisitive as ψ.

Suppose, towards a contradiction, that φ is strictly more inquisitive than ψ. Then there must be a state σ such that:

- φ is inquisitive in σ: $\sigma\lfloor\varphi\rfloor$ contains at least two possibilities;
- ψ is not inquisitive in σ: $\sigma\lfloor\psi\rfloor$ contains at most one possibility.

We assumed φ to be compliant with ψ. This means that $|\varphi| \subseteq |\psi|$, and therefore $\sigma \cap |\varphi| \subseteq \sigma \cap |\psi|$. $\sigma\lfloor\varphi\rfloor$ contains at least two possibilities, so $\sigma \cap |\varphi|$ cannot be empty. Hence, $\sigma\cap|\psi|$ cannot be empty either, which means that $\sigma\lfloor\psi\rfloor$ contains at least one possibility. We already knew that $\sigma\lfloor\psi\rfloor$ contains *at most* one possibility, so now we know that it contains *exactly* one possibility: $\sigma \cap |\psi|$.

Now consider the possibilities for ψ in general, not restricted to σ. There must be at least one possibility for ψ that contains $\sigma \cap |\psi|$. Call this possibility α. We will show that the restriction of α to $|\varphi|$ is not contained in any possibility for φ, which contradicts the assumption that φ is compliant with ψ, and thus establishes the fact that compliance implies homogeneity.

We have that $\sigma \cap |\varphi| \subseteq \sigma \cap |\psi|$, and therefore $\sigma \cap |\varphi| \subseteq \alpha$. But we also have that $\sigma \cap |\varphi| \subseteq |\varphi|$. It follows that $\sigma \cap |\varphi| \subseteq \alpha \cap |\varphi|$. $\sigma \cap |\varphi|$ cannot be contained in any possibility for φ, because $\sigma\lfloor\varphi\rfloor$ contains at least two possibilities. Thus, $\alpha \cap |\varphi|$ cannot be contained in any possibility for φ either. □

Put together, compliance and homogeneity give rise to a comparative notion of compliance. Compliance by itself determines whether or not a sentence is a coherent contribution to a conversation. But it does not say whether one sentence is a *better* contribution than another. If there are two or more compliant responses, then the notion of homogeneity determines which of these responses are optimal. Such optimal choices are preferred by the maxim of Quantity.

Definition 16 (Maxim of Quantity). *If φ and χ are two possible responses to an initiative ψ that both meet the maxims of Quality and Relation, then φ is preferred over χ iff φ is more homogeneous than χ.*

For responses to a question $?\psi$, the combined forces of compliance and homogeneity first of all always prefer informative responses over ones that are not. Compliance guarantees that such an informative response is a 'precise' non-overinformative answer. Among those answers that are qualitatively allowed with respect to the information state of the responder, up to logical equivalence, homogeneity prefers less partial, more informative answers. The most homogenous compliant responses are complete answers, for which it holds that $!\varphi \models ?\psi$. But if $!\chi$ properly entails $!\varphi$, then $!\chi$ is excluded by compliance.

If Quality does not allow any informative response to a question $?\psi$, then compliance and homogeneity allow for a response with a question $?\varphi$, where $?\varphi$ is related to and more homogeneous than $?\psi$. Compliance ensures that $?\varphi$ is easier to answer than $?\psi$. Homogeneity says "the easier to answer the better".

It may be helpful to illustrate this point with a concrete example. Consider a dialogue between two people, A and B. Suppose A raises an issue by uttering

$?p \wedge ?q$ (see figure 4 for a graphical representation of the proposition expressed by this sentence). Now suppose B is not able to resolve this issue directly. Then he may try to resolve the issue indirectly by raising a sub-issues. Now consider two sentences that B may utter in this situation: $?q$ and $p \rightarrow ?q$ (again, see figure 4 for graphical representations of the corresponding propositions). Now, it is very unlikely that A will have an answer to $?q$, given that he has just asked $?p \wedge ?q$ himself. On the other hand, it is not so unlikely that A will have an answer to $p \rightarrow ?q$. Intuitively, this question is weaker than $?q$, it merely asks whether or not p and q are related in a certain way. Thus, it is much more advisable for B to ask $p \rightarrow ?q$ than to ask $?q$. Both $?q$ and $p \rightarrow ?q$ are compliant with the original question. Homogeneity captures the preference for $p \rightarrow ?q$.

6 Inquisitive Implicatures of Alternative Questions

The inquisitive maxims of Quality, Quantity, and Relation play much the same role as the maxims in Gricean pragmatics. In particular, they give rise to conversational *implicatures*. But since the computation of implicatures is based on the semantic content of a sentence, and since inquisitive semantics enriches the notion of semantic content, the notion of a conversational implicature is enriched as well. We will illustrate this by means of a small case-study, showing that certain well-known, but ill-understood phenomena involving *alternative questions* can be explained in terms of inquisitive conversational implicatures.

6.1 Not Neither

Consider the alternative question in (1), where SMALLCAPS are used to indicate intonational emphasis.

(1)   Will ALF or BEA go to the party?
     a.   Alf will go to the party.
     b. #Neither Alf nor Bea will go.

We take it that (1), with the indicated intonation pattern, is translated into our propositional language as $?(p \vee q)$. The proposition expressed by this sentence is depicted in figure 9(a). There are three possibilities for $?(p \vee q)$, namely $|p|$, $|q|$, and $|\neg p \wedge \neg q|$. This means that (1-a) is correctly predicted to be an optimally compliant response. However, the *neither*-response in (1-b) is also predicted to be optimally compliant, whereas in reality this response is unexpected, and should be marked as such, for example by using an interjection like: *Well, actually...* We use the # sign to indicate that (1-b) requires such conversational marking.

     We will propose a pragmatic explanation for the observation that the *neither*-response in (1-b) is an unexpected reaction to (1) and needs to be marked as such. The explanation will be based on the idea that a sentence can come with certain pragmatic *suggestions* that go beyond its proper semantic content. Just as conversational implicatures, suggestions can be cancelled. Only, in inquisitive pragmatics cancelation is a cooperative affair: the required conversational
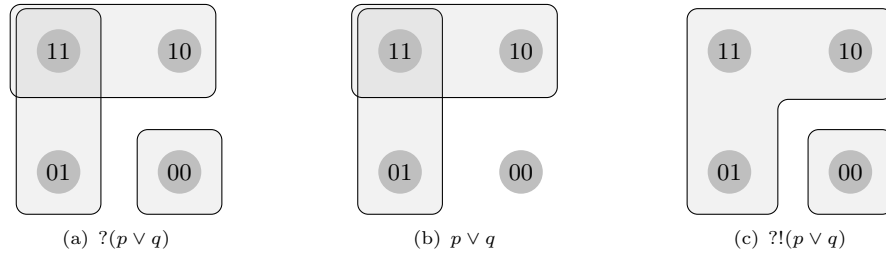
Fig. 9. Alternative question, hybrid disjunction, and polar disjunctive question.

marking of the response in (1-b) signals that the responder proposes to cancel a suggestion made by the utterance of the initiator. If this is the right analysis of interjections like *Well, actually...*, it remains to be explained why the alternative question in (1) suggests that the *neither*-response in (1-b) is unexpected.

Before we turn to that, we first consider a slightly different example, namely the disjunction in (2).

(2)   ALF or BEA will go to the party.
    a.   (Yes,) Alf will go to the party.
    b.   No, neither Alf nor Bea will go.

We take it that (2), with the indicated intonation pattern, is translated into our logical language as the hybrid disjunction $p \vee q$. The proposition expressed by this sentence, which we have seen before, is depicted in figure 9(b).

Notice that the *neither*-response in (2-b) is preceded by an interjection, *No*, which signals rejection. What we want to point out with this example, however, is that there is a difference between canceling a pragmatic suggestion (which is what happens in (1-b)), and rejecting a proposal that is embodied by the semantic content of a sentence (which is what happens in (2-b)). Cancelation applies to pragmatic suggestions; rejection applies to semantic content. Having introduced this distinction, we now turn to the pragmatic explanation of why (1) suggests that (1-b) is unexpected. Homogeneity will play a key role.

The crucial observation is that the alternative question in (1), translated as $?(p \vee q)$, is more inquisitive, and therefore less homogeneous, than the polar question $?!(p \vee q)$, which we take to be the translation of the English polar question in (3).

(3)   Will Alf or Bea go to the party?
    a.   (Yes.) Alf or Bea will go.
    b.   (No.) Neither Alf nor Bea will go.

Notice that in English the polar question in (3) is only distinguished from the alternative question in (1) by intonation.

The proposition expressed by the polar question ?!$(p \lor q)$ is depicted in figure 9(c). There are two possibilities for ?!$(p \lor q)$, namely $|!(p \lor q)|$ and $|\neg(p \lor q)|$, which are expressed by the optimally compliant responses in (3-a) and (3-b).

When comparing the polar question in (3) with the alternative question in (1) there are two things to note. First, the *neither*-response in (3-b) does not need any conversational marking, whereas it did as a reaction to (1). Second, the positive answer in (3-a) is a completely natural reaction to (3), whereas it would be decidedly odd as a response to (1).

From a logical-semantical perspective this last observation is unexpected. !$(p \lor q)$ counts as a compliant response to ?$(p \lor q)$, because the single possibility for !$(p \lor q)$ is the union of two of the three possibilities for ?$(p \lor q)$. From a semantic perspective, then, !$(p \lor q)$ is a compliant response to ?$(p \lor q)$, it partially resolves the issue, by excluding the possibility that $\neg p \land \neg q$. But the pragmatic explanation for the oddity of (3-a) as a response to (1) is exactly the same as the explanation why (1-a) needs to be conversationally marked as a response to (1). Namely, if (1) already suggests that the *neither*-response is unexpected, then saying that at least one of the two will go is utterly redundant.

As mentioned above, the key to the explanation of the unexpectedness of the *neither*-answer is the observation that the polar question ?!$(p \lor q)$ is less inquisitive, and thus more homogeneous, than the alternative question ?$(p \lor q)$. From the perspective of homogeneity, the polar question is therefore preferred over the alternative question. This means that, if the initiator asks the alternative question, there must be a specific reason why she did not ask the polar question, which is in principle preferred. And there is only one potential reason, namely that the polar question is not inquisitive in her own information state. If this is the case, the polar question does not necessarily lead to enhancement of the common ground, and should therefore be avoided. The quantitative preference is overruled by a qualitative restraint.

Thus, we are led to the conclusion that the polar question is not inquisitive in the initiator's information state, while the alternative question is. But this can only be the case if the initiator already assumes that at least one of Alf and Bea will go to the party. The *neither*-response is inconsistent with this assumption, and this is why it is unexpected.

6.2   Not Both

We stay with the alternative question, repeated in (4), but now consider two additional responses, (4-c) and (4-d).

(4)   Will ALF or BEA go to the party?
   a.   Alf will go to the party.
   b. #Neither Alf nor Bea will go.
   c. #Both Alf and Bea will go.
   d.   Only Alf will go, Bea will not go.

A first observation is that (4) does not only suggest that the *neither*-response in (4-b) is unexpected, but also that the *both*-response in (4-c) is unexpected. Both the *neither*- and the *both*-response require conversational marking with an interjection like *Well, actually....*

A related observation is that the response in (4-d) needs no conversational marking. In fact, it functions in much the same way as the optimally compliant response in (4-a), despite the fact that it is, semantically speaking, more informative and therefore more homogeneous. In the context of the alternative question, (4-a) and (4-d) have exactly the same effect.

If indeed the alternative question suggests that the *both*-response is unexpected, then we have the basis for an explanation of the fact that the answer in (4-a) is pragmatically strengthened to what is explicitly expressed in (4-d). Responding with (4-a) indicates *acceptance* of the suggestion that Alf and Bea will not both go to the party. Otherwise, the responder should have opted for the more homogeneous response in (4-c). So, the alternative question in (4) and the response in (4-a) *together* generate the implicature that only Alf will go. The implicature is established in a cooperative fashion. The only difference between (4-a) and (4-d) is that in the latter the implicature is explicated. And because (4) already suggests that Alf and Bea will not both go to the party, the over-informativeness of (4-d) does not require any conversational marking.

What remains to be explained is why (4) suggests that the *both*-response is unexpected. In this case, homogeneity and compliance both play a key role. The crucial observation is that, although $p \wedge q$ is more homogeneous than either p or q, only the latter two are compliant responses to $?(p \vee q)$. There must be a reason why the initiator excluded the more homogeneous response $p \wedge q$ from being compliant. And the only potential reason is that $p \wedge q$ is *unacceptable* in her own information state. Again, a quantitative preference is overruled by a qualitative restraint.

Thus, we are led to the conclusion that the initiator assumes that Alf and Bea will not both go to the party. The *both*-response is inconsistent with this assumption, and this is why it is unexpected.

7   Mission Accomplished?

We would consider our mission acomplished, if we have managed to convince you, first of all, that it is possible to extend classical semantics in an easy and conservative way, leading to a new notion of meaning, that puts informativeness and inquisitiveness on equal footing.

Secondly, we also hope to have convinced you that the new view on semantics is of logical interest, that the new logical notions that inquisitive semantics gives rise to, most notably homogeneity and compliance, are just as interesting to study from a logical perspective as the classical notion of entailment.

Thirdly, and most importantly, we hope to have indicated that adding inquisitiveness to semantic content, leads to logical notions that give a new perspective on pragmatics.

Bibliography

Alonso-Ovalle, L. (2006). *Disjunction in Alternative Semantics*. Ph.D. thesis, University of Massachusetts, Amherst.

Ciardelli, I. and Roelofsen, F. (2009). Generalized Inquisitive Logic: Completeness via Intuitionistic Kripke Models. Manuscript, University of Amsterdam. Submitted for publication.

Gerbrandy, J. (1999). *Bisimulations on Planet Kripke*. Ph.D. thesis, University of Amsterdam.

Grice, H. (1975). Logic and conversation. In P. Cole and J. Morgan, editors, *Syntax and Semantics*, volume 3, pages 41–58.

Groenendijk, J. (2008a). Inquisitive semantics and dialogue pragmatics. Rutgers lecture notes, `http://www.illc.uva.nl/inquisitive-semantics`.

Groenendijk, J. (2008b). Inquisitive semantics: Two possibilities for disjunction. In P. Bosch, D. Gabelaia, and J. Lang, editors, *Seventh International Tbilisi Symposium on Language, Logic, and Computation*. Springer-Verlag.

Groenendijk, J. (2009). Inquisitive semantics: Questions, assertions, and hybrids. Manuscript, Amsterdam, `www.illc.uva.nl/inquisitive-semantics`.

Groenendijk, J. and Stokhof, M. (1984). *Studies on the Semantics of Questions and the Pragmatics of Answers*. Ph.D. thesis, University of Amsterdam.

Hamblin, C. L. (1973). Questions in Montague English. *Foundations of Language*, **10**, 41–53.

Isaacs, J. and Rawlins, K. (2008). Conditional questions. *Journal of Semantics*, **25**, 269–319.

Karttunen, L. (1977). Syntax and semantics of questions. *Linguistics and Philosophy*, **1**, 3–44.

Kratzer, A. and Shimoyama, J. (2002). Indeterminate pronouns: The view from Japanese. In Y. Otsu, editor, *The Proceedings of the Third Tokyo Conference on Psycholinguistics*, pages 1–25, Tokyo (Hituzi Syobo).

Lewis, D. (1969). *Convention, a Philosophical Study*. Harvard University Press.

Mascarenhas, S. (2009). Inquisitive semantics and logic. Forthcoming Master Thesis, University of Amsterdam.

Murray, S. (2009). A hamblin semantics for evidentials. Accepted by Semantics and Linguistic Theory.

Rooth, M. (1985). *Association with Focus*. Ph.D. thesis, University of Massachusetts, Amherst.

Stalnaker, R. (1978). Assertion. *Syntax and Semantics*, **9**, 315–332.

Velissaratou, S. (2000). Conditional questions and which-interrogatives. Master Thesis, University of Amsterdam.

Zimmermann, E. (2000). Free choice disjunction and epistemic possibility. *Natural Language Semantics*, **8**, 255–290.