Meanings as proposals:
a new semantic foundation for Gricean pragmatics

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Abstract

A disjunction may pragmatically imply that only one of the disjuncts is true. The traditional Gricean account of this exhaustivity implicature is not without problems. Nevertheless, we think that not the Gricean picture itself, but the underlying conception of meanings as chunks of information may be unfit. Starting instead from a conception of meanings as proposals, within the framework of inquisitive semantics, we develop, algebraically characterise and conceptually motivate a formal semantics and pragmatics, the latter still Gricean in spirit.

Among the difficulties we discuss and resolve are the problem of characterising relevant alternatives, the problem of embedded implicatures and the unwanted negation problem. The analysis is extended to a pragmatic account of mention-some questions.

1 Introduction[1]

1.1 Some problems for a Gricean pragmatics

Sentence (1) asserts that it is rainy or windy, and may pragmatically imply that not both are the case.

(1) It's rainy or windy.

The existence of a 'not both'-implicature is suggested by the fact that one can say 'it's rainy or windy or both' without a sense of redundancy, as well as the fact that a 'both'-response to (1) would be slightly unexpected.

If we translate (1) as $p \vee q$, the traditional Gricean account of the 'not both'-implicature of (1) reads as follows (roughly adopted from (Chierchia, Fox, & Spector, 2008)):

Reasoning pattern 1 (Traditional account)

1. *The initiator said* $p \vee q$.
2. *If* $p \vee q$ *is relevant, then presumably* p, q *and* $p \wedge q$ *are too.*
3. *The initiator could have said* $p \wedge q$, *which is stronger and relevant.*
4. *The reason for the initiator choosing* $p \vee q$ *over* $p \wedge q$ *might be that he does not believe that* $p \wedge q$.
5. *It is likely that the initiator has an opinion as to whether* $p \wedge q$ *is true.*
6. *Hence, the initiator must believe that* $p \wedge q$ *is false.*

There are a number of weaknesses in this approach, many of which have to do with **characterising the set of relevant alternatives** used in step 2 of the reasoning above. Under certain natural assumptions regarding the concept of relevance, the set of relevant alternatives grows too big to yield any implicature at all (except implicatures of ignorance), as discussed, e.g., in (Chierchia et al., 2008). This has been partially resolved by postulating lexically specified *scales* of alternatives (Horn, 1972). However, it is not so clear conceptually and technically where the scales come from, and they are not immune to trouble, either.

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(Chierchia et al., 2008) discuss the problem of **embedded implicatures**, i.e., implicatures that seem to arise from within the scope of, e.g., a quantifier.

(2) a. Each student read *Othello* or *King Lear*.
b. Each student read *Othello* and *King L.*.

Since (2b) is a scalar alternative to (2a), the above reasoning predicts the implicature that the speaker believes that not every student read both. But this is arguably too weak. What should come out is the implicature that every student did not read both. For this, the alternatives would have to be computed within the scope of the quantifier, but this seems to go against a genuinly Gricean pragmatics.

Also non-embedded disjunctions face problems. In what Spector (2007) calls the **unwanted negations problem**, the Gricean approach predicts that a triple disjunction $p \vee q \vee r$, given its scalar alternative $(p \wedge q) \vee r$, would imply $\neg r$ - something which is clearly not the case.

It has been noted that the implicature of (1) is perhaps an instance of a larger class of **exhaustivity** implicatures (Rooij & Schulz, 2006). For example, similar pragmatic strengthening seems to be going on in (3), paraphraseable as 'it's either only rainy, or only windy, or both rainy and windy':

(3) It's rainy or windy or both.

However, it is not clear what, if any, the relevant alternatives to (3) should be that would yield an exhaustivity implicature. Replacing any disjunction(s) in (3) by a conjunction results in a formula equivalent to $p \wedge q$, incorrectly predicting the same 'not both'-implicature as for (1). [2]

Related to the issue of exhaustivity are **mention-some questions** (e.g., Rooij & Schulz, 2006). Such questions do not ask for an exhaustive answer, but rather are satisfied with the responder mentioning some possible instances:

(4) a. A: I will pick up the key this afternoon. Will your father or mother be home?
B: My father will be home.

b. A: Where can I buy toilet paper around here?
B: In the shop around the corner.

Here B's responses do not imply that A's mother will not be home or that the shop around the corner is the only place that sells toilet paper. This lack of exhaustivity can be tied to the pragmatics debate by observing that the indicative counterpart of (4) does not imply exhaustivity:

(5) You can pick up the key this afternoon. My father or mother will be home.

However, reasoning pattern 1 above does not provide any means for canceling the 'not both' implicature in this case.

Another weakness, independent of how the set of alternatives is characterised, is what (Sauerland, 2005) calls the **epistemic step**. Going from step 4 to 6 in reasoning pattern 1 above requires a strengthening from not believing, to believing that not, i.e., from $\neg\Box\varphi$ to $\Box\neg\varphi$. This strengthening does not follow from the Gricean maxims and logic alone, but requires an extra, stipulated assumption, given in step 5 above.

We note that the authors cited so far, and notably also Alonso-Ovalle (2008), have all come up with solutions, partial or whole, to these difficulties for the traditional Gricean account. For reasons of space, however, we will not discuss their solutions in the present paper. However, to our awareness the essentially Gricean accounts among them all require a stipulative notion of relevance (assuming, e.g., closure under conjunction) or the epistemic step, and typically both.

1.2 Aims and approach

So far, we have discussed (all too briefly) several difficulties for a traditional Gricean pragmatics, that have to do with characterising relevant alternatives (the requirement for scales, the unwanted negation problem), the ad-hoc nature of the epistemic step, and a more general account of exhaustivity (example (3), mention-some questions). This paper is devoted to overcoming them while maintaining the Gricean spirit.

Our approach is to base an in essence Gricean account of the implicatures of (1) and (3) upon

[2] We assume that for the aims and approach of this paper, the two sentences (1) and (3) can be straightforwardly translated into propositional logic as $p \vee q$ and $p \vee q \vee (p \wedge q)$, respectively.

a new conception of meaning. Existing accounts are built upon a classical, boolean semantics, that models meanings as chunks of information, or upon a dynamic semantics, based on the view of meaning as context change potential (e.g., Rooij & Schulz, 2006).[3] We follow the framework of Inquisitive Semantics in taking this one step further, regarding meaning as *information exchange potential* (Groenendijk & Roelofsen, 2009; Ciardelli, Groenendijk, & Roelofsen, 2009; Roelofsen, 2011). There are various ways to make this slogan more concrete, and how this is done will determine properties of the resulting semantics and of the pragmatics built upon it.

Basic inquisitive semantics (InqB) follows from a conception of meanings as *requests for information* (Roelofsen, 2011). InqB has the merit that uttering a disjunction introduces several semantic alternatives, among which a responder is offered a choice. This enrichment of the semantics provides new handles for the pragmatics. Indeed, InqB has been used as a semantic foundation for a pragmatic account of the 'not both'-implicature of (1), that avoids the problematic 'epistemic step' described above (Groenendijk & Roelofsen, 2009). However, InqB, and thereby the pragmatics, does not distinguish between (1) and (3), yielding wrong predictions. Section 4 contains a brief comparison of our approach with (Groenendijk & Roelofsen, 2009).

Unrestricted inquisitive semantics (InqU), as defined in (Ciardelli et al., 2009; Ciardelli, 2010), is a more promising candidate for an account of (1) and (3). For one, it shares with InqB the merit that disjunction introduces alternatives. Second, InqU, unlike InqB, assigns distinct meanings to (1) and (3), offering at least a semantic handle for a Gricean account to also differentiate between them. For this reason, we will base our pragmatic account upon InqU.

InqU lacks the thorough conceptual motivation and algebraic characterisation that (Roelofsen, 2011) developed for InqB. Developing a pragmatic account of (1) and (3) based on InqU cannot be achieved (both technically and conceptually) without first filling in some of the gaps in our understanding of InqU. We will do so by motivating a version of InqU from scratch, starting from a particular conception of meaning, and characterising it algebraically.

Based on this semantics, our essentially Gricean account of examples (1) and (3) will turn out to be technically remarkably simple and conceptually illuminating, and it overcomes all of the mentioned weaknesses of the traditional approach.

[3](Alonso-Ovalle, 2008) is an exception, using Alternative Semantics as the foundation of a Gricean pragmatics.

2 Unrestricted inquisitive semantics

InqU, as defined in (Ciardelli et al., 2009), is based on a view of meanings as *proposals* to update the common ground in one of several ways, or, in the same paper and in the same breath, as proposals to take certain possibilities into consideration, or to draw *attention* to those possibilities. The road from this conceptual stance to the fully-fledged semantics has not been paved, and the endpoint, i.e., the semantics, has not been characterised algebraically. This is what we attempt in the current section.

2.1 Meanings as proposals

We consider only the language of propositional logic:

Definition 1 (Syntax) *For φ ranging over formulae, p over proposition letters:*
$\varphi := p|\bot|(\varphi \vee \varphi)|(\varphi \wedge \varphi)|(\varphi \to \psi)$,
with $\neg\varphi := \varphi \to \bot$.

The semantics for this language is defined relative to a suitable model:

Definition 2 (Model) *A model M is a tuple $\langle \boldsymbol{W}, I\rangle$, where $\boldsymbol{W}$ is a set of worlds and I is an interpretation function that, relative to a possible world, maps each proposition letter to a truth value.*

Based on a model, an epistemic state is defined as any subset of the set of possible worlds of the model:

Definition 3 (Epistemic state) *An epistemic state based on the model $\langle \boldsymbol{W}, I\rangle$ is a set $s \subseteq \boldsymbol{W}$.*

We think of meanings as proposals. One does not propose a piece of information; rather, one proposes *doing something* with that information, such as updating the common ground with it. Hence, we define meanings, *proposals*, as sets of functions on epistemic states:

Definition 4 (Proposal [to be refined]) *A proposal based on the model $\langle \mathbf{W}, I \rangle$ is a set of functions on epistemic states based on $\langle \mathbf{W}, I \rangle$, i.e., functions $f : \wp \mathbf{W} \to \wp \mathbf{W}$.*

Because in the present paper we will not be concerned with, e.g., revision mechanisms, we restrict ourselves to functions that are *eliminative* and *distributive*. This allows us to simplify the definition of the resulting semantics, and will make it look and feel like InqB, despite the conceptual shift, as well as InqU in (Ciardelli et al., 2009), as we will see shortly. A function on states is eliminative iff it only *eliminates* worlds, i.e., it does not change the worlds or create new worlds. Conceptually, this means that we consider only functions that model information *growth*, not *loss*; i.e., all functions are actual *update* functions.

Definition 5 (Eliminativity) *$f : \wp \mathbf{W} \to \wp \mathbf{W}$ is eliminative iff $\forall s \subseteq \mathbf{W}$, $f(s) \subseteq s$.*

A function is distributive if we could, instead of applying the function to a state s, apply the function to all singleton substates of s, take the union of their outputs, and obtain the same result. In other words, this means that updates operate locally on worlds, not necessarily globally on states.

Definition 6 (Finite distributivity) *$f : \wp \mathbf{W} \to \wp \mathbf{W}$ is finitely distributive iff $\forall s, s' \subseteq \mathbf{W}$, $f(\varnothing) = \varnothing$ and $f(s \cup s') = f(s) \cup f(s')$.*

Any eliminative, distributive function can be fully characterised by its effect on the uninformed state $\mathbf{W}$ (Benthem, 1989):

Fact 1 (Update decomposition) *For all $f : \wp \mathbf{W} \to \wp \mathbf{W}$, if f is eliminative and finitely distributive, then for all $s \subseteq \mathbf{W}$, $f(s) = f(\mathbf{W}) \cap s$.*

This means that every such update function f corresponds to a unique static object $f(\mathbf{W})$. We will call such objects 'updates-as-states', or just 'updates' when no confusion can arise. (We do not call them 'states', because even though that is what they are, it is not what they represent, conceptually.) Using this result, we refine the definition of proposals to be sets of updates-as-states:

Definition 7 (Proposal) *A proposal A based on the model $\langle \mathbf{W}, I \rangle$ is a set of updates-as-states based on $\langle \mathbf{W}, I \rangle$, i.e., $A \subseteq \wp \mathbf{W}$. Let $[\varphi]$ denote the proposal denoted by a formula φ.*

What $[\varphi]$ consists in will be defined by the semantics.

Through Fact 1, a proposal becomes the same kind of object as a proposition in InqB, i.e., a set of states. However, crucially, it *represents* a different kind of object, namely, a set of update functions. Furthermore, we *think* of proposals in a different way. How we think of proposals must be expressed in a meta-language, for which we choose English.

Definition 8 (The Proposal View) *Every formula φ is paraphrasable as 'let's execute one of the updates in $[\varphi]$'.*

This view on meaning will determine how the semantics is to be defined.

2.2 Conjunction and disjunction

Let us first look at the semantic operation that should underly a **conjunction** of sentences. Meanings, spelled out in our meta-language according to the Proposal View, behave as follows under conjunction:

Observation 1 (Behaviour of conjunction) *Let's do one of the updates in A and let's do one of the updates in B ≡ Let's do two updates, one in A and one in B ≡ Let's do one of the updates in $A \sqcap B := \{a \cap b : a \in A, b \in B\}$.*[4]

Hence, we will take the semantics of conjunction to be pointwise intersection.

The proposal $\{\mathbf{W}\}$ is the identity element for pointwise intersection, i.e., for all $A \in \wp\wp\mathbf{W}$, $A \sqcap \{\mathbf{W}\} = A$. Pointwise intersection is associative and commutative. It is not idempotent: if a proposal, consisting of multiple updates, is made twice, a different update can be chosen the first and the second time, and both of them executed, giving a different result than if the proposal had been made only once (cf. footnote 2). These properties imply that the set of proposals with pointwise intersection and its identity element form a *commutative monoid*:

Fact 2 *$\langle \wp\wp \mathbf{W}, \sqcap, \{\mathbf{W}\} \rangle$ is a commutative monoid:*

1. $A \sqcap \{\mathbf{W}\} = A$

[4] If A and B are the same proposal, it is not evident that pointwise intersection is indeed adequate. For instance, 'let's have coffee or tea, and let's have coffee or tea' would be equivalent to 'let's have coffee, tea *or both*'. However, a dynamic stance on conjunction ('and then') makes this result acceptable.

2. $A \sqcap (B \sqcap C) = (A \sqcap B) \sqcap C$

3. $A \sqcap B = B \sqcap A$

Because pointwise intersection is not idempotent, it cannot give the meet with respect to any partial order (the non-idempotency would be in conflict with the reflexivity of the order). However, commutative monoids come with a partial order, called the *divisibility order*, with respect to which pointwise intersection *would have* given the meet, had it been idempotent.

Definition 9 (Divisibility order)
$A \leq_{\sqcap} B$ *iff* $\exists C. B \sqcap C = A$.

This can be read as follows: $A \leq_{\sqcap} B$ iff A can be $\sqcap$-decomposed, i.e., factorized, into B and some other proposal C, i.e., iff B is a divisor of A.

Let us now turn to the semantic operation that corresponds to **disjunction**. We spell out the Proposal View again:

Observation 2 (Behaviour of disjunction) *Let's do one of the updates in A or let's do one of the updates in B ≡ Let's do one of the updates in A or one of the updates in B ≡ Let's do one of the updates in $A \cup B$.*

Hence, we will take the semantics of disjunction to be given by set union.

The proposal $\varnothing$ is the identity element for union, and union is associative, commutative and idempotent, so we have:

Fact 3 $\langle \wp\wp \boldsymbol{W}, \cup, \varnothing \rangle$ *is a commutative, idempotent monoid, i.e.:*

1. $A \cup \varnothing = A$
2. $A \cup (B \cup C) = (A \cup B) \cup C$
3. $A \cup B = B \cup A$
4. $A \cup A = A$

Every commutative, idempotent monoid has a partial order with respect to which it is a join-semilattice, and the operation a join operator. We will call this the *semilattice order*. It can be defined analogously to the divisibility order, but with $\cup$ instead of $\sqcap$, but happens to correspond to the inverse of set inclusion.

Definition 10 (Semilattice order)
$A \geq_{\cup} B$ *iff* $\exists C. B \cup C = A$ *(iff* $A \cup B = A$ *iff* $B \subseteq A$*).*

Fact 4 $\langle \wp\wp \boldsymbol{W}, \geq_{\cup} \rangle$ *is a join-semilattice, with* $\cup$ *as join.*

Union and pointwise intersection interact in the following ways. First, $\varnothing$, the identity element for $\cup$, is an annihilator for $\sqcap$, i.e., $\varnothing \sqcap A = A \sqcap \varnothing = \varnothing$. Second, $\sqcap$ distributes over $\cup$. These properties imply that the two monoids together form a *commutative, idempotent semiring*, i.e., a semiring with the additional properties that the first operation ($\cup$) is idempotent and the second operation ($\sqcap$) commutative.

Fact 5 (Algebraic characterisation)
$\langle \wp\wp \boldsymbol{W}, \cup, \sqcap, \varnothing, \{\boldsymbol{W}\} \rangle$ *is an idempotent semiring, i.e.:*

1. $\langle \wp\wp \boldsymbol{W}, \cup, \varnothing \rangle$ *is a commutative, idempotent monoid;*
2. $\langle \wp\wp \boldsymbol{W}, \sqcap, \{\boldsymbol{W}\} \rangle$ *is a commutative monoid;*
3. $A \sqcap (B \cup C) = (A \sqcap B) \cup (A \sqcap C)$*;*
4. $\varnothing \sqcap A = A \sqcap \varnothing = \varnothing$.

2.3 Two orders: entailment and compliance

There are two orders on the set of proposals, the semilattice order ($\geq_{\cup}$) and the divisibility order ($\leq_{\sqcap}$). If we associate entailment with the semilattice order, then entailment will allow for $\vee$-introduction, but not for $\wedge$-elimination. If we associate entailment with the divisibility order, entailment will allow for $\wedge$-elimination, but not for $\vee$-introduction. The choice is guided conceptually, by seeing what one may generally conclude from a proposal (# indicates that the entailment does not go through):

Observation 3 (Behaviour of entailment)

1. $\dfrac{\textit{Let's have coffee and a biscuit}}{\textit{Let's have coffee}}$

2. $\dfrac{\textit{Let's have coffee}}{\textit{Let's have coffee or beer}}$ #

These observations show that entailment on proposals should not allow for $\vee$-introduction, but for $\wedge$-elimination.

Hence, we associate entailment with the divisibility order, i.e., the order with respect to which $\sqcap$ is almost-but-not-quite a meet operation:

Definition 11 (Entailment)
For any $A, B \in \wp\wp \boldsymbol{W}$*,* A entails B*,* $A \vDash B$*, iff* $A \leq_{\sqcap} B$ *(iff* $\exists C. B \sqcap C = A$*).*

Note that, because pointwise intersection is not idempotent, $A \vDash B$ does not mean that after expressing A, expressing B is redundant.

The semilattice order can be interpreted as follows. If $A \geq_{\cup} B$, i.e., $B \subseteq A$, then all updates proposed by B are already proposed by A. If this is the case, we say that B *complies* with A, or that A *makes* B *compliant*. For clarity, we associate a new symbol with the semilattice order thusly interpreted:

Definition 12 (Compliance) *A makes B compliant, $A \propto B$, iff $A \geq_{\cup} B$ (iff $B \subseteq A$).*

Compliant responses to an initiative will play an important role in our pragmatic account of the implicatures of (1) and (3) in section 3. In particular, both implicature-yielding and implicature-providing responses can be characterised by means of the notion of compliance.

We wish to emphasize that from an algebraic viewpoint, entailment and compliance are both equally fundamental notions.

2.4 Implication

For implication, it is much less clear to which expression in our metalanguage the semantics of implication should correspond. Much more than in the case of conjunction and disjunction, we believe this is a matter of technical convenience and empirical adequacy. In the present paper, we make only a semi-motivated choice and spell out some formal properties.

In InqB, although not presented here, implication requires that for every possible update with the antecedent, an update with the consequent is chosen, and that the common ground is updated in a way that effectively implements this mapping from antecedent possibilities to consequent possibilities. Following the same strategy in the unrestricted case leads to the following definition (from Ciardelli et al., 2009):

Definition 13 (Conditional proposal)
$A \Rightarrow B := \{\{w \in \mathbf{W} : \textit{for all } \alpha \in A, \textit{if } w \in \alpha \textit{ then } w \in f(\alpha)\} : f : A \to B\}$

This notion of implication has some properties that one would expect of implication. For instance, $A \Rightarrow B$ gives us a proposal C such that $A \sqcap C \vDash B$, i.e., modus ponens is a sound derivation rule. Nevertheless, unlike in classical semantics, $A \Rightarrow B$ does not in general give us the *entailment-weakest* proposal C such that $A \sqcap C \vDash B$. In fact, there is no unique such proposal. This was pointed out to me by Roelofsen (p.c.) for the original definition of entailment in (Ciardelli et al., 2009), but it holds also for the new definition of entailment adopted here:

Fact 6 (No relative pseudo-complement)
There is not generally a unique $\vDash$-weakest proposal C such that $A \sqcap C \vDash B$.

To see this, consider a model with three worlds a, b, c, let $A = \{\{a, b\}\}$, $B = \{\{a\}, \{b\}\}$. The proposals $\{\{a, c\}, \{b, c\}\}$, $\{\{a\}, \{b, c\}\}$ and $\{\{a, c\}, \{b\}\}$ are all entailment-weakest proposals C such that $A \sqcap C \vDash B$.

We do have the following result:

Fact 7 (Singleton consequent) *If B is a singleton proposal, then $A \Rightarrow B$ is the unique $\vDash$-weakest proposal C such that $A \sqcap C \vDash B$.*

Proof sketch for reasons of space: if B is a singleton set, there is only one possible mapping from A-updates to B-updates, and we can rewrite $A \Rightarrow B = \{\{w \in \mathbf{W} : \text{if } w \in \bigcup A, \text{ then } w \in \bigcup B\}\} = \{\overline{\bigcup A} \cup \bigcup B\}$. This is just classical material implication with an extra set of curly brackets.

2.5 Semantics

To obtain InqU, we associate the basic operations of our semiring of proposals with the logical connectives.

Definition 14 (Unrestricted inquisitive semantics)
For p a proposition letter, φ and ψ formulae:

1. $[\![p]\!] = \{\{w : w(p) = 1\}\}$;
2. $[\![\bot]\!] = \{\varnothing\}$;
3. $[\![\varphi \vee \psi]\!] = [\![\varphi]\!] \cup [\![\psi]\!]$;
4. $[\![\varphi \wedge \psi]\!] = [\![\varphi]\!] \sqcap [\![\psi]\!]$;
5. $[\![\varphi \to \psi]\!] = [\![\varphi]\!] \Rightarrow [\![\psi]\!]$.

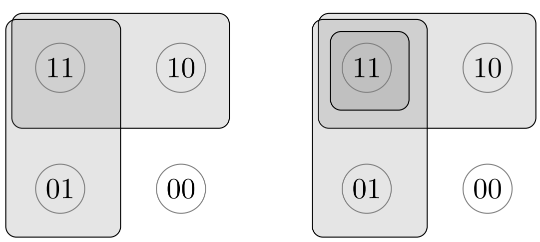
Recall that negation $\neg\varphi$ is defined as abbreviating $\varphi \to \bot$. Since $\bot$ denotes the singleton set $\{\varnothing\}$, fact 7 tells us that the semantic operation corresponding to negation is a *pseudo-complement* operation, i.e., $[\![\neg\varphi]\!]$ gives the entailment-weakest proposition A such that $[\![\varphi]\!] \sqcap A = [\![\bot]\!]$.

The semantics is equivalent to InqU in (Ciardelli et al., 2009), apart from the notion of entailment (and apart from some technical differences in how empty sets are treated). We can obtain the *information* conveyed by a proposal, by taking the union of all the proposed updates-as-states. Denoting by $[\varphi]$ the meaning of φ according to classical, boolean semantics, we can state the following:

Fact 8 (Conservativeness)
For any formula φ, $[\varphi] = \bigcup [\![\varphi]\!]$.

2.6 Example

As the reader can verify, (1) and (3), translated as $[\![p \vee q]\!]$ and $[\![p \vee q \vee (p \wedge q)]\!]$, are assigned the proposals depicted in figure 2.6. It is illustrated for a model that consists of four worlds (small circles), that differ with respect to two proposition letters p and q ('10' indicates that p is true and q is false, '11' that both are true, etc.). All rounded rectangles represent updates-as-states.



(a) $[\![p \vee q]\!]$ (b) $[\![p \vee q \vee (p \wedge q)]\!]$

Figure 1: The proposals denoted by (1) and (3) are distinct.

3 Unrestricted inquisitive pragmatics

Before presenting our account in detail, we will roughly sketch the *division of labour* employed to overcome the difficulties for a Gricean pragmatics mentioned in the introduction. The difficulties, recall, had to do with characterising relevant alternatives (the requirement for scales, the unwanted negation problem), the ad-hoc nature of the epistemic step, and a more general account of exhaustivity (example (3), mention-some questions).

Following (Groenendijk & Roelofsen, 2009), and in line with the collaborative nature of proposals, we assume that implicatures arise not from sentences in isolation, but from responses to an initiative. The initiator chooses which reponses are compliant, thereby *suggesting* a particular range of implicatures. The relevant alternatives for computing implicatures of a response are the update functions proposed by the initiator, in accordance with the following inquisitive version of the Gricean maxim of relation:[5]

Definition 15 (Maxim of relation (inquisitive))
Include in your proposals only functions that update the common ground with relevant information.

The relevant alternatives can thus be taken straight from the semantics, which renders the lexically specified, syntactic-semantic scales unnecessary, and the unwanted negation problem will not even occur.

The epistemic step will be made unnecessary by spelling out the context change potential of proposals in terms of *drawing attention* to, or away from, certain possibilities. As we will show, the pragmatic behaviour of both examples (1) and (3), as well as mention-some questions, are all captured by the same, simple reasoning pattern. In addition, a semantic characterisation of implicature-avoiding responses will be given.

3.1 Attending and unattending possibilities

We have defined InqU as a static semantics. Proposals are sets, static objects, instead of update functions on a context (although of course the elements in the set are conceived of as update functions on the common ground). Indeed, we have said nothing yet as to what kind of context proposals should change. Presumably, the context will record which proposals have been made, who committed to which update functions, etc..

For the present purposes, we assume rather minimalistically that the context change potential of a proposal is, for each proposed update function, to draw attention to the possibility that it is truthfully executed, i.e., to the possibility that the actual world is contained in the update-as-state, thereby 'unattending' all previously attended possibilities. This attentive aspect of proposals occurs also, quite centrally, in (Ciardelli et al., 2009).

[5] 'Alternative' here is a slightly misleading notion, for some updates may be included (qua state) in others, and hence not be genuine alternatives.

It is not necessary to redefine the entire semantics dynamically. It suffices to characterise a proposal's attending/unattending potential as follows (it is more natural here to call updates-as-states *possibilities*):

Definition 16 (Attending/Unattending)
A proposal B attends *the possibilities in B. In response to a proposal A, B* unattends *the possibilities $\alpha \in A$ s.t. $\alpha \cap \bigcup B \notin B$.*

For instance, replying to $p \vee q$ with p unattends the possibility that q. Replying with the stronger $p \wedge q$ does not unattend any possibility, since *given the new information*, the possibility that p (q) holds is still attended.

3.2 An account of (1) and (3)

Making explicit the attentive effect of proposals reveals that answering compliantly can be partly a destructive act. Given that all possibilities raised by the initiator are relevant in accordance with the maxim of relation, unattending any one of them will require a good reason. A reasonable explanation is that the responder knows that the possibility is not, in fact, a live possibility. This reasoning pattern is spelled out below for example (1), translated as $p \vee q$, with the response p.

Reasoning pattern 2 (Unrestr. inq. account)

1. *The initiator said $p \vee q$, attending the possibilities that p and q.*
2. *The possiblities that p and q are relevant.*
3. *The responder said p, unattending the possibility that q.*
4. *The reason for unattending this relevant possibility may reasonably be that the responder believes that q is false.*

The same reasoning works for (3), translated as $p \vee q \vee (p \wedge q)$, with the response p. Now $p \wedge q$ is added among the unattended possibilities, but this makes no difference, since $\neg q$ already entailed $\neg(p \wedge q)$.

Responding to either example (1) or (3) with 'both', $p \wedge q$, does not unattend any possibility. It provides so much information that the possibilities for p and q coincide, but they are still attended given the new information (cf. definition 16). Hence, this response does not yield an implicature for either example.

Responding to the examples with $p \vee q$, however, does make a difference. In response to (1) it does not unattend any possibility and no implicature arises, whereas in response to (3) it unattends the possibility that $p \wedge q$, yielding a 'not both' implicature. We think this is as it should be.

The relation between unattending and implying, as due to reasoning pattern 2, is as follows:

Fact 9 (Unattending and implying) *A response B to A, that does not unattend* all *possibilities of A,* implies *(that the world is contained in) $\boldsymbol{W} - \bigcup\{\alpha : B$ in response to A unattends $\alpha\}$.*

We restrict this fact to responses that maintain at least one of the possibilities of the initiative. Responses that unattend all possibilities of the initiative, e.g., $\neg\neg(p \vee q)$ in response to $p \vee q$, do not seem to give rise to reasoning pattern 2 and the resulting implicatures, perhaps because such responses cause a conversational crisis of some sort; but we leave this to future work.

Of course, initiatives, too, may license pragmatic inferences. We want to say that (1), although it does not imply anything, *suggests* that not both p and q obtain, while (3) does not. The following definition of suggestion achieves this.

Definition 17 (Suggestion)
Let $\mathsf{sing}(A)$ denote the set of singleton compliant responses to a proposal A. A proposal A suggests *that the actual world is in $\bigcup\{\beta$: for some $B \in \mathsf{sing}(A), B$ in response to A implies $\beta\}$*

Intuitively, this definition says that any proposal suggests what all its singleton compliant responses imply.

Finally, we can characterise the class of responses that yield exhaustivity implicatures (again excluding responses that unattend all possibilities of the initiative):

Fact 10 (Responses that imply exhaustivity)
A response B to A, that does not unattend all *possibilities of A, yields exhaustivity implicatures iff $B \not\models A$.*

Responses that entail the initiative, unattend nothing and, hence, do not yield exhaustivity implicatures. For example, this is the case for $p \vee (p \wedge q)$ in response to $p \vee q$, which could be seen as translating 'p, and maybe q'.

3.3 Mention-some: relevance in interaction

In reasoning pattern 2, step (iv) is clearly the defeasible one. In particular, it relies on the assumption that the possibilities that the initiator deemed relevant, remain relevant when the responder selects one of them. Of course, this assumption is not always appropriate. In particular, in response to mention-some questions, exemplified in (4) in the introduction, selecting one possibility renders all others irrelevant (Rooij & Schulz, 2006).

For instance, in response to the first example ('I will pick up the key...'), after ascertaining that the father will be home, the possibility that the mother will be home as well is no longer relevant - one person being home is sufficient for picking up the key. Therefore, step (iv) in reasoning pattern 2 does not go through, and the response does not yield the 'not both'-implicature.

More generally, because what is relevant may change during an interaction, responses to a mention-some question do not come with an exhaustivity implicature, and hence mention-some questions do not come with an exhaustivity suggestion.

3.4 Embedded implicatures

The difficulty of embedded implicatures, recall, was that in order to get the correct implicatures for disjunctions embedded under a quantifier, the relative alternatives somehow have to be computed in the embedded position (cf. example (2)). Clearly, InqU has the advantage that alternatives are a fundamental, compositionally computed part of the semantics. Indeed, no work remains to be done except to show the present account behaves well.

As we do not wish to introduce a complete first-order machinery, we will assume a finite domain $\{d_0 \dots d_n\}$ and the existence of sufficiently many propositional variables, such that we may treat a universal quantifier as a conjunction over all individuals in the domain. This simplistic account of quantification suffices for the present purposes.

Without loss of generality, let our domain consist of Mary, John and Bob, $\{m, j, b\}$. Let k_d denote the fact that individual d read *King Lear*, and similarly o_d for *Othello*. The problematic sentence in (2) then translates as:

(6) $(o_m \vee k_m) \wedge (o_j \vee k_j) \wedge (o_b \vee k_b)$

As the reader can verify by distributing the conjunctions over the disjunctions, the proposal denoted by this formula contains an update for $o_m \wedge o_j \wedge o_b$, an update for $o_m \wedge o_j \wedge k_b$, etc..

Responding compliantly by selecting any one of these possibilities unattends all the others. By reasoning pattern 2, such responses yield the implicature that every student read only either *Othello* or *King Lear*, not both (and similar, weaker implicatures arise for non-singleton compliant responses). The formula as a whole, then, suggests exhaustivity in exactly the same way as examples (1) or (3).

4 Comparison to basic inq. pragmatics

We will briefly compare our approach to the inquisitive pragmatics based on InqB, developed in (Groenendijk & Roelofsen, 2009), at least as far as examples (1) and (3) are concerned. Skipping over some important, but for the present scope inessential, differences, their account of (1) could read as follows:

Reasoning pattern 3 (Basic inq. account)

1. *The initiator said* $p \vee q$.
2. p *and* q *are compliant responses, while* $p \wedge q$ *is not.*
3. $p \wedge q$ *is stronger than either* p *or* q.
4. *The reason for not making the stronger response* $p \wedge q$ *compliant might be that the initiator believes* $p \wedge q$ *to be false.*

First, note that this account, like ours, has no dubious epistemic step. Deciding to not make a stronger response compliant, like unattending a possibility in our approach, is an active deed that needs justification. Second, this account requires the assumption that relevance is closed under conjunction (for where does $p \wedge q$, as an alternative, come from?). In our account, on the other hand, what is relevant is determined solely by the initiator.

More concretely, this account fails for (or was not designed for) example (3) ($p \vee q \vee (p \wedge q)$). First, in InqB $p \vee q$ and $p \vee q \vee (p \wedge q)$ denote the same proposition. Second, transfering reasoning pattern 3 to the richer InqU would not work. For $p \vee q \vee (p \wedge q)$, step (ii) would no longer apply, and no implicature would result.

5 Conclusion and outlook

Starting from the view of meanings as proposals, we conceptually motivated and algebraically characterised an unrestricted inquisitive semantics (InqU). The algebraic backbone of InqU turned out to be a commutative, idempotent semiring, and this gave rise to a new entailment order, and a compliance order of algebraically equal stature. We hope that the algebraic characterisation of InqU will help to link inquisitive semantics to other formalisms, such as propositional dynamic logic (see Eijk & Stokhof, 2006 for a recent overview). This could lead to a transfer of interesting proofs and concepts.

Based on InqU, we defined an essentially Gricean account of some exhaustivity implicatures, and showed how it overcomes a number of difficulties for the more traditional Gricean account. Among the difficulties we discussed were the problem of characterising relevant alternatives and the epistemic step. In addition, an analysis was given of the pragmatics of mention-some questions. The core ingredients for dealing with these analyses are the inherent, semantic notion of alternative in InqU and the pragmatics' focus on initiative/response pairs rather than single utterances. Both essentially followed from the same conceptual starting point: to conceive of meanings as proposals.

The present paper could not do sufficient justice to existing semantic and pragmatic theories of the phenomena discussed, several of which have been mentioned. In particular, (Chierchia et al., 2008) contains many more interesting challenges for a traditional Gricean pragmatics, each of which must be investigated from the viewpoint of unrestricted inquisitive semantics and pragmatics. For now, the relative ease (fingers crossed) with which the same reasoning scheme could be applied to the various phenomena discussed in this paper is at least a promising start.

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