

Information, Issues, and Attention*

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1 Introduction

Traditionally, the meaning of a sentence is identified with its *informative* content. However, even in a conversation whose only purpose is to exchange information, sentences are not only used to *provide* information. They are also used to *request* information. That is, sentences may be both informative and inquisitive.

Inquisitive semantics intends to capture these two dimensions of meaning in a uniform way.¹ It takes a sentence to express a proposal to update the common ground of a conversation. Such a proposal does not necessarily specify just one way of updating the common ground. It may suggest alternative ways of doing so, inviting other participants to establish one or more of the proposed updates. Formally, a proposition consists of one or more *possibilities*. Each

* An important source of inspiration for this paper was Ede's work on *might* and free choice disjunction (Zimmermann 2000). A preliminary, significantly shorter version of the paper first appeared as Ciardelli & Groenendijk & Roelofsen (2009) and the present, extended version of the paper was largely written in 2010. At that time, the framework of inquisitive semantics that the paper builds on still stood in its infancy. In the meantime, the framework has become more mature, and our general perspective on it has changed in certain respects (see, e.g., Ciardelli & Groenendijk & Roelofsen 2012, 2013a,b; Roelofsen 2013). However, these changes in perspective are largely orthogonal to the main proposal that is made in the present paper, which is to generalize the basic notion of meaning that is provided by inquisitive semantics in order to capture *attentive content* as well as informative and inquisitive content. We are very grateful to Maria Aloni, Luis Alonso-Ovalle, Scott Anderbois, Rajesh Bhatt, Maria Bittner, Chris Brumwell, Seth Cable, Noah Constant, Chris Davis, Paul Dekker, Sam van Gool, Tikitu de Jager, Stefan Kaufmann, Jan Köpping, Angelika Kratzer, Sarah Murray, Edgar Onea, Kathryn Pruitt, Aynat Rubinstein, Will Starr, Frank Veltman and Matthijs Westera for useful feedback on the ideas presented here, and to the Netherlands Organisation for Scientific Research (NWO) for financial support.

1 We assume here the formulation of inquisitive semantics as given in Ciardelli, (2009); Groenendijk & Roelofsen (2009). See Groenendijk (2009); Mascarenhas, (2009) for a different formulation, and Ciardelli, (2009); Ciardelli & Groenendijk & Roelofsen (2013b); Ciardelli & Roelofsen (2011); for arguments in favor of the former. Also, see Ciardelli & Groenendijk & Roelofsen (2012, 2013a,b); Roelofsen (2013) for a more recent perspective on the system proposed in Ciardelli, (2009); Groenendijk & Roelofsen (2009).

possibility is a set of possible worlds, embodying a potential update of the common ground. A sentence is *informative* iff there are possible worlds that are eliminated from the common ground by each of the proposed updates, and it is *inquisitive* iff it proposes two or more alternative updates, requesting information from other participants in order to establish at least one of these updates. Thus, construing propositions as sets of possibilities makes it possible to capture both the informative and the inquisitive content of a sentence.

In the present paper we argue that this notion of meaning has an additional advantage. Namely, it is also suitable to capture what we will call the *attentive* content of a sentence: its potential to draw attention to certain possibilities.

One empirical phenomenon that, in our view, calls for an account of attentive content, is the behavior of *might* sentences, like (1):²

(1) John might be in London.

This sentence clearly differs from the assertion in (2) and the question in (3).

(2) John is in London.

(3) Is John in London?

(1) differs from (2) in that it does not provide the information that John is in London, and it differs from (3) in that it does not require an informative response: one may respond to (1) simply by nodding, or saying “ok”.

Intuitively, the semantic contribution of (1) lies in its potential to *draw attention* to the possibility that John is in London. It is this attentive aspect of meaning that we wish to capture, and we will find that the notion of meaning propounded by inquisitive semantics is especially well-suited for this purpose.

The paper is organized as follows. Section 2 starts with a recapitulation of inquisitive semantics, as formulated in Ciardelli, (2009); Groenendijk & Roelofsen (2009), and also presents an alternative, for our purposes more flexible definition of the semantics. Section 3 shows how attentive content can be

2 The idea that a semantic analysis of *might* sentences should capture their potential to draw attention to certain possibilities is not new. It has been informally alluded to in various places in the literature, and several formal accounts have been proposed. See for instance Swanson (2006), Brumwell, (2009), de Jager (2009), Franke & de Jager (2011), as well as the closely related work of Yalcin, (2008) and Dekker (2010). All these accounts differ substantially from the one that will be offered here, both technically and in empirical scope. Some discussion will be provided in section 6, but a detailed comparison is left for a future occasion.

captured in a natural extension of this framework. In particular, it offers a straightforward analysis of the attentive content of *might* sentences, and shows that this analysis accounts for certain rather striking empirical facts concerning the interaction between *might* on the one hand, and disjunction, conjunction, negation, and implication on the other. Section 4 turns to pragmatic aspects of the interpretation of sentences that are not merely informative, but also inquisitive and/or attentive. This will lead, among other things, to a pragmatic account of the *epistemic* component of the interpretation of *might*. The proposed account will be compared with the classical analysis of *might* as an epistemic modal operator, and also with the treatment of *might* in Veltman's (1996) update semantics. Section 5 discusses the behaviour of *might* in certain embedded contexts, and argues on the basis of this that the semantic meaning of *might* sentences is, under certain conditions, strengthened in a particular way before being composed with the semantic meaning of the embedding operator. Section 6 closes with some final remarks.

2 Inquisitive Semantics

In inquisitive semantics, sentences are taken to express *proposals* to update the common ground of a conversation in one or more ways. Technically, the proposition expressed by a sentence is taken to be a set of alternative *possibilities*. Each possibility is a set of possible worlds, embodying a way to update the common ground. In this setting, a sentence may be *informative*, in the sense that certain possible worlds may be eliminated from the common ground by any of the proposed updates, and it may also be *inquisitive*, in the sense that it may express a proposition consisting of two or more alternative possibilities, requesting information from other participants in order to establish at least one of these alternatives.

Thus, the proposition that a sentence expresses in inquisitive semantics embodies both the information that it *provides* and the information that it *requests* from other conversational participants. If a sentence ϕ expresses a proposition $[\phi]$, it provides the information that at least one of the possibilities in $[\phi]$ obtains, and, in case $[\phi]$ contains two or more alternative possibilities, it requests information from other participants in order to establish at least one of these possibilities.

2.1 Alternatives

In Ciardelli, (2009); Groenendijk & Roelofsen (2009), propositions are not just construed as arbitrary sets of possibilities, but rather as sets of *alternative*

possibilities, i.e., sets of possibilities such that no possibility is contained in any other possibility. The rationale behind this is as follows.

Suppose that a proposition $[\phi]$ contains two possibilities, α and β (possibly among others), such that $\alpha \subset \beta$. In this case, α does not really help in any way to represent the information that ϕ provides or requests. For, on the one hand, saying that at least one of α and β obtains is just as informative under these circumstances as saying that β obtains. And on the other hand, asking other participants to provide enough information to establish at least one of α or β is just the same as asking them to provide enough information to establish β . Thus, possibilities that are included in other possibilities do not really contribute to representing the informative and inquisitive content of a sentence. Therefore, as long as we are only interested in capturing informative and inquisitive content, non-maximal possibilities may be disregarded, and propositions can be construed as sets of alternative possibilities.³

2.2 Propositions via Support

We will define an inquisitive semantics for a propositional language, which is based on a finite set of atomic sentences, and has \neg , \wedge , \vee , and \rightarrow as its basic logical operators. There are also two additional operators, $?$ and $!$, to which we will refer as *non-inquisitive* and *non-informative closure*, respectively. $?\phi$ is defined as an abbreviation of $\phi \vee \neg\phi$ and $!\phi$ is defined as an abbreviation of $\neg\neg\phi$. The rationale behind these definitions will become clear presently.

We will provide two alternative definitions of the semantics. The first is the original definition from Ciardelli, (2009) and Groenendijk & Roelofsen (2009).

3 There is an important caveat to note here: strictly speaking, non-maximal possibilities may only be disregarded if they are included in a maximal possibility. In the propositional setting that we consider here that is always the case because there are only finitely many distinct possibilities. However, as observed and discussed in detail in Ciardelli (2009, 2010) and Ciardelli & Groenendijk & Roelofsen (2013c), this is not necessarily the case in the first-order setting.

This is one technical point where more recent formulations of inquisitive semantics take a different route: rather than construing propositions as sets of *alternative* possibilities, they take propositions to be sets of possibilities that are *downward closed*, i.e., if a proposition contains a certain possibility α then it also contains every possibility $\beta \subset \alpha$. This gives essentially the same results for the propositional setting, but it extends more straightforwardly to the first-order setting. Moreover, it more naturally allows for an algebraic characterization of the semantics, which provides important insight into the logical workings of the system (Ciardelli & Groenendijk & Roelofsen 2012, 2013a; Roelofsen 2013). However, for our current purposes it is convenient to stick to the view of propositions as sets of alternative possibilities, as in Ciardelli, (2009); Groenendijk & Roelofsen (2009).

This is an ‘indirect’ definition, in the sense that the propositions expressed by the sentences of our language are defined via the intermediary notion of *support*. The second definition that we will provide, also already discussed in Ciardelli, (2009), is more direct—it bypasses the notion of support, and immediately construes the propositions expressed by the sentences of our language in a recursive fashion.

In the support setup, the basic ingredients for the semantics are *possible worlds* and *states*. A possible world is a valuation function that assigns truth values to every atomic sentence in the language. We will use w as a meta-variable ranging over possible worlds, and we will use ω to denote the set of all possible worlds. A state is a set of possible worlds. We will use s, t as meta-variables ranging over states.

The proposition expressed by a sentence is defined in terms of the notion of *support* (just as, in a classical setting, the meaning of a sentence is usually defined in terms of truth). Support is a relation between states and sentences. We write $s \models \phi$ for ‘ s supports ϕ ’.

Definition 1 (Support⁴).

1. $s \models p$ iff $\forall w \in s : w(p) = 1$
2. $s \models \neg\phi$ iff $\forall t \subseteq s : t \not\models \phi$
3. $s \models \phi \wedge \psi$ iff $s \models \phi$ and $s \models \psi$
4. $s \models \phi \vee \psi$ iff $s \models \phi$ or $s \models \psi$
5. $s \models \phi \rightarrow \psi$ iff $\forall t \subseteq s : \text{if } t \models \phi \text{ then } t \models \psi$

It follows from the above definition that for any sentence ϕ , the empty state supports both ϕ and $\neg\phi$. Thus, we can think of \emptyset as the *inconsistent* state.

Definition 2 (Propositions and possibilities).

- The *proposition* expressed by ϕ is the set of maximal states supporting ϕ , that is, the set of states that support ϕ and are not properly included in any other state supporting ϕ .
- Every maximal state supporting ϕ is called a *possibility* for ϕ .

4 Readers familiar with intuitionistic logic will notice that the notion of support is very similar to the notion of satisfaction in Kripkean semantics for intuitionistic logic. For an exploration of this connection, see Ciardelli, (2009) and Ciardelli & Roelofsen (2011).

In a classical setting, the proposition expressed by ϕ is the set of all possible worlds that make ϕ true. Here, the proposition expressed by ϕ is defined in terms of support rather than in terms of truth. It may be expected, then, that the proposition expressed by ϕ would be defined as the set of all states supporting ϕ . Rather, though, it is defined as the set of all *maximal* states supporting ϕ . This is motivated by the considerations in section 2.1: as long as we are only interested in informative and inquisitive content, propositions can be construed as sets of *alternative* possibilities. If one state is included in another, we do not regard these two states as alternatives.

2.3 *Bypassing Support*

We will now provide a more direct definition of the propositions expressed by the sentences of our language. This alternative definition will yield exactly the same result as the original one, but later on, when we are no longer exclusively interested in informative and inquisitive content, but also in attentive content, we will see that the alternative definition can be adapted straightforwardly, while the original definition in terms of support does not provide such flexibility.

In this alternative setup, we provide a direct recursive definition of the possibilities for a sentence. We will use α, β here as meta-variables ranging over possibilities, and \mathcal{P} as a meta-variable ranging over sets of possibilities. Propositions are non-empty sets of alternative possibilities:

Definition 3 (Propositions).

A proposition is a non-empty set of alternative possibilities, that is, a set of possibilities \mathcal{P} such that $\mathcal{P} \neq \emptyset$ and for no $\alpha, \beta \in \mathcal{P}$: $\alpha \subset \beta$.

In order to give a recursive definition of the propositions expressed by the sentences of our language, we define an operator ALT which transforms any non-empty set of possibilities \mathcal{P} into a non-empty set of *alternative* possibilities.

Definition 4 $\text{ALT}\mathcal{P} = \{\alpha \in \mathcal{P} \mid \text{there is no } \beta \in \mathcal{P} \text{ such that } \alpha \subset \beta\}$

The proposition expressed by a sentence ϕ is denoted by $[\phi]$, and is recursively defined as follows.

Definition 5 (Inquisitive semantics bypassing support).

1. $[p] = \{\{w \mid w(p) = 1\}\}$ if p is atomic
2. $[\neg\phi] = \{\overline{\cup[\phi]}\}$
3. $[\phi \vee \psi] = \text{ALT}([\phi] \cup [\psi])$
4. $[\phi \wedge \psi] = \text{ALT}\{\alpha \cap \beta \mid \alpha \in [\phi] \text{ and } \beta \in [\psi]\}$
5. $[\phi \rightarrow \psi] = \text{ALT}\{\gamma_f \mid f \in [\psi]^{[\phi]}\}$, where $\gamma_f = \bigcap_{\alpha \in [\phi]} (\alpha \Rightarrow f(\alpha))$

The clause for implication needs some further explanation. First, $[\psi]^{[\phi]}$ denotes the set of functions from $[\phi]$ to $[\psi]$. Thus, every $f \in [\psi]^{[\phi]}$ is a function mapping every possibility α in $[\phi]$ to some possibility $f(\alpha)$ in $[\psi]$. Second, the semantic conditional operator \Rightarrow remains to be specified. For simplicity, we define \Rightarrow as material implication here, but in principle a more sophisticated semantic conditional operator could be ‘plugged in’ here.

Definition 6 (Semantic conditional operator). For any two possibilities α and β :

$$- \alpha \Rightarrow \beta := \overline{\alpha} \cup \beta$$

Definitions 5 and 6 assure that $[\phi]$ is always a set of alternative possibilities, to which we will refer as the possibilities for ϕ . The following correspondence result says that the direct recursive definition of the semantics yields exactly the same results as the original definition via support.

Proposition 7 (Correspondence). For any sentence ϕ and any state α :

$$- \alpha \in [\phi] \text{ iff } \alpha \text{ is a maximal state supporting } \phi$$

2.4 Illustration

Let us briefly go through the clauses of definition 5 one by one. In doing so, it will be useful to have some terminology and notation to refer to the classical meaning of a sentence. For any sentence ϕ , we will denote the set of possible worlds where ϕ is classically true as $|\phi|$, and we will refer to this set of possible worlds as the *truth set* of ϕ . It will also be useful to make a distinction between sentences whose proposition consists of a single possibility, and sentences whose proposition consists of two or more alternative possibilities. We will refer to the former as *classical* sentences, and to the latter as *inquisitive* sentences. Figure 1 provides some examples of inquisitive sentences, which will be discussed in more detail below.

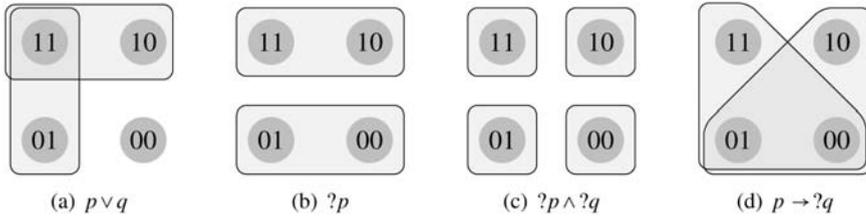


FIGURE 1 Some examples of inquisitive sentences. In each figure, 11 is a possible world where both p and q are true, 10 is a possible world where p is true and q is false, etcetera.

2.4.1 Atoms

The proposition expressed by an atomic sentence p always consists of just one possibility, $\{w \mid w(p) = 1\}$, which coincides with its truth set, $|p|$. Thus, an atomic sentence is always classical.

2.4.2 Negation

In a classical setting, negation amounts to set complementation. That is, the truth set of $\neg\phi$ is defined as the complement of the truth set of ϕ itself. In the present framework, the proposition expressed by ϕ is not a simple set of possible worlds, but rather a set of possibilities, each of which is in turn a set of possible worlds. In order to determine the proposition expressed by $\neg\phi$, we first take the union of all the possibilities for ϕ , and then take the complement. The resulting possibility, $\overline{\bigcup[\phi]}$, is the unique possibility for $\neg\phi$. This means that negated sentences, just like atomic sentences, are always classical.⁵

2.4.3 Non-inquisitive Closure

The non-inquisitive closure of ϕ , $!\phi$, is defined as an abbreviation of $\neg\neg\phi$. Like any other negated sentence, $\neg\neg\phi$ is never inquisitive. Moreover, $\neg\neg\phi$ always has exactly the same informative content as ϕ itself. As will be discussed in more detail below, the informative content of ϕ is captured by the union of all the possibilities for ϕ . Since $[\neg\neg\phi] = \{\bigcup[\phi]\}$, we always have that $\bigcup[\neg\neg\phi] = \bigcup[\phi]$. That is, besides always being non-inquisitive, $\neg\neg\phi$ always ‘preserves’ the informative content of ϕ . This is exactly what is to be expected of a non-inquisitive closure operator.

5 We should note that this is not the only possible way to treat negation in an inquisitive setting. See Groenendijk & Roelofsen (2010, 2014); Lojko, (2012) for an alternative treatment.

2.4.4 Disjunction

Disjunctions are typically inquisitive. To determine the proposition expressed by a disjunction $\phi \vee \psi$ we first collect all possibilities for ϕ and all possibilities for ψ , and then apply ALT to obtain a proposition. For instance, as depicted in figure 1(a), the proposition expressed by $p \vee q$ consists of two possibilities: the possibility that p , and the possibility that q .

2.4.5 Non-informative Closure

The non-informative closure of ϕ , $?\phi$, is defined as an abbreviation of $\phi \vee \neg\phi$. This means that $[?\phi] = \text{ALT}([\phi] \cup [\neg\phi])$. For instance, as depicted in figure 1(b), the proposition expressed by $?p$ consists of two possibilities, the possibility that p , and the possibility that $\neg p$. In general, $\phi \vee \neg\phi$ is never informative, and always preserves the inquisitive content of ϕ , in a sense to be made more precise below. This is exactly what is to be expected of a non-informative closure operator.

2.4.6 Conjunction

To determine the proposition expressed by a conjunction $\phi \wedge \psi$ we take the pairwise intersection of all possibilities for ϕ and all possibilities for ψ , and then apply ALT to obtain a proposition. Notice that if ϕ and ψ are both classical, then conjunction simply amounts to intersection, just as in the classical setting. Figure 1(c) depicts the proposition expressed by $?p \wedge ?q$. In this case both conjuncts are inquisitive, and conjunction amounts to pairwise intersection.

2.4.7 Implication

The clause for implication is the one that is most involved. Let us consider two cases separately. First, suppose that the consequent of the implication, ψ , is non-inquisitive. As a concrete example, take $(p \vee q) \rightarrow r$. In this case, there exists only one function from $[\phi] = \{|p|, |q|\}$ to $[\psi] = \{|r|\}$, namely the function that maps both $|p|$ and $|q|$ to $|r|$. Call this function f_* . Then the only possibility for $[\phi \rightarrow \psi]$ is γ_{f_*} , which is defined as follows:

$$\bigcap_{\alpha \in [\phi]} (\alpha \Rightarrow f_*(\alpha))$$

Given the definition of \Rightarrow , this amounts to $|(p \rightarrow r) \wedge (q \rightarrow r)|$, which can be simplified to $|(p \vee q) \rightarrow r|$. Thus, $(p \vee q) \rightarrow r$ behaves classically. And this holds more generally: whenever the consequent ψ of a conditional $\phi \rightarrow \psi$ is non-inquisitive, the unique possibility for that conditional is $|\phi \rightarrow \psi|$.

Now suppose that ψ is inquisitive, but that the antecedent, ϕ , is non-inquisitive. Take as a concrete example the conditional question $p \rightarrow ?q$. In this case,

there is one possibility for the antecedent, $|p|$, and two for the consequent, $|q|$ and $|\neg q|$. So there are two functions from $[\phi]$ to $[\psi]$ in this case, one mapping $|p|$ to $|q|$, and one mapping $|p|$ to $|\neg q|$. Call the first f_q and the second $f_{\neg q}$. The corresponding possibilities are:

$$\begin{aligned} \gamma_{f_q} &= |p| \Rightarrow |q| = |p \rightarrow q| \\ \gamma_{f_{\neg q}} &= |p| \Rightarrow |\neg q| = |p \rightarrow \neg q| \end{aligned}$$

So the proposition expressed by $p \rightarrow ?q$ is $\{|p \rightarrow q|, |p \rightarrow \neg q|\}$, as depicted in figure 1(d). This reflects the empirical observation that the expected answers to a conditional question like (4) are (5a) and (5b):

- (4) If John goes to London, will he fly British Airways?
- (5) a. Yes, if he goes to London, he will fly BA.
b. No, if he goes to London, he won't fly BA.

2.4.8 Implication and Negation

Before moving on, let us briefly remark that negation and implication are closely related in the present system. Namely, $\neg\phi$ is always equivalent with $\phi \rightarrow \perp$, where \perp can be any sentence that expresses the absurd proposition $\{\emptyset\}$. This conception will be useful in section 3.4.

2.5 Informative and Inquisitive Content

In the introduction, we pointed out informally that propositions, construed as sets of alternative possibilities, capture both the informative and the inquisitive content of a sentence. Now we are in a position to say more precisely what this means. The *informative content* of a sentence ϕ , denoted by $\text{info}(\phi)$, is characterized by the *union* of all the possibilities for ϕ . Possible worlds that are not included in $\cup[\phi]$ are eliminated from the common ground if any of the updates proposed by ϕ is realized. In this sense, ϕ proposes to eliminate any possible world that is not in $\cup[\phi]$.

The *inquisitive content* of a sentence ϕ , denoted by $\text{inq}(\phi)$, should capture what kind of response is needed to settle the proposal expressed by ϕ . One way to settle this proposal is to *accept* it, and to provide enough information to realize one or more of the proposed updates. Another way to settle the proposal is to *reject* it. Thus, the inquisitive content of ϕ must reflect what kind of information is required to realize one of the proposed updates, or to reject the proposal altogether. The information that is required to realize one of the proposed updates is determined by the possibilities for ϕ , while the

information that is required to reject the proposal is determined by the unique possibility for $\neg\phi$. Thus, on a first approximation, $\text{inq}(\phi)$ should be defined as $[\phi] \cup [\neg\phi]$. However, this definition needs to be refined. In line with earlier remarks, only the *maximal* possibilities in $[\phi] \cup [\neg\phi]$ really determine which information is *required* to settle the proposal expressed by ϕ . Thus, $\text{inq}(\phi)$ is defined as $\text{ALT}([\phi] \cup [\neg\phi])$. Incidentally, the only non-maximal possibility in $[\phi] \cup [\neg\phi]$, if any, is the *empty* possibility. So the only effect of ALT here, if any, is to remove the empty possibility. In sum:

Definition 8 (Informative and inquisitive content).

- $\text{info}(\phi) = \bigcup[\phi]$
- $\text{inq}(\phi) = \text{ALT}([\phi] \cup [\neg\phi])$

The inquisitive content of a sentence ϕ always corresponds with the proposition expressed by $?\phi$.

Proposition 9. For any sentence ϕ , $\text{inq}(\phi) = [?\phi]$

The informative content of a sentence always corresponds with its truth set.

Proposition 10. For any sentence ϕ , $\text{info}(\phi) = |\phi|$

This means that the system presented here extends classical propositional logic in a ‘conservative’ way: every sentence is assigned exactly the same informative content as in the classical setting. The difference is that classical propositional logic is exclusively concerned with informative content, while our system captures inquisitive content as well.

Finally, informative and inquisitive content completely exhaust the meaning of a sentence in the present system. Two sentences have the same informative and inquisitive content if and only if they express exactly the same proposition.

Proposition 11. (Informative and inquisitive content exhaust meaning).

For any ϕ and ψ , $[\phi] = [\psi] \iff \text{info}(\phi) = \text{info}(\psi)$ and $\text{inq}(\phi) = \text{inq}(\psi)$

2.6 Informative and Inquisitive Sentences

We will say that a sentence ϕ is informative if and only if $\text{info}(\phi)$ does not cover the entire logical space. In this case, there are possible worlds that are not

included in $\bigcup[\phi]$, and ϕ proposes to eliminate these possible worlds from the common ground.

We will say that ϕ is inquisitive if and only if ϕ does not provide enough information to establish any of the updates that it proposes. In this case, an informative response is required in order to establish one or more of the proposed updates.

When does ϕ not provide enough information to establish any of the updates that it proposes? Just in case $\text{info}(\phi)$ is not contained in any of the possibilities for ϕ . But $\text{info}(\phi)$ is defined as $\bigcup[\phi]$. So if $\text{info}(\phi)$ is contained in some possibility for ϕ , then it must actually *coincide* with that possibility, and we must have that $\text{info}(\phi) \in [\phi]$. So ϕ is inquisitive if and only if $\text{info}(\phi) \notin [\phi]$. In sum:

Definition 12 (Informative and inquisitive sentences).

- ϕ is *informative* iff $\text{info}(\phi) \neq \omega$;
- ϕ is *inquisitive* iff $\text{info}(\phi) \notin [\phi]$.

Inquisitive sentences can also be characterized as sentences expressing a proposition that contains at least two alternative possibilities.

Proposition 13 (Alternative characterization of inquisitive sentences).

- ϕ is *inquisitive* iff $[\phi]$ contains at least two alternative possibilities.

In illustrating the clauses of our semantics, we saw that it was useful to also have a term for *classical* sentences, whose proposition consists of exactly one possibility.

Definition 14 (Classical sentences).

- ϕ is *classical* iff $[\phi]$ contains exactly one possibility.

Clearly, given proposition 13, a sentence is classical just in case it is non-inquisitive.

Proposition 15 (Classical and inquisitive sentences).

- ϕ is classical iff it is not inquisitive.

Classical sentences ‘behave classically’ in the sense that their unique possibility always coincides with their truth set. Interestingly, such classical behavior is preserved by all connectives except for disjunction.

Proposition 16 (Connectives preserving classical behavior).

For any proposition letter p and any sentences ϕ and ψ :

1. p and $\neg\phi$ are classical;
2. If both ϕ and ψ are classical, then so is $\phi \wedge \psi$;
3. If ψ is classical, then so is $\phi \rightarrow \psi$.

It follows that any disjunction-free sentence is classical, which means that disjunction is the only source of non-classical behavior in the present system.

Corollary 17. Any disjunction-free sentence is classical.

Tautologies are defined as sentences that express the trivial proposal, and contradictions are defined as sentences that express the absurd proposal.

Definition 18 (Tautologies and contradictions).

- ϕ is a *tautology* iff $[\phi] = \{\omega\}$
- ϕ is a *contradiction* iff $[\phi] = \{\emptyset\}$

It is easy to see that a sentence is a contradiction in the present system iff it is a classical contradiction. However, this does not hold for tautologies. Classically, a sentence is meaningful (non-tautological) iff it is informative. In the present system, a sentence is meaningful if it is informative, but also if it is inquisitive. Thus, a sentence like $?p$, which is a classical tautology, is now meaningful.

Conversely, any sentence which is *not* informative or inquisitive is a tautology. So the only way for a sentence to be meaningful in the present system is to be informative or inquisitive.

Proposition 19. A sentence is non-tautological iff it is informative or inquisitive.

Informative and inquisitive sentences have been defined directly in terms of the propositions that they express. However, they can also be characterized in terms of our syntactic non-inquisitive and non-informative closure operators.

Definition 20 (Equivalence).

Two sentences ϕ and ψ are *equivalent*, $\phi \sim \psi$, if and only if $[\phi] = [\psi]$.

Proposition 21 (Semantic categories and syntactic operators).

1. ϕ is non-informative iff $\phi \sim ?\phi$
2. ϕ is non-inquisitive iff $\phi \sim !\phi$

2.7 *Proper Possibilities and the Empty Possibility*

Possibilities have been defined as arbitrary sets of possible worlds. This means, in particular, that the *empty* set of possible worlds also counts as a possibility. It is worth commenting briefly on this feature of the system.

First, note that the empty possibility, unlike any other possibility, embodies an update that always leads to an *inconsistent* common ground. Thus, assuming that conversational participants aim to maintain a consistent common ground, the empty possibility embodies an update that cannot seriously be proposed, and certainly will never be established. In this light, we really only think of non-empty possibilities as proper possibilities.

Definition 22 (Proper possibilities).

- A proper possibility is a non-empty set of possible worlds;
- For any sentence ϕ , $\Pi(\phi)$ will denote the set of proper possibilities for ϕ .

There is only one proposition that contains the empty possibility, namely the absurd proposition, $\{\emptyset\}$, which is expressed by contradictions. Propositions expressed by non-contradictory sentences always consist entirely of proper possibilities. This means that the set of proper possibilities for a sentence always completely determines its meaning.

Proposition 23 (Proper possibilities fully determine meaning).

For any two sentences ϕ and ψ :

- $[\phi] = [\psi]$ iff $\Pi(\phi) = \Pi(\psi)$

This concludes the recapitulation of the basic system of inquisitive semantics that covers informative and inquisitive content. We now turn to the main concern of this paper of adding attentive content as a third component of meaning.

3 Attention

We observed in the introduction that, at least in some intuitive sense, the semantic contribution of sentences like (6) lies in their potential to draw attention to certain possibilities, in this case the possibility that John is in London.

(6) John might be in London.

The conception of a proposition as a set of possibilities is ideally suited to capture this intuition. We can simply think of the proper possibilities for a sentence ϕ as the possibilities that ϕ draws attention to; the possibilities that it proposes to take into consideration. At the same time, we can still think of ϕ as providing the information that at least one of the possibilities in $[\phi]$ obtains, and as requesting information in order to establish one or more of these possibilities. Thus, if a proposition is conceived of as a set of possibilities, it may in principle capture the informative, inquisitive, and attentive content of a sentence all at once.

Recall that in section 2 propositions were formally defined as sets of *alternative* possibilities. This was because non-maximal possibilities did not contribute in any way to the representation of informative and inquisitive content, and these were the only aspects of meaning that we were interested in. However, as soon as attentive content becomes of interest, non-maximal possibilities should be taken into account as well. In general, there is no reason why a sentence may not draw attention to two possibilities α and β such that $\alpha \subset \beta$. Thus, there is no general need to filter out non-maximal possibilities anymore.

What we do want to preserve is the characteristic feature of our system that the meaning of a sentence is completely determined by its *proper* possibilities. Thus, we will assure that the proposition expressed by non-contradictory sentences always consists entirely of proper possibilities. As before, the only proposition that contains the empty possibility will be $\{\emptyset\}$, the absurd proposition, expressed by contradictions.

Definition 24 (Propositions).

A proposition is either a non-empty set of proper possibilities, or $\{\emptyset\}$.

In defining the semantics of our formal language, we will of course no longer make use of ALT (which turned any \mathcal{P} into a set of *alternative* possibilities), but

rather of a function PRO , which turns any \mathcal{P} into a proposition in the sense of definition 24. Other than this, the semantics remains untouched.⁶

Definition 25. $\text{PRO}\mathcal{P} = \begin{cases} \mathcal{P} - \{\emptyset\} & \text{if } \mathcal{P} \neq \{\emptyset\} \\ \mathcal{P} & \text{if } \mathcal{P} = \{\emptyset\} \end{cases}$

Definition 26 (Unrestricted inquisitive semantics).

1. $\llbracket p \rrbracket = \{\{w \mid w(p) = 1\}\}$ if p is atomic
2. $\llbracket \neg\phi \rrbracket = \{\bigcup \llbracket \phi \rrbracket\}$
3. $\llbracket \phi \vee \psi \rrbracket = \text{PRO}(\llbracket \phi \rrbracket \cup \llbracket \psi \rrbracket)$
4. $\llbracket \phi \wedge \psi \rrbracket = \text{PRO}\{\alpha \cap \beta \mid \alpha \in \llbracket \phi \rrbracket \text{ and } \beta \in \llbracket \psi \rrbracket\}$
5. $\llbracket \phi \rightarrow \psi \rrbracket = \text{PRO}\{\gamma_f \mid f \in \llbracket \psi \rrbracket^{\llbracket \phi \rrbracket}\}$, where $\gamma_f = \bigcap_{\alpha \in \llbracket \phi \rrbracket} (\alpha \Rightarrow f(\alpha))$

In comparing the system defined in section 2 with the one defined here, we will refer to the former as *restricted* inquisitive semantics, or $\text{Inq}_{\mathcal{C}}$ for short, and to the latter as *unrestricted* inquisitive semantics, or Inq_{\emptyset} for short.

Notice that in definition 26 we use the notation $\llbracket \phi \rrbracket$ in order to avoid confusion with $[\phi]$. Thus, $|\phi|$ is the proposition that is classically expressed by ϕ , $[\phi]$ is the proposition expressed by ϕ in $\text{Inq}_{\mathcal{C}}$, and $\llbracket \phi \rrbracket$ is the proposition expressed by ϕ in Inq_{\emptyset} . If no confusion arises, we will henceforth simply refer to $\llbracket \phi \rrbracket$ as the proposition expressed by ϕ , and to the elements of $\llbracket \phi \rrbracket$ as the possibilities for ϕ .

The basic formal connection between $\text{Inq}_{\mathcal{C}}$ and Inq_{\emptyset} is that $[\phi]$ always consists of the *alternative* possibilities in $\llbracket \phi \rrbracket$.

Proposition 27. For every sentence ϕ , $[\phi] = \text{ALT}\llbracket \phi \rrbracket$

Corollary 28. For every sentence ϕ , $\bigcup \llbracket \phi \rrbracket = \bigcup [\phi] = |\phi|$

We will continue to use $\Pi(\phi)$ to denote the set of proper possibilities for ϕ . As in $\text{Inq}_{\mathcal{C}}$, the meaning of a sentence is determined by its proper possibilities.

Proposition 29 (Proper possibilities fully determine meaning).

6 This semantics was first introduced under the name of *possibility semantics* in Ciardelli, (2009), where it served a different purpose, namely, to directly associate possibilities to first-order formulas that lack maximal supporting states. The only difference with the definition given there is that, in the present setting, the empty state is filtered out from any consistent proposition.

For any two sentences ϕ and ψ :

- $\llbracket \phi \rrbracket = \llbracket \psi \rrbracket$ iff $\Pi(\phi) = \Pi(\psi)$

3.1 *Informativeness, Inquisitiveness, and Attentiveness*

As in $\text{Inq}_{\mathcal{A}}$, the informative content of a sentence ϕ in Inq_{\emptyset} is characterized by the union of all the possibilities for ϕ , $\text{info}(\phi) = \bigcup \llbracket \phi \rrbracket$. As stated above, $\bigcup \llbracket \phi \rrbracket = \bigcup [\phi] = |\phi|$ for every ϕ , so the informative content of a sentence is exactly the same in Inq_{\emptyset} and in $\text{Inq}_{\mathcal{A}}$. In particular, Inq_{\emptyset} preserves the classical treatment of informative content, just as $\text{Inq}_{\mathcal{A}}$ did.

The notion of inquisitive content also remains exactly the same. In order to determine the inquisitive content of a sentence ϕ , we first collect all the possibilities for ϕ and all the possibilities for $\neg\phi$, obtaining $\llbracket \phi \rrbracket \cup \llbracket \neg\phi \rrbracket$, and then filter out non-maximal possibilities using ALT. Even though $\llbracket \phi \rrbracket$ now may contain non-maximal possibilities, the end-result of this procedure will be the same as in $\text{Inq}_{\mathcal{A}}$.

Definition 30 (Informative and inquisitive content).

- $\text{info}(\phi) = \bigcup \llbracket \phi \rrbracket$
- $\text{inq}(\phi) = \text{ALT}(\llbracket \phi \rrbracket \cup \llbracket \neg\phi \rrbracket)$

We also still have that $\text{inq}(\phi) = [?\phi]$ for every ϕ . However, it is *not* the case for every ϕ that $\text{inq}(\phi) = \llbracket ?\phi \rrbracket$, again reflecting the fact that inquisitive content is characterized exclusively in terms of *alternative* possibilities.

Proposition 31. For every sentence ϕ , $\text{inq}(\phi) = [?\phi]$

Now let us turn to the characterization of informative and inquisitive sentences. The basic definitions directly carry over from $\text{Inq}_{\mathcal{A}}$ to Inq_{\emptyset} :

Definition 32 (Informative and inquisitive sentences).

- ϕ is informative if and only if $\text{info}(\phi) \neq \omega$;
- ϕ is inquisitive if and only if $\text{info}(\phi) \notin \llbracket \phi \rrbracket$.

The alternative characterization of inquisitive sentences given in proposition 13 also carries over to Inq_{\emptyset} , although here it is important to emphasize, again, that in order for ϕ to be inquisitive, $\llbracket \phi \rrbracket$ must really contain two or more *alternative* possibilities, not just two or more possibilities. For instance, if $\phi =$

$p \vee (p \wedge q)$, then $\llbracket \phi \rrbracket = \{|p|, |p \wedge q|\}$, while $\text{info}(\phi) = |p|$. So $\llbracket \phi \rrbracket$ contains two possibilities, but $\text{info}(\phi) \in \llbracket \phi \rrbracket$ which means that ϕ provides enough information to realize one of the proposed updates, and therefore that ϕ is not inquisitive. More generally, as long as $\llbracket \phi \rrbracket$ contains only one maximal possibility (besides an arbitrary number of non-maximal possibilities) it provides enough information to establish one of the updates that it proposes, and it is therefore not inquisitive. Only if $\llbracket \phi \rrbracket$ contains two or more alternative possibilities, can we be sure that ϕ is inquisitive.

Proposition 33 (Alternative characterization of inquisitive sentences).

- ϕ is inquisitive iff $\llbracket \phi \rrbracket$ contains at least two alternative possibilities.

Besides inquisitiveness and informativeness, attentiveness also plays a role in Inq_\emptyset . The attentive content of a sentence ϕ , $\text{att}(\phi)$, will be defined as the set of proper possibilities for ϕ , $\Pi(\phi)$. These are the possibilities that ϕ draws attention to, that it proposes to take into consideration. It will be useful to introduce a second, more constrained notion of attentive content as well, which is embodied by the *non-maximal* possibilities for ϕ . Maximal possibilities partly determine attentive content, but also informative and inquisitive content. Non-maximal possibilities are insignificant as far as informative and inquisitive content are concerned. Thus, we can think of these non-maximal possibilities as making up the *residual attentive content* of a sentence ϕ , $\text{att}_R(\phi)$. If $\text{att}_R(\phi) \neq \emptyset$, that is, if ϕ draws attention to non-maximal possibilities, then we will say that ϕ has residual attentive content, or for short, that it is *attentive*.

Definition 34 (Attentiveness).

- $\text{att}(\phi) = \Pi(\phi)$
- $\text{att}_R(\phi) = \text{att}(\phi) - [\phi]$
- ϕ is attentive iff $\text{att}_R(\phi) \neq \emptyset$

In Inq_Q , the meaning of a sentence was completely exhausted by its informative and inquisitive content. This is no longer the case in Inq_\emptyset . For instance, p and $p \vee (p \wedge q)$ have exactly the same informative and inquisitive content, but express different propositions in Inq_\emptyset . However, the meaning of a sentence is fully determined by its informative, inquisitive, and residual attentive content.

Proposition 35. For any two sentences ϕ and ψ , the following are equivalent:

1. $\llbracket \phi \rrbracket = \llbracket \psi \rrbracket$
2. $\text{info}(\phi) = \text{info}(\psi)$, $\text{inq}(\phi) = \text{inq}(\psi)$, and $\text{att}_R(\phi) = \text{att}_R(\psi)$

As in $\text{Inq}_{\mathcal{C}}$, tautologies are defined as sentences that express the trivial proposal, and contradictions are defined as sentences that express the absurd proposal.

Definition 36 (Tautologies and contradictions).

- ϕ is a *tautology* iff $\llbracket \phi \rrbracket = \{\omega\}$;
- ϕ is a *contradiction* iff $\llbracket \phi \rrbracket = \{\emptyset\}$.

The only way for a sentence to be meaningful (non-tautological) in Inq_{\emptyset} is to be informative, inquisitive, or attentive.

Proposition 37.

A sentence is non-tautological in Inq_{\emptyset} iff it is informative, inquisitive, or attentive.

As in $\text{Inq}_{\mathcal{C}}$, we say that a sentence ϕ is *classical* just in case $\llbracket \phi \rrbracket$ contains exactly one possibility.

Definition 38 (Classical sentences).

- ϕ is *classical* iff $\llbracket \phi \rrbracket$ contains exactly one possibility.

Given corollary 28, classical sentences ‘behave classically’ in the sense that their unique possibility always coincides with their truth set. In $\text{Inq}_{\mathcal{C}}$, a sentence was classical if and only if it was non-inquisitive. This is no longer the case in Inq_{\emptyset} . Now, a sentence is classical only if it is neither inquisitive nor attentive.

Proposition 39 (Classical behavior, inquisitiveness and attentiveness).

- ϕ is classical iff it is neither inquisitive nor attentive.

As in $\text{Inq}_{\mathcal{C}}$, classical behavior is preserved by all connectives except disjunction.

Proposition 40 (Connectives preserving classical behavior).

For any proposition letter p and any sentences ϕ and ψ :

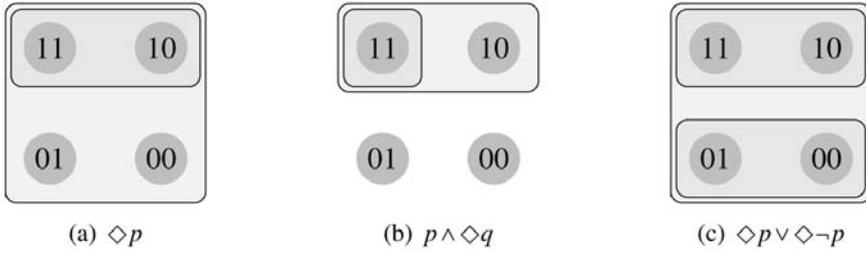


FIGURE 2 Three sentences with residual attentive content

1. p and $\neg\phi$ are classical;
2. If both ϕ and ψ are classical, then so is $\phi \wedge \psi$;
3. If ψ is classical, then so is $\phi \rightarrow \psi$.

This means, in particular, that disjunction is still the only source of non-classical behavior in Inq_{ϕ} .

Corollary 41. Any disjunction-free sentence is classical.

3.2 Might

Let us consider some examples of attentive sentences. First consider the proposition depicted in figure 2(a). This proposition consists of two possibilities: the possibility that p , and the ‘trivial possibility’, ω . We take this to be the proposition expressed by ‘*might p*’. It draws attention to the possibility that p , but does not provide or request any information.

We will add an operator \diamond to our formal language to represent *might*, and define $\diamond\phi$ as an abbreviation of $\phi \vee \top$, where \top can be any tautological sentence. This means that the proposition expressed by $\diamond\phi$ always consists of all the proper possibilities for ϕ , plus the trivial possibility ω .

$$- \llbracket \diamond\phi \rrbracket = \Pi(\phi) \cup \{\omega\}$$

As such, the effect of $\diamond\phi$ is to draw attention to all the proper possibilities for ϕ without providing or requesting any information.

To get a better first impression of what this attentive treatment of *might* amounts to, let us consider two more concrete examples. First, consider the proposition depicted in figure 2(b). This is the proposition expressed by $p \wedge \diamond q$. It consists of two possibilities: $|p|$ and $|p \wedge q|$. As such, it provides the information that p holds, and draws attention to the possibility that q may hold as well.

The proposition depicted in figure 2(c) is the proposition expressed by $\diamond p \vee \diamond \neg p$. It is especially instructive to consider how this sentence differs from the polar question $?p$. The latter is inquisitive; it requires a choice between two alternative possibilities. $\diamond p \vee \diamond \neg p$ on the other hand, does not require an informative response: it draws attention to the possibility that p and to the possibility that $\neg p$, and other participants may indeed confirm one of these possibilities in their response. But they are not required to do so; they may also just say “ok”. This would not be a compliant response to $?p$.

3.3 Closure Operators

In $\text{Inq}_{\mathcal{A}}$, the non-informative closure of a sentence ϕ , $?\phi$, was defined as an abbreviation of $\phi \vee \neg\phi$, and the non-inquisitive closure of ϕ , $!\phi$, was defined as an abbreviation of $\neg\neg\phi$. As long as we are only interested in inquisitive and informative content, these definitions are appropriate: we saw that $?\phi$ is never informative, and that it always preserves the inquisitive content of ϕ , while $!\phi$ is never inquisitive, and always preserves the informative content of ϕ . However, as soon as attentive content is taken into account, these closure operators have to be reconsidered. In particular, apart from preserving inquisitive and informative content, respectively, $?\phi$ and $!\phi$ should now also preserve attentive content.

What does it mean to preserve attentive content? We cannot ask that $?\phi$ and $!\phi$ draw attention to *exactly* the same possibilities as ϕ itself. For then $?\phi$ and $!\phi$ would have to be entirely equivalent to ϕ . What we can ask, however, is that $?\phi$ and $!\phi$ draw attention at least to all the possibilities that ϕ itself draws attention to. That is, $?\phi$ and $!\phi$ may draw attention to additional possibilities as well, but they should not ignore any of the possibilities for ϕ . In more formal terms, we require that $\text{att}(\phi) \subseteq \text{att}(?\phi)$ and that $\text{att}(\phi) \subseteq \text{att}(!\phi)$.

It is easy to see that $?\phi$ is already defined in such a way that $\text{att}(\phi) \subseteq \text{att}(?\phi)$ for all ϕ . However, it is not the case that $\text{att}(\phi) \subseteq \text{att}(!\phi)$ for all ϕ . For instance, $\text{att}(\diamond p) = \{\omega, |p|\}$, while $\text{att}(!\diamond p) = \{\omega\}$. So $\text{att}(\diamond p) \not\subseteq \text{att}(!\diamond p)$. This means that the definition of $!\phi$ needs to be revised. We want $!\phi$ to be non-inquisitive, which means that $\text{info}(!\phi)$ has to be an element of $\llbracket !\phi \rrbracket$. At the same time, $!\phi$ should preserve the informative content of ϕ , which means that $\text{info}(!\phi)$ must coincide with $\text{info}(\phi)$, and $!\phi$ should preserve the attentive content of ϕ , which means that $\text{att}(\phi)$ must be contained in $\text{att}(!\phi)$. The simplest way to meet these three requirements is to define $!\phi$ in such a way that $\llbracket !\phi \rrbracket$ consists of all the possibilities for ϕ , plus the union of all these possibilities. One way to achieve this is to define $!\phi$ as an abbreviation of $\phi \vee \neg\neg\phi$. Recall that the unique possibility for $\neg\neg\phi$ is the union of all the possibilities for ϕ . So the proposition expressed by $\phi \vee \neg\neg\phi$ indeed consists of all the possibilities for ϕ plus the union of all these possibilities.

Definition 42 (Non-informative and non-inquisitive closure in Inq_\emptyset).

- $? \phi := \phi \vee \neg \phi$
- $! \phi := \phi \vee \neg \neg \phi$

Now, the semantic categories of informative and inquisitive sentences can be characterized in terms of the corresponding syntactic closure operators.

Definition 43 (Equivalence).

Two sentences ϕ and ψ are *equivalent* in Inq_\emptyset , $\phi \approx \psi$, if and only if $\llbracket \phi \rrbracket = \llbracket \psi \rrbracket$.

Proposition 44 (Semantic categories and syntactic operators).

- ϕ is non-informative iff $\phi \approx ? \phi$ and ϕ is non-inquisitive iff $\phi \approx ! \phi$

Incidentally, \diamond can be seen as a combined non-informative and non-inquisitive closure operator. That is, $\diamond \phi$ is never informative and never inquisitive, and it always preserves the attentive content of ϕ . Indeed, the class of sentences that are neither informative nor inquisitive can be characterized in terms of \diamond as follows:

Proposition 45. For any sentence ϕ :

- ϕ is neither informative nor inquisitive iff $\phi \approx \diamond \phi$

It should be noted that $\diamond \phi$ is *not* generally equivalent with $?! \phi$ or with $! ? \phi$. That is, the fact that \diamond can be seen as a combined non-informative and non-inquisitive closure operator does not mean that it can be ‘mimicked’ by first applying non-informative closure and then non-inquisitive closure, or the other way around. \diamond makes a sentence ϕ non-informative and non-inquisitive at once by adding the trivial possibility ω , while $?!$ first adds the union of all the possibilities for ϕ and then the unique possibility for $\neg \phi$ (if this possibility is non-empty), and $! ?$ first adds the unique possibility for $\neg \phi$ (if non-empty) and then ω . So each closure operator potentially adds one possibility, and \diamond therefore typically operates ‘more directly’ than $?!$ or $! ?$.

We would like to end this subsection by putting forth the hypothesis that ‘declarativeness’ in natural language typically involves non-inquisitive closure of the kind discussed above (see also Roelofsen 2013). One way to flesh out this idea would be to define the semantic contribution of declarative clause type

markers in natural languages in terms of non-inquisitive closure. A disjunctive declarative like *John is in London or in Paris* would then draw attention to the possibility that John is in London and the possibility that John is in Paris, but it would not be inquisitive, i.e., it would not request an informative response (recall that disjunctions in our formal language *are* typically inquisitive). This would also distinguish non-informative declarative disjunctions (*John is in London or he is not in London*) from polar questions (*Is John in London?*). The latter would be inquisitive, while the former would be ‘merely’ attentive. Further consequences of this hypothesis will have to be explored in future work.

3.4 Might Meets the Propositional Connectives

It is well-known that *might* interacts with the propositional connectives in peculiar ways. In particular, it behaves differently in this respect from expressions like ‘it is possible that’ or ‘it is consistent with my beliefs that’, which is problematic for any account that analyzes *might* as an epistemic modal operator. The present analysis sheds new light on this issue.

3.4.1 Disjunction and Conjunction

Zimmermann (2000: pp. 258–259) observed that (7), (8), and (9) are all equivalent.⁷

- (7) John might be in Paris or in London. $\diamond(p \vee q)$
- (8) John might be in Paris or he might be in London. $\diamond p \vee \diamond q$
- (9) John might be in Paris and he might be in London. $\diamond p \wedge \diamond q$

Notice that *might* behaves differently from clear-cut epistemic modalities here: (10) is not equivalent with (11).

- (10) It is consistent with my beliefs that John is in London or
it is consistent with my beliefs that he is in Paris.
- (11) It is consistent with my beliefs that John is in London and
it is consistent with my beliefs that he is in Paris.

⁷ These types of examples have also often been discussed in the recent literature in relation to the phenomenon of *free choice permission*, which involves deontic modals (cf. Aher 2012, 2013; Aloni 2007; Alonso-Ovalle, 2006; Chemla 2009; Forbes 2014; Fox 2007; Geurts 2005; Klinedinst, 2007; Simons 2005).

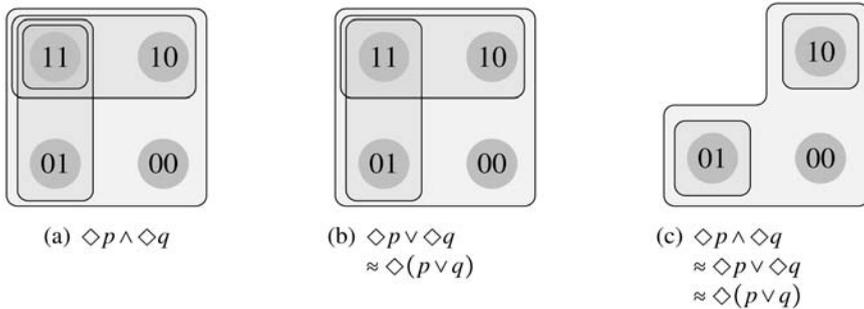


FIGURE 3 Might interacting with conjunction and disjunction

A further subtlety is that Zimmermann’s observation seems to crucially rely on the fact that ‘being in London’ and ‘being in Paris’ are mutually exclusive. If they had not been chosen in this specific way, the equivalence between (7) and (8) on the one hand, and (9) on the other would not have obtained. To see this, consider the following examples:

- (12) John might speak English or French. $\diamond(p \vee q)$
- (13) John might speak English or he might speak French. $\diamond p \vee \diamond q$
- (14) John might speak English and he might speak French. $\diamond p \wedge \diamond q$

‘Speaking English’ and ‘speaking French’ are not mutually exclusive, unlike ‘being in London’ and ‘being in Paris’. To see that (12) and (13) are not equivalent with (14) consider a situation, suggested to us by Anna Szabolcsi, in which someone is looking for an English-French translator, i.e., someone who speaks *both* English and French. In that context, (14) would be perceived as a useful recommendation, while (12) and (13) would not.

These patterns are quite straightforwardly accounted for in $\text{In}q_\emptyset$. The proposition expressed by $\diamond p \wedge \diamond q$ is depicted in figure 3(a), and the proposition expressed by $\diamond(p \vee q)$ and $\diamond p \vee \diamond q$ (which are equivalent in $\text{In}q_\emptyset$) is depicted in figure 3(b). Notice that $\diamond p \wedge \diamond q$, unlike $\diamond(p \vee q)$ and $\diamond p \vee \diamond q$, draws attention to the possibility that $p \wedge q$, that is, the possibility that John speaks both English and French. This explains the observation that (14) is perceived as a useful recommendation in the translator-situation, unlike (12) and (13).

In Zimmermann’s example, p stands for ‘John is in London’ and q for ‘John is in Paris’. It is impossible for John to be both in London and in Paris. So possible worlds where p and q are both true must be left out of consideration. Once this

is taken into account, $\diamond(p \wedge q)$, $\diamond p \vee \diamond q$, and $\diamond p \wedge \diamond q$ all express exactly the same proposition, as depicted in figure 3(c).

3.4.2 Implication and Negation

Now let us consider how *might* interacts with implication and negation. First, consider a sentence where *might* occurs in the consequent of an implication:

(15) If John is in London, he might be staying with Bill.

The corresponding expression in our formal language, $p \rightarrow \diamond q$, is equivalent with $\diamond(p \rightarrow q)$. It draws attention to the possibility that ‘if p then q ’, without providing or requesting information. This seems a reasonable account of the semantic effect of (15). Indeed, one natural response to (15) is to confirm that John is staying with Bill if he is in London. But such an informative response is not required. Nodding, or saying “ok” would also be compliant responses.

Now let us consider an example where *might* occurs in the antecedent of an implication:

(16) If John might be in London, he is staying with Bill. $\diamond p \rightarrow q$

This sentence is perceived as odd. In Inq_\emptyset , this observation may be explained by the following general property of implication:

Proposition 46 (Redundancy of non-informative antecedents).

If ϕ is non-informative and ψ is classical, then: $\phi \rightarrow \psi \approx \psi$.

This proposition says that non-informative antecedents of implications with a classical consequent are completely redundant. This means, in particular, that $\diamond p \rightarrow q$ is equivalent to q , i.e., that (16) is equivalent to its bare consequent, “John is staying with Bill”. This may be part of the reason why constructions like (16) are generally not used, and are perceived as odd if they do occur.

Our general empirical prediction is that an implication whose antecedent is non-informative and whose consequent is classical is always ‘marked’.⁸ This has particular consequences for negation, which can be seen in our system as a

⁸ In some cases, marked sentences may not be perceived as odd, but rather associated with a marked meaning, i.e., a meaning that differs from the one they are standardly associated with. Such cases will be discussed in detail in section 5.

special instance of implication (see the end of section 2.4). In English, standard sentential negation cannot take wide scope over *might*. For instance, (17) can only be taken to draw attention to the possibility that John is not in London.

(17) John might not be in London.

Notice, again, that *might* behaves differently from clear-cut epistemic modalities here, which can occur in the scope of negation:

(18) It is not consistent with my beliefs that John is in London.

The fact that *might* cannot occur in the scope of negation is explained in Inq_\emptyset by the fact that $\neg\Diamond\phi$ is always a contradiction (recall that $\neg\Diamond\phi$ is equivalent with $\Diamond\phi \rightarrow \perp$, which, by proposition 46, is equivalent with \perp). Thus, $\neg\Diamond\phi$ expresses the absurd proposal. $\Diamond\neg\phi$ on the other hand, seems to have exactly the semantic effect of sentences like (17): it draws attention to the possibility that $\neg\phi$.

Notice that questions cannot be interpreted in the scope of negation either. This basic parallel between *might* sentences and questions is straightforwardly captured: $\neg?\phi$ is always contradictory, just like $\neg\Diamond\phi$. The general prediction is that any non-informative sentence is uninterpretable in the scope of negation.

4 Inquisitive Pragmatics

Gricean pragmatics generally assumes a classical, truth-conditional semantics, where the meaning of a sentence is identified with its informative content. Inquisitive semantics departs from this basic assumption. It does not identify semantic meaning with informative content, but also takes inquisitive and attentive content into account. This shift in semantic meaning changes our perspective on pragmatics. Gricean pragmatics can be seen as a pragmatics of providing information. Inquisitive semantics gives rise to a pragmatics of *exchanging* information.

Such a pragmatics has been articulated in (Groenendijk & Roelofsen 2009). It is concerned with conversations where the participants' main purpose is to exchange information in order to resolve a given issue as effectively as possible.⁹

9 In Westera (2012, 2013) a Gricean pragmatics is formulated in relation to a semantics that, unlike that of Groenendijk & Roelofsen (2009), not only models informative and inquisitive, but also attentive content.

In such a cooperative effort, each participant must first of all be *sincere*. That is, if a speaker utters a sentence ϕ , she must believe that at least one of the possibilities for ϕ can be established (*informative sincerity*), and moreover, each possibility for ϕ must be consistent with her information state (*inquisitive sincerity*).

Participants must also be *transparent*. That is, if a hearer cannot execute a proposed update because that would lead to inconsistency of her own information state, she must publicly announce this, so that other participants will also refrain from executing the update. Moreover, if one participant makes a certain proposal and no other participant objects, then each participant must update both her own information state and her representation of the common ground according to the proposal. Notice that the sincerity requirement is *speaker* oriented, while the transparency requirement is *hearer* oriented.

Besides these qualitative sincerity and transparency requirements, inquisitive pragmatics postulates that, among proposals that are sincere and *compliant* with the issue under discussion,¹⁰ there is a general quantitative preference for *more informative* proposals—the more relevant information one provides, the more likely it is that the given issue will be resolved.¹¹ Without going into the more subtle details, let us lay out the basic repercussions that a pragmatic theory along these lines has for the interpretation of *might*.

4.1 *Quality Implicatures*

There are two empirical observations about *might* that we have not discussed at all so far, even though each of them has given rise to one of the two ‘classical’ semantic theories of *might*. Both observations can be illustrated by means of our initial example:

(19) John might be in London.

The first observation, perhaps the most basic one, is that if someone utters (19) we typically conclude that she considers it *possible* that John is in London. This observation has given rise to the analysis of *might* as an epistemic modal operator.

10 Compliance is a formal notion of relatedness. Its precise definition is not relevant for our present purposes. See Groenendijk & Roelofsen (2009) for discussion.

11 Groenendijk & Roelofsen (2009) also postulate a general preference for *less inquisitive* proposals. However, this preference is often overruled by other pragmatic factors, and irrelevant for our present purposes.

The second observation is that if someone hears (19) and already knows that John is not in London, she will typically object, pointing out that (19) is inconsistent with her information state. In this sense, even though *might* sentences do not provide any information about the state of the world, they can be ‘inconsistent’ with a hearer’s information state. One classical account of this observation is that of Veltman (1996). Veltman’s update semantics specifies for any given information state σ and any given sentence ϕ , what the information state $\sigma[\diamond\phi]$ is that would result from updating σ with ϕ . The update effect of $\diamond\phi$ is defined as follows:

$$\sigma[\diamond\phi] = \begin{cases} \emptyset & \text{if } \phi \text{ is inconsistent with } \sigma \\ \sigma & \text{otherwise} \end{cases}$$

The idea is that, if ϕ is inconsistent with a hearer’s information state, then updating with $\diamond\phi$ leads to the absurd state. To avoid this, the hearer must make a public announcement signaling the inconsistency of ϕ with her information state. As a result, whoever uttered $\diamond\phi$ in the first place may also come to discard the possibility that ϕ holds.

Our semantics does not directly explain these observations. However, we believe that this is rightly so. In our view, both observations should be explained pragmatically. And they can be. It follows from the inquisitive sincerity requirement that if a cooperative speaker expresses a certain proposal $[\phi]$ and α is a possibility in $[\phi]$, then α must be consistent with the speaker’s information state. In particular, a cooperative speaker who utters (19) must consider it possible that John is in London.

On the other hand, it follows from the transparency requirement that if a hearer is confronted with a sentence ϕ , and one of the possibilities for ϕ is inconsistent with her information state, then she must signal this inconsistency, in order to prevent other participants from considering the possibility in question a ‘live option’.

Thus, both observations are accounted for. And this pragmatic account, unlike the mentioned semantic analyses, extends straightforwardly to more involved cases. Consider for instance:

(20) John might be in London or in Paris.

This sentence is problematic for both semantic accounts just mentioned. The epistemic modality account predicts that the speaker considers it possible that John is in London or in Paris. But note that this is compatible with the speaker knowing perfectly well that John is not in London. What (20) implies is something stronger, namely that the speaker considers it possible that John

is in London *and* that she considers it possible that John is in Paris. This follows straightforwardly on our pragmatic account.

Now consider a hearer who is confronted with (20) and who knows that John is possibly in Paris, but certainly not in London. We expect this hearer to object to (20). But Veltman's update semantics does not predict this: it predicts that an update with (20) has no effect on her information state. Our pragmatic account on the other hand, does urge the hearer to object.

The only task of our semantics is to specify which proposals can be expressed by means of which sentences. The pragmatics, then, specifies what a context—in particular, the common ground and the information state of the speaker—must be like in order for a certain proposal to be made, and how a hearer is supposed to react to a given proposal, depending on the common ground and her own information state. Together, these two components account for the basic features of *might* that classical semantic theories take as their point of departure. Shifting some of the weight to pragmatics evades problems with more involved cases, like (20), in a straightforward way. But, of course, the necessary pragmatic principles can only be stated if the underlying semantics captures more than just informative content.

4.2 *Quantity Implicatures*

If someone says that John might be in London, we typically do not only conclude that she considers it possible that John is in London, but also that she considers it possible that he is *not* in London. In short, we infer that she is *ignorant* as to whether John is in London or not. Notice, however, that this inference is not always warranted. For instance, if a child is figuring out, as a homework exercise, who Napoleon Bonaparte was, a helping mother may say: "He might have been a French emperor". In this case, we do not conclude that the mother must be ignorant about Napoleon's historical role. Probably, she did not want to take the entire homework assignment off her child's hands, but just leave him with the lighter task of verifying her suggestion.

This kind of context dependency is characteristic of Gricean quantity implicatures. In the current setting, the implicature is straightforwardly derived. We have already seen how to establish the inference that the speaker considers it *possible* that John is in London. Moreover, it follows from the quantitative preference for more informative compliant proposals that whenever a cooperative speaker S expresses a proposition $\llbracket\phi\rrbracket$ and α is a possibility in $\llbracket\phi\rrbracket$ such that $\text{info}(\phi) \not\subseteq \alpha$ (that is, S proposes α as a potential update, but does not provide enough information to actually establish that update), we can conclude that S does not have sufficient information to directly propose an update with α . After all, assuming that $\llbracket\phi\rrbracket$ compliantly addresses the relevant question under

discussion, a direct proposal to update with α would also be compliant, and moreover, it would be more informative than $\llbracket\phi\rrbracket$ itself. Thus, the only possible reason why S did not directly propose an update with α is that she does not have sufficient information to do so.

Ignorance implicatures arise in exactly the same way for disjunctions, questions, and other inquisitive/attentive utterances. When working within a traditional semantic framework, where meaning is identified with just truth-conditional informative content, it is far from trivial to derive the right ignorance implicatures for disjunctions, since it is difficult in such a framework to decide in any principled way what the ‘alternatives’ are that a disjunction should be compared with. In the current setting, these alternatives are directly determined by the richer semantics.

5 Epistemic Re-interpretation

In certain embedded environments, $\diamond p$ really seems to be interpreted as saying that p is consistent with some contextually given body of information (usually, but not necessarily, the information state of the speaker). One may be tempted to conclude that this is simply due to *might* being ambiguous, permitting both an ‘epistemic use’ and an ‘attentive use’, and possibly other usages as well.

However, it may be worth trying to avoid such a conclusion, at least in its strongest form. For, if *might* were simply ambiguous between an attentive use and an epistemic use, then we would lose our explanation for the fact that *might* obligatorily takes wide scope over standard negation, unlike sentential operators like ‘it is consistent with my beliefs that’. Recall the relevant example:

(21) John might not go to London.

We pointed out in section 3.4 that $\neg\diamond p$ is always a semantic contradiction, and offered this as an explanation for the fact that negation cannot take wide scope in (21). But this explanation only goes through, of course, if the semantic contribution of $\diamond p$ is to draw attention to the possibility that p . If $\diamond p$ were ambiguous, and could also be interpreted semantically as saying that p is consistent with some contextually determined body of information, then there would be no reason anymore why negation should obligatorily take narrow scope. After all, we saw that negation is perfectly happy with wide scope in sentences like (22):

(22) It is not consistent with my beliefs that John will go to London.

Thus, rather than assuming plain ambiguity, we would like to offer a more nuanced account of the epistemic interpretation of $\diamond p$ in the relevant embedded environments. In particular, we will argue that in such environments there is generally a specific *reason* not to interpret $\diamond p$ as simply drawing attention to the possibility that p . We hypothesize that this triggers *re-interpretation* of $\diamond p$ in terms of the ignorance implicatures that it typically triggers when not embedded. We will discuss three environments where this phenomenon occurs: in the scope of negation, in the antecedent of a conditional, and in questions.¹²

5.1 *Negation*

Standard negation cannot take wide scope over *might*. However, there is a complication: wide scope *can* be established by using ‘it is not true that’ instead of standard negation. Consider:

(23) It is not true that John might go to London.

This sentence conveys that the speaker believes that John will not go to London. If the sentence were analyzed as $\neg \diamond \varphi$, then according to Inq_\emptyset it would be a contradiction, which is evidently not the right analysis. What is going on here, we think, is that the sentence is interpreted as a denial of the *implicature* of the embedded clause. It is in fact a common use of ‘it is not true that’ constructions to deny pragmatic inferences or presuppositions of their complement clause. For example, in (24) the implicature of the embedded clause is denied, and in (25) the presupposition of the embedded clause is denied:

(24) It is not true that John has four children. He has five.

(25) It is not true that the king of France is bald. There is no king of France.

Moreover, it seems that (23) is not necessarily interpreted as denying that it is *possible* that John will go to London. It may also be interpreted as denying the stronger implicature that it is *unknown* whether John will go to London or not.

12 The proposal made here is in line with recent observations by Levinson (2000) and Chierchia & Fox & Spector (2012), among others, that the semantic contribution of certain expressions is sometimes strengthened ‘locally’, i.e., before it enters the semantic composition process. Construing this process as ‘re-interpretation’ is especially in line with Geurts’ (2009) take on such phenomena.

For, someone who utters (23) may continue as in (26), but also as in (27) (where SMALLCAPS indicate contrastive stress).¹³

(26) It is not true that John might go to London. He will go to PARIS.

(27) It is not true that John might go to London. He WILL go to London.

These observations support the idea that ‘it is not true that’ constructions can be interpreted as denying pragmatic inferences that the embedded clause gives rise to, and thus lend support to a re-interpretation analysis of examples like (23).

One may ask, of course, why this same re-interpretation strategy could not be applied in (21). We would argue that re-interpretation only occurs if it is triggered. In (21), negation can take narrow scope, and the interpretation of $\diamond\neg p$ is unproblematic. Thus, there is no need for re-interpretation. In (23) however, negation is forced to take wide scope, and $\neg\diamond p$ is, at face value, a contradiction. This is what triggers re-interpretation in this case.

Below we will see that another reason to re-interpret a given construction is that under its standard interpretation, it expresses a meaning that could also have been expressed by a simpler construction. This mechanism, usually referred to as *blocking* or *division of pragmatic labor*, is widely assumed to play a crucial role in the process of interpretation (cf. Horn 1984, 2004).

5.2 Conditionals

We observed in section 3.4 that a conditional with *might* in its antecedent is sometimes difficult to interpret. The example was:

(28) If John might be in London, he is staying with Bill.

There are other examples, however, which *can* be interpreted. For instance:

(29) If John might be in London, I won’t go there.

This sentence is interpreted as stating that if it is *possible* that John is in London, then the speaker will not go there. Thus, *might* seems to be interpreted as an

13 Note that in (27), it is strongly preferred, perhaps even necessary, to not only place contrastive stress on *will*, but also on *might*. This observation does not seem to affect our argument, however. See (Fox & Spector, 2009) for relevant discussion.

epistemic possibility modal here.¹⁴ This is a case, we would say, where blocking plays a role. It follows from proposition 46 that the meaning of (29), taken at face value, could just as well have been expressed by the bare consequent, “I won’t go to London”. This triggers re-interpretation of the *might* construction in the antecedent in terms of the implicatures that it typically generates.

Re-interpretation also applies to (28), but it does not improve its intelligibility. This is explained by the fact that, if the antecedent of (28) is re-interpreted, the sentence as a whole becomes paraphrasable as:

(30) If it is possible that John is in London, he is staying with Bill.

What this is supposed to communicate is, for reasons that need not concern us here, still quite unclear.¹⁵ This is why re-interpretation does not ‘save’ (28).

5.3 Questions

Finally, consider a question containing *might*:

(31) Might John be in London?

Taken at face value, (31) is presumably interpreted as $? \diamond p$. But $? \diamond p$ is equivalent with $\diamond p$. Thus, the meaning that is standardly assigned to (31) could just as well have been expressed by the simpler sentence “John might be in London”. Therefore, this interpretation is blocked for (31), and the sentence is re-interpreted in terms of the implicatures that *might* typically evokes.¹⁶

These observations support the hypothesis that, rather generally, non-attentive readings of *might* are the result of re-interpretation. More work is needed, of course, to solidify this claim. But we think this is a direction worth pursuing.¹⁷

14 Note that the relevant epistemic state does not seem to be the speaker’s own information state here, but rather the information state that would be obtained if all discourse participants would bundle their beliefs. Notice also that the subject of the consequent, “I”, can be replaced by “Sue” for instance. In that case, it is even clearer that the relevant epistemic state must be contextually determined in sometimes intricate ways. There is an ongoing debate about this issue, which is largely orthogonal to what is at stake here. See von Stechow & Gillies (2010) for a recent proposal and further references.

15 See Papafragou (2006) and Portner (2009: pp. 145–167) for relevant discussion.

16 See Roussarie (2009) for a recent alternative account of *might* in questions.

17 A weaker hypothesis that may be worth considering is that the attentive use of *might* is historically primary, and that non-attentive usages are derivative, though (partly) grammaticized (in the general spirit of, e.g., Levinson 2000).

6 Final Remarks

The idea that the core semantic contribution of *might* sentences lies in their potential to draw attention to certain possibilities has been entertained before. For instance, Groenendijk & Stokhof & Veltman (1996) wrote that “in many cases, a sentence of the form *might- ϕ* will have the effect that one becomes aware of the possibility of ϕ ”.¹⁸ However, it was thought that capturing this aspect of the meaning of *might* would require a more complex notion of possible worlds and information states, and a different way to think about growth of information. Thus, immediately following the above quotation, Groenendijk & Stokhof & Veltman (1996) write that their own framework “is one in which possible worlds are total objects, and in which growth of information about the world is explicated in terms of elimination of possible worlds. Becoming aware of a possibility cannot be accounted for in a natural fashion in such an eliminative approach. It would amount to extending partial worlds, rather than eliminating total ones. To account for that aspect of the meaning of *might* a constructive approach seems to be called for”.

The present paper has taken a different route. Possible worlds are still total objects, and growth of information is still explicated in terms of eliminating possible worlds. What has changed is the very *notion of meaning*. Our semantics does not specify what the truth conditions of sentences are, or what their update effect is, but rather what the proposal is that they express. And this shift in perspective immediately facilitates a simple and perspicuous way to capture attentive content.

It is perhaps worth emphasizing that, even though our efforts in this paper have been focused on giving a systematic account of the possibilities that *might* sentences draw attention to, we certainly do not think that this is all there is to the meaning of *might*. Drawing attention to possibilities may have several side-effects. We discussed how ignorance implicatures typically enter the picture through (possibly grammaticized) pragmatic reasoning. Another potential side-effect is that participants may be led to *hypothetically effectuate* the updates that have been brought under attention for the purpose of further discussion.

This ‘hypothetical update’ aspect of the use of *might* is familiar from the literature on modal subordination (Brasoveanu, 2007; Kaufmann 2000; Roberts 1989; among others) and also closely related to a prominent line of work on

18 See also the more recent work of Swanson (2006), Franke & de Jager (2011), Brumwell, (2009), and de Jager (2009).

conditionals, starting with Ramsey (1931) and Stalnaker (1968). The literature on modal subordination is typically concerned with constructions like (32):

(32) A wolf might come in. It would eat you first.

The system proposed here is not dynamic and does not deal with quantification. As such, it has no chance of accounting for constructions like (32). However, transferring its key features to a dynamic, first-order system, may not only lead to a principled account of (32); it is also expected to take care of cases like (33), (34), and (35):

(33) A wolf or a lion might come in. It would eat you first.

(34) A wolf or a lion might come in. Would it eat you first?

(35) If a wolf or a lion comes in, would it eat you first?

Such cases have, to the best of our knowledge, always been thorns in the eyes of theories dealing with modal subordination and/or conditionals.

Finally, we would like to emphasize that the primary purpose of this paper was not so much to propose a novel analysis of *might*, but rather to develop a formal framework that can be used to capture attentive content more generally. The analysis of *might* was intended to illustrate the usefulness of the framework.

Attentive content seems to play a crucial role in many other domains as well. For instance, certain types of *evidentials* are taken to ‘present a certain proposition, without establishing whether that proposition holds or not’ (see, for instance, Faller, 2002; Murray, 2010). In this respect, such evidentials seem to behave very much like our attentive *might*.

Another phenomenon that seems to require an account of attentive content is that of *in subordinate interrogatives*.¹⁹ Truckenbrodt (2006) provides the German example in (36), which contrasts with the non-in subordinate interrogative in (37):

(36) *Ob es ihm gut geht?*
Whether it him well goes
‘I wonder whether he is doing well.’

¹⁹ We are grateful to Seth Cable for bringing this phenomenon to our attention.

- (37) *Geht es ihm gut?*
 Goes it him well
 'Is he doing well?'

Again, sentences like (36) are reported to 'present' a certain issue, without really requesting an informative response from other participants. There is a sharp contrast in this respect between (36) and (37): the latter does request an informative response. These are precisely the type of distinctions that the framework developed in this paper could help to elucidate.

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