

## Solving for Interpretation

**Abstract:** We might profitably compare interpretation in discourse to the solution of a simultaneous equation in multiple variables. In a given utterance, there may be one or more anaphoric expressions or ellipses whose interpretation must be resolved, and one or more quantificational operators whose intended domain must be determined. I sketch how a general Gricean principle of Retrievability guides the resolution of all these types of variables and other kinds of context-sensitivity as well, taking into account requirements of relevance and salience which reflect the intentional structure of discourse generally assumed by interlocutors. In particular, relevance to an understood Question under Discussion constrains the search space for anaphora resolution and domain restriction in a thorough-going way, offering the foundation for a theory of salience. Moreover, the interaction between conventional content and context can only be captured in a dynamic model in which the formally modeled context changes in the course of compositional interpretation. This characterization of the role of context in interpretation stands in contrast to a commonly assumed model which treats interpretation (processing and comprehension) as a sequential affair, in which first we parse, then resolve a few indexicals in the course of compositionally determining the semantic content of the utterance, and finally put Gricean icing on the propositional cake. But the proposed model is also more constrained than some other models of pragmatically-guided processing, including those of Sperber & Wilson (1985) and those based principally on rhetorical relations. I review experimental evidence from the psycholinguistic literature on both processing and acquisition which suggests that the intention-structured model of discourse is psychologically plausible and explanatory, and that it reveals important features of the interface between purely linguistic competence and more general cognitive processes, including practical reasoning, and information storage and retrieval.

### 1. Introduction: The range of relevant phenomena<sup>1</sup>

I am interested in how we successfully convey meaning, in something like the sense defined by Paul Grice (1957):

Grice's notion of utterance meaning:

"U meant<sub>nn</sub> something by uttering x" is true iff, for some audience A, U uttered x intending:

- (1) A to produce a particular response *r*
- (2) A to think (recognize) that U intends (1)
- (3) A to fulfill (1) on the basis of his fulfillment of (2). (Grice 1957)

In hypothesizing about how speakers successfully convey meaning (hereinafter, in Grice's sense) and how, on the other hand, addressees successfully retrieve the speaker's intended meaning of an utterance, we are speculating about the nature of the process of interpretation. I take interpretation to be something humans do, or attempt to do, any time they encounter an utterance of a human language which they speak. There is no canonical language use apart from interpretation. If that is so, then understanding how we grasp meaning<sub>nn</sub> is an essential part of understanding how we, as human agents, acquire and process language.

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One reason this is worth emphasizing is that in general the conventional content of an utterance—that aspect of its meaning which can be derived from the composition of the meanings of its parts in keeping with its syntactic structure—radically underdetermines the meaning of the utterance, as intended by the speaker and grasped by the addressee. But in view of our notable communicative success through language, it seems intuitively correct that we must have good reason to expect that our interlocutors can grasp our intended meanings. In fact, on the assumption that one can only rationally intend to do something if it is rational to believe that it can be achieved, the following principle follows from Grice's definition:

**Retrievability:** In order for an utterance to be a rational, cooperative act in a discourse interaction *D*, it must be reasonable for the speaker to expect that the addressee can grasp the speaker's intended meaning in so-uttering in *D*.

In view of the gap between conventional content and conveyed meaning, this is a strong principle, since it requires that cooperative speakers expect that their *uniquely* intended meaning<sub>nm</sub> can be recognized as such by an addressee. For example, in Roberts (2010) I argue that Retrievability enables us to derive the uniqueness implications associated with anaphoric expressions like English definite descriptions, without stipulating those as part of the conventional content of *the* (contra Russell and the subsequent Russellian or E-type interpretations proposed in the literature). And Retrievability leaves no room for felicitous ambiguity (thereby, one might argue, entailing Grice's Manner implicature).<sup>2</sup>

What might be the grounds for the assumption of Retrievability on the part of a speaker? To make this question more vivid, we'll briefly consider a range of examples in which contextual factors crucially influence the understood truth conditions for an utterance. The kinds of phenomena involved include anaphora and ellipsis resolution, domain restriction, presupposition projection and satisfaction, and embedded conversational implicatures. I have argued (Roberts 1995,1996,2004a,2006,2010,to appear; Roberts et al.2009; Simons et al.2010) that with all these kinds of phenomena, conceiving of context as a structure on the interlocutors' publicly evident intentions, especially as reflected in their intention to address an accepted question under discussion (QUD), sheds light on how we Retrieve meaning.

Here are some examples.

#### Anaphora resolution:

In keeping with my work on definiteness (op.cit.), I take the class of anaphoric NPs in English to include the full range of definite NPs, including personal pronouns, definite descriptions, demonstratives, and proper names. In addition, I argue there that the *antecedent* of a definite is not an NP, but a discourse referent weakly familiar in the interlocutors' Common Ground. Hence, the remarks here are intended to generalize over cases in which, say, a pronoun or definite description has an overt NP antecedent, those in which it is deictic or refers to perceptually salient entities, those in which the speaker intends to refer to entities generally familiar (*the sun*), etc. This is not to say that there is nothing different about these cases, but that such differences are not relevant here.

The descriptive content of a definite NP usually under-determines the intended antecedent:

- (1) [Context: You and I are sitting in a café discussing how to understand Sperber & Wilson's (1985) definition of Relevance, and I say:]

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<sup>2</sup> This does *not* mean that Retrievability makes vagueness infelicitous. If one's meaning is vague, then in order for one's utterance to be successful, one's addressee need only Retrieve a vague meaning.

*I see it now!*

[Even though I'm holding a coffee mug by the handle right under your nose and shaking it for emphasis, you don't take *it* to refer to the mug.] (Roberts 2010)

(1) argues that anaphora resolution is guided more by the subject matter under discussion than by contextual salience in a more general sense. Coherent discourse requires that interlocutors stick to the subject, and that leads to greater salience for entities relevant to that subject. We see this clearly in (2), where the question posed by A makes John maximally relevant:

- (2) A: What's up with John<sub>i</sub>?—I saw him talking with Mac<sub>k</sub> earlier.  
B: He<sub>i/#k</sub> found a dent in his fender.

Note that *his* can take *Mac* as antecedent if the context is rich enough—e.g. we know that Mac has a car and that John is Mac's concerned father—though out of the blue the presumed cause of the subject's distress is his own fender. In (2), given the QUD uttered by A (and barring deixis to Mac), the antecedent of *he* can only be the discourse referent anchored to John. This is despite the fact that *Mac* is more recently uttered than *John*.

We might define **the interlocutors' attentional field** as those contextually relevant<sup>3</sup> entities which seem to be most salient in a given context. If the attentional field is sufficiently restricted, this helps a hearer to readily Retrieve the intended antecedent for an anaphoric element even though the trigger's descriptive content by itself would not suffice to single out a particular antecedent from among those recently discussed or jointly familiar to the interlocutors. Discourse goals often interact with other means of increasing salience to limit the interlocutors' attentional field in a given context, as we saw in (1) and (2). We see this also in the contextual minimal pair in (3) and (3'), where deixis combines with the QUD to permit the addressee to Retrieve the intended antecedent for *that* in Margaret's last utterance:

- (3) [Tim and Margaret are sitting at a conference table in her psycholinguistics lab, working on a grant proposal for some eye-tracking experiments. Tim is making notes on his laptop computer, not a MacIntosh brand.]  
Margaret: How do you like your laptop?  
Tim: It's not bad, but it's getting kind of old. I wish I had a Mac. Macs are far better for graphics, and it turns out that I'm doing a lot more graphics than I'd expected.  
Margaret: [gesturing with her thumb over her shoulder, in the direction of her desk in the middle of the room] I just got [that]F last year.  
[In the direction Margaret is pointing there's a lot of stuff: a desk with a big pile of papers and a flat screen Mac computer monitor on it, past the desk an eye-tracker, past that a wall calendar.]  
(Roberts 2010)

- (3') Margaret: How do you like your laptop?  
Tim: It's not bad, but it's getting kind of old. Anyway, let's get back to business. What do you think of this budget?  
Margaret: [gesturing with over her shoulder, in the same direction as in (1)] Could we add some money to replace that?

Informally polled, native speakers take *that* in (3) to refer to Margaret's laptop, while in (3') it is taken to be the eyetracker (at least, if one knows what one kind of equipment one typically buys through grants for

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<sup>3</sup> In the following section I review the formal notion of Relevance (to the QUD) defined in Roberts (1996). For those that are familiar with that notion, it can be understood hereinafter as the formal content of claiming that some proposition or entity are relevant in a given context.

research involving eye-tracking). These examples argue that even deixis does not generally resolve anaphora by itself; instead, it helps narrow the attentional field, as does the QUD, together yielding (in these and other felicitous examples) exactly one most salient and plausible antecedent in that field.

Plausibility is also a factor in (4):

- (4) [Context: visual array with (among other things) two hats and two rabbits, exactly one of which is in a hat:] Remove the rabbit from the hat. (Stone & Webber 1998)

It's a precondition on removing something from a space that it be there to begin with. So *remove* in (4) triggers the presupposition that the denotation of its direct object (a rabbit) is in the denotation of the source argument complement of *from* (a hat). There are, in the visual field, exactly one rabbit and exactly one hat which jointly satisfy this presupposition. Given that it is only reasonable to expect an addressee to adopt an intention—here, to remove said rabbit from said hat—if there is reason to believe that it can be accomplished, and that for that to be the case all the preconditions for achieving that intention must obtain, then *the rabbit* and *the hat* must refer to the ones that satisfy the precondition. Hence, we see that anaphora resolution must be compatible with, and in some cases is guided by, the satisfaction of other conventionally triggered presuppositions.

#### Domain restriction:

Domain restriction subsumes a fairly wide range of cases where some quantificational operator—a quantificational determiner, modal, adverb of quantification or tense (Roberts 1989, 1996a; Cipria & Roberts 2000)—has its intended domain of quantification implicitly restricted. Often, this restriction is purely Relevance-driven; this is illustrated in (5'), involving modal subordination (a species of domain restriction) with no overt conventional trigger. Unlike (5), where the speaker is committed to a prediction that the birds will get hungry, in (5') the prediction is conditional on Edna forgetting to fill the feeder.

- (5) The birds will get hungry (this winter).  
(5') If Edna forgets to fill the birdfeeder, she will feel very bad.  
The birds will get hungry. (Roberts 1989)

But domain restriction may also be driven partly by the need to satisfy a conventionally triggered presupposition: For example, it may not be possible to globally satisfy a presupposition triggered under the scope of an intensional operator. We see this in (6) with anaphoric *she* and *the girl* under the scope of *always* and *usually* (respectively), in (7) with *too* in the conditional, and in (8) with the sluiced complement of *where* under the scope of *usually*.

Interaction with anaphoric trigger:

- (6) Harvey courts a girl at every convention.  
She always comes to the banquet with him.  
The girl is usually very pretty. (Karttunen 1976)

Interaction with *too*:

- (7) If Mary comes, we'll have a quorum. If Susan comes too, we'll have a majority.  
(Heim 1992)

Interaction with sluicing:

- (8) Stefanie often eats out when she's travelling on business. If she doesn't know the city well, where is usually influenced by the latest Zagat ratings.

In such cases, if the context is appropriate, accommodated restriction on the domain of the intensional operator can resolve the problem, so long as there is a plausibly relevant way of restricting the operator's domain which simultaneously satisfies the presupposition arising from the conventional trigger: In (6), we take it that the adverbs of quantification *always* and *usually* only range over those relevant events when Harvey is courting a girl at some convention or other; in (7), we take the implicit modal in the second conditional to range only over those relevant situations in which Mary comes. (More on (8) below.) Then the entity, proposition or question required to satisfy the presupposition will be locally relevant and available, in the restriction on the operator, though not globally available.

### Presupposition projection:

There are other cases where a conventionally triggered presupposition may fail to project. Even though a conventional presupposition trigger occurs within the scope of an operator which generally acts as a hole to presupposition, the presupposition it triggers may fail to project past that operator if the presupposition itself is at issue—its truth the subject of the QUD (Roberts 2006, Roberts et al. 2009, Simons et al. 2010). In (10), it seems that the presupposition that there is a unique King of France does not project, unlike in (9); the difference seems to be that in (10) the QUD is precisely whether there *is* such a king—hence the implication is itself at-issue, while in (9) that is not the issue.

#### Projection of definite descriptions:

- (9) Q: Which monarchs attended the Swedish wedding last year?  
 A: The king of France wasn't there.  
 Implied presumption that there is a King of France, assertion that he wasn't there.
- (10) Q: Does France have a king?  
 A: The king of France wasn't one of the guests at the Swedish wedding last year.  
 'It's not the case that there is a King of France who was at the wedding' (so probably/perhaps there is no King of France) (Simons et al. 2010)

The same pattern is observed in (11) and (12): It is usually a precondition on winning an election that one has run for election. Hence, the presumption in (11) that Bill will run. But questioning this implication, as in (12), i.e. making it at-issue, makes it less likely that it will project.

#### Projection of lexical preconditions:

- (11) Q: How do you expect the election to go?  
 A: Well, Bill certainly won't win.  
 Implicates that Bill will run, asserts that he won't win.
- (12) Q: Will Bill run in the election?  
 A: He won't win.  
 'If Bill runs, he won't win.' (Simons et al. 2010)

Conversely, there is a tendency for contextually backgrounded material to project, even though it doesn't involve a conventional presupposition trigger:

#### Focal backgrounding:

- (13) Paula isn't registered in PARIS (Kratzer 1991)  
 Roughly: 'It is not in Paris that Paula is registered', implicating that she's registered somewhere else.
- (14) PAULA isn't registered in Paris.  
 Roughly: 'It is not Paula who is registered in Paris', implicating that someone else is registered there.

Many other authors have discussed presuppositions triggered by prosodic focus (e.g. Geurts & van der Sandt 2004). But prosody alone cannot offer the answer, since the distinctions in the contextual minimal-pairs in (9)/(10) and (11)/(12) do not depend on their being spoken aloud. So the question is more general: Why does backgrounded material project? If we assume that prosodic focus reflects the QUD (Roberts 1996,1998), then (13) and (14) reflect the assumption of different questions, as also reflected in the cleft paraphrases; and it is the thematic portion of the utterance (as opposed to the rheme) which is backgrounded and tends to project from under negation (Roberts et al.2009, Simons et al. 2010). That is, backgrounding in (13)/(14) is a function of the QUD, as in the other two pairs. Hence, the most promising explanation for such examples hinges on the relationship of the QUD to the potential for projection.

#### Conversational implicature:

Implicatures are often driven by the evident goals of the speaker or addressee and the relationship of the utterance to those goals. Consider:

- (15) A: Are you 21?  
B: Yes.  
A: How old are you?  
B: 28 (Thomason, Hobbs & Moore 1996)

If we take A to be a bartender, B a youthful-looking customer, then knowing typical American laws regarding who may consume alcohol, we understand A's first question to be directed at the goal of ascertaining whether B meets those criteria. Hence there is no scalar implicature in either the question or B's reply. The second question then seems to have a different goal (at least in part because the first goal has presumably been addressed, though A may doubt B's veracity), and this yields the implicature that B is no more than 28, i.e. he is exactly 28 years old. Hence, B's two answers are consistent.

The same kind of phenomena is displayed in (16)-(18), where the nature of the QUD and the underlying domain goals of A drive a quantity implicature in some cases, but not in others:

- (16) A: I'm having a dinner party and I need exactly six more chairs.  
B: John has four chairs.  
(17) A: I'm having a dinner party and I need exactly four more chairs.  
B: John has four chairs.  
(18) A: I'm having a dinner party and I need exactly two more chairs.  
B: John has four chairs. (Welker 1994)

The B utterances in these examples seem to implicate different things: in (16B) and (18B) that John has *at most* four chairs; in (17B) that he has *at least* four chairs (and maybe more). Indirect speech acts are also presumably of this type; e.g., *Can you pass the salt?* may be used as a request for the addressee to pass the salt instead of a mere request for information about the ability of that addressee, but generally just in case the addressee might have reason to believe that the speaker wants the salt.

Besides their reflection in overt questions, evident domain goals and intentions can come to bear in the generation of Relevance implicatures, as well:

- (19) A: Do you want some coffee?  
B: Coffee would keep me awake. (Sperber & Wilson 1985)

(19B) will be taken as an answer to (19A), and hence as relevant, just in case A has reason to believe that B has reason to believe that A knows that B wants/does not want to stay awake.

All this argues that conventional implicatures may be driven by the QUD and the evident goals and intentions of the interlocutors, but to see that this can have clearly truth conditional effects, we need to consider embedded implicatures.

### Embedded implicatures:

There has been quite a bit of work on embedded implicatures in the recent literature (Chierchia 2004, Chierchia, Fox & Spector 2011, Simons (2010,2011). Simons (2011) argues that these cannot all be conventionally triggered; she considers not only scalar implicatures, but Relevance implicatures (her “local enrichment implicatures”) as well:

### Scalar implicatures:

(20) Kai ate the broccoli or he ate some of the peas. (Sauerland 2004)

(21) If I give an extension to some of my students, the others will be upset. (Simons 2011)

### Local enrichment implicatures (Horn’s R-implicatures; Levinson’s I-implicatures):

(22) A: How will you get to SALT?

B: Either I’ll rent a car or I’ll fly.

‘Either I’ll rent a car *and drive that car to SALT* or I’ll fly’ (Simons 2011)

(23) If you need to get to SALT, you could rent a car or you could fly.

Local issue: how to get to SALT

The not-all implicatures in (20) and (21) are not inherited by the global context; (20) as a whole doesn’t implicate that Kai didn’t eat all of the peas, nor does (21) implicate that the speaker won’t give an extension to all of his students (and in fact, that might be the solution to his dilemma!). But the truth conditional interpretation for each seems to hinge on the corresponding embedded implicature: E.g., in (21), the problem is precisely that in case the speaker gives some-but-not-all his students an extension, then those who do not get one will be upset. In fact, (21) is an implicative counterpart of the famous anaphoric donkey sentences—here, the resolution of anaphora triggered by *the others* requires that there be some subset of a maximally salient set which are excluded from having some salient property, and the only way to resolve this anaphoric element in (21) is by assuming that *some* means *not all*, so that there is a salient subset of the set of all the speaker’s students which do not get an extension. (21) thus involves bridging based on a conversational implicature.<sup>4</sup> Similarly, in Simons’ (22) and the conditional assertion variant in (23), one of the options involves the enrichment implicature, but it is not assumed globally that the speaker will drive a car to SALT, and in (23) it’s not even assumed that she will *go* to SALT.

Simons (2011) argues that these cases make it plausible that “embedded clauses are accessible as input to pragmatic inference and for modification by pragmatic inference”. That is, the conversational context to which an implicature makes a contribution might be not the global, but a merely local context in the sense of Heim (1983) or DRT, i.e. in dynamic interpretation. In particular, not only an entire disjunctive assertion, but each of its conjuncts might be subject to a requirement of Relevance to the QUD. Then we would expect to see embedded implicatures, merely local but affecting the resulting truth conditions for the whole. Hence the QUD, in (20), and/or domain goals, like getting to SALT in (22), can drive local

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<sup>4</sup> Bridging (Clark 1975) is a phenomenon wherein an anaphoric expression has no overt coreferential antecedent, but is understood as related in some relevant way to the denotation of an antecedently occurring NP. Here, *some of my students* is related, via the quantity implicature to the group of students who don’t get extensions, so the resolution of *the others* to that excluded group is bridged by *some of my students*.

implicature. Starr (2010, 2011) argues that the (suppositional) semantics and pragmatics for *if*-clauses is closely related to that for questions, citing, among other evidence from the semantics of conditionals the fact that *if*-clauses can serve as the complements of predicates that take interrogative complements, like *wonder* (24) and *ask* (25), and in interrogative equatives like that in (26):

- (24) Albert wondered if/whether Mabel loved John.
- (25) Mabel asked if/whether John was going to the party
- (26) The future is coming. The question is if/whether we will be ready for it. (Starr 2010,2011)

Hence, it is tempting to argue that the antecedent of a conditional itself raises an issue—whether or not the antecedent is true, or, as in the case of (23), how to satisfy the addressee’s hypothetical goal.

Neale (1992) points out that Grice held that **calculability** is crucial in conversational implicature:

. . .the final test for the presence of a conversational implicature [has] to be, as far as I [can] see, a derivation of it. One has to produce an account of how it could have arisen and why it is there. And I am very much opposed to any kind of sloppy use of this philosophical tool, in which one does not fulfill this condition.

(Grice 1981:187) [a passage not reproduced in Grice 1989]

As Simons (2011) points out, assuming that implicatures are calculated locally goes against the usual assumption (e.g., Anscombe & Ducrot 1983, Recanati 2003) that (as she puts it) “Conversational implicatures are pragmatic consequences of an act of saying something...[and] an act of saying something can be performed only by means of a complete utterance, not by means of an unasserted clause such as a disjunct or the antecedent of a conditional.” And, she continues, “If we take local pragmatic effects to contribute to sentence meaning, then we lose the clear separation between *what a sentence means* (a conventionally determined proposition) and *what a speaker means* (determined by speaker intentions, to which complete sentence meaning provides a guide).” These two problems share what she calls the “Accessibility Problem”: “On standard views, (the content of) embedded clauses is not supposed to be accessible either as input to pragmatic reasoning or for modification by pragmatic reasoning.” She contrasts this with what she calls “the dynamic pragmatic view” (citing Geurts 2010):

- (27) **The dynamic pragmatic view** (Kadmon 2001, Geurts 2010; version of Simons 2011)  
The production of a complex sentence made up of subordinate clauses constitutes an instruction to carry out a structured update to the conversational context/DRS, made up of several sub-updates. The conventional content of a subordinate clause is only a guide to the sub-update intended by the speaker.

We see evidence for the dynamic pragmatic view not only from the embedded implicatures (especially the donkey-anaphora licensed by embedded implicature in (21)), but from examples involving simultaneous anaphora resolution and domain restriction of an operator (5') (6), parallel cases with presupposition satisfaction under the scope of an operator (7), and sluicing and domain restriction for an intensional operator (7), as well as a QUD-related constraint on presupposition projection (10). In all these examples (a) there’s some aspect of meaning which cannot be derived solely from conventional content, (b) that content is Retrieved partly as a function of recognition of the QUD or other (domain) goals, and (c) arguably, Retrieving the intended content requires a certain amount of local reasoning in the course of interpretation—local in the sense of involving content which is not in the global common ground. For example, in (8), from above:

- (8) Stefanie often eats out when she’s travelling on business. If she doesn’t know the city well, where is usually influenced by the latest Zagat ratings.



We satisfy the presupposition triggered by *where* by restricting the domain of *usually*. We bridge *the city* in the *if*-clause to some arbitrary instance of the business trips made relevant by the first utterance—reasoning that most such trips are to cities and hence taking the city in question to be Stefanie’s destination away from home on an arbitrary instance of those trips. Accordingly we restrict *usually* to those occasions on which she makes such a trip. Since we have just been informed that one thing Stefanie does on such trips is eat out, and since one always eats out at some specific location, the sluice with *where* is accordingly resolved to *where she eats out*. So the interpretation must simultaneously resolve anaphora, domain restriction, and a sluice, each independently but conventionally triggered, all resolved via reasoning on the basis of local content with respect to the previous context—where the relevant content itself was not asserted but only non-globally entertained under the scope of *often*. One might add, as well, the resolution of the Reference Time, or Topic Time, for *influence*, if one takes those to be generally assumed. More elaborate examples can be constructed. E.g. see Roberts (1995,1996b).

Hence, I would argue that in those examples where the retrieval of implicit content is driven or constrained by conventionally triggered presuppositions, determining interpretation can profitably be conceived of as the solution of a simultaneous equation in multiple variables. On the assumption that the speaker is competent and cooperative, in order to Retrieve the single intended interpretation, one must solve for all those variables in such a way that the resulting interpretation is compatible with its conventional content, satisfies all the conventionally triggered presuppositions, and is pragmatically plausible and relevant in its context. All this on-line, in the course of dynamic compositional interpretation.

In section 2, I sketch the conception of discourse and of the interaction of content with context which I have proposed as an explanatory framework for the kind of phenomena just discussed. A proposal for a formal dynamic semantics in which this notion of context would have its play, and detailed arguments for how this works with respect to the above examples, would go well beyond the purview of the present paper, though I have written about all of them (with respect to this framework) in the other papers cited. Rather, my present aim lies elsewhere: in an argument for what this range of phenomena shows us about language processing and the language faculty, which I sketch in sections 3 and 4, respectively.

## 2. A framework for Retrieving the meaning<sub>mn</sub> of an utterance<sup>5</sup>

In this section, I will briefly describe the theoretical apparatus which I propose to use to explain the kinds of phenomena discussed in the previous section. First I offer a sketch of the general pragmatic theory I have developed elsewhere, on independent grounds. Then I outline how this framework can be extended to offer an explanatory theory of Retrievability and Salience.

### 2.1 A theory of Context of Utterance

Hypothesis:<sup>6</sup> **The structure of a discourse interaction is designed to help satisfy Retrievability**, to make it be reasonable to intend that one’s audience will recognize that one intends them to both grasp the proposition one intends to express and recognize that one proposes that this proposition is true.

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<sup>5</sup> Except where noted, this discussion is drawn from Roberts (1996, 2004, to appear).

<sup>6</sup> This formulation works only for assertions, because of the assumption of truth(/falsity). The hypothesis can be elaborated to apply to questions and suggestions, as well, but in the interest of brevity I won’t do so here.

Discourse is modeled as a collaborative game, both driven and constrained by publicly evident intentions of the interlocutors, whose nature and adoption, in turn, are constrained by what it is to conduct a rational collaborative inquiry.<sup>7</sup> Chief among these intentions at any time is the intention to address the agreed-upon QUD. A characterization of discourse along these lines is intended to provide the foundation for the development of an integrated, falsifiable pragmatic theory, subsuming the full range of classical topics in linguistic pragmatics and suggesting a number of heretofore unexplored connections between these topics.

If linguistic discourse is a game, then a context of utterance at a given point in the game can be modeled formally as a structured set of intentions and information—the score, which we take to ideally be evident to all the interlocutors in the discourse:

(28) **Scoreboard of a rational discourse interaction  $D$ :**

At any given point  $t$  in  $D$ , the information shared by the interlocutors is structured as follows:

$I$ , the set of interlocutors at  $t$

$G$ , a set of sets of goals in effect at  $t$ , such that

for all  $i \in I$ , there is a (possibly empty)  $G_i$  which is the set of goals which  $i$  is committed at  $t$  to trying to achieve, and

$G = \{ G_i \mid i \in I \}$ .

$G_{\text{com}} = \{ g \mid \forall i \in I: g \in G_i \}$ , the set of the interlocutors' common goals at  $t$ .

$M$ , the set of moves made by interlocutors up to  $t$ , with distinguished sub-sets:

$A \subseteq M$ , the set of assertions

$Q \subseteq M$ , the set of questions

$S \subseteq M$ , the set of suggestions

$\text{Acc} \subseteq M$ , the set of accepted moves

$<$  is a total order on  $M$ , the order of utterance

$\text{CG}$ , the common ground, the set of propositions treated as if true by all  $i \in I$  at  $t$

$\text{DR}$ , the set of discourse referents, corresponding to entities entailed to exist in  $\text{CG}$

$\text{QUD} \subseteq Q \cap \text{Acc}$ , the ordered set of questions<sup>8</sup> under discussion at  $t$ , s.t.

for all  $Q \in \text{QUD}$  there is a  $g \in G_{\text{com}}$  such that  $g$  is the goal of answering  $Q$ , and

for all  $Q \in \text{QUD}$ , it is not the case that  $\text{CG}$  entails an answer to  $Q$

To capture the canonical relationship between  $\text{QUD}$  and the interlocutors' goals, we can define a subset of  $G_{\text{com}}$ ,  $G_Q = \{ g \in G_{\text{com}} \mid \text{there is some } Q \in \text{QUD} \text{ and } g \text{ is the goal of answering } Q \}$  (this consists of those common goals already guaranteed by the first condition on  $\text{QUD}$ ). For all  $i \in I$ , if  $i$  is a sincere,

<sup>7</sup> Like Sperber & Wilson and Thomason et al., the proposed approach to retrieving meaning<sub>nn</sub> is based on the assumption that the interaction of interlocutors in discourse is essentially cooperative, in fact *collaborative* (see Clark 1996 for extended discussion of relevant literature). Some have recently argued that Grice was wrong in characterizing the construction of discourse by interlocutors as cooperative (Merin 1999; Franke, de Jager & van Rooij 2009). But I think that reflects a misunderstanding: Parties who are competing or even hostile can perfectly well simultaneously cooperate when it is in their mutual interest. Players on opposite teams must cooperate in (ostensibly) playing by the rules, or else they forfeit the game. The point of discourse is to cooperate linguistically in order to share information—if only lies, threats, and intimidation! Respecting this common goal requires cooperation only *in the limited sense of accurately conveying the intended meaning*. This does not preclude competition and even adversarial relations with respect to any other goals the interlocutors individually may have.

<sup>8</sup> It is important to note that, as standard in formal semantics, a question is a semantic entity, the set of propositions which are possible answers to the question. This is *not* the same thing as an interrogative sentence, but does serve as the latter's denotation. However, entertaining a question needn't involve uttering an interrogative.

competent and cooperative interlocutor in  $D$ , we can use  $G_Q$  to characterize two kinds of publicly evident goals held by  $i$  at  $t$ :

$$\begin{aligned} \text{Discourse Goals of } i &= G_Q \\ \text{Domain Goals of } i &= G_i \setminus G_Q \end{aligned}$$

$G_{\text{com}} \setminus G_Q$  is the set of common Domain Goals of all the interlocutors at that point in discourse.

If an agent is rational, then ideally her intentions are consistent. Hence, one's discourse goals are ideally consistent with, and presumably (on the assumption that there are other things more important than linguistic inquiry) subservient to one's domain goals. Of course, if it is clear that individual interlocutors have goals which are not common, and which limit their willingness to share information, this can be captured in the proposed scoreboard. For example, if a hostile witness in a trial is asked whether the accused took money from his firm and answers *He regularly wrote checks to cover his expenses*, one should not take this reply to necessarily be a complete answer to the question, as all good prosecuting attorneys know. That is, the witness will uncooperatively construe the question itself in the narrowest possible way, to avoid having to lie or to give information that might serve the prosecution; but given her obvious overarching personal goal of giving as little information as possible, this is predictable.

The schematic scoreboard in (1) constitutes a theory of the **context of utterance**. It is idealized, so as to permit us to make predictions about what a speaker reasonably meant by a given utterance. As in Stalnaker (1979), it is important to understand that not all the information in the CG of the scoreboard need be introduced linguistically. Some propositions in CG may represent background information of the participants, perceptually accessible information, etc.

Given this overall intentional structure, we can characterize three principal kinds of moves in a discourse game, all guided and constrained by the interlocutors' goals as reflected in the QUD.

- (29) **Pragmatics of Assertion:** (following Stalnaker 1979)  
If an assertion of  $\alpha$  is accepted by the interlocutors in a discourse  $D$ ,  $|\alpha|^D$  is added to CG.
- (30) **Pragmatics of Questions:** (Roberts 1996; cf. Hamblin 1973, Groenendijk & Stokhof 1984)  
If a question  $? \alpha$  is accepted by the interlocutors in a discourse  $D$ , then  $? \alpha|^D$ , a set of propositions, is added to the QUD in  $D$ . A question is removed from QUD iff either its answer is entailed by CG or it is determined to be unanswerable.
- (31) **Pragmatics of Suggestions:** (Roberts 2004; see also Portner 2007)  
If a suggestion posed by  $!P$ ,  $P$  a one-place predicate, is accepted by the intended addressee  $i$  in a discourse  $D$ ,  $|P|^D$  is added to  $G_i$ , the set of  $i$ 's goals in  $D$ , and  $|\text{intend}(i, [P(i)])|^D$  is added to CG.  
Once an intention has been fulfilled or it is determined that the intended agent  $i$  cannot practically fulfill it, it is removed from  $G_i$ .

**Strategies of Inquiry** are sequences of moves designed to (at least partially) satisfy the aims of the game while obeying the game's constraints. Hence, strategy of inquiry will have a hierarchical structure based on a set of questions partially ordered by entailment. Roberts (2004) argues that rhetorical relations between utterances in a discourse (Mann & Thompson 1986, 1988, Asher & Lascarides 1994, 1998a, b) pertain to features of such strategies. Hence, the proposed framework is intended to integrate the findings from the work based on rhetorical structure theory.

A rational agent's intentions are ideally intrinsically bound up with her plans for action (Bratman 1987). Hence we have:

- (32) **Rational Cooperation in a Discourse *D*:** Make your utterance one which promotes your current intentions in *D*. (cf. Grice's Cooperative Principle 1967, and its counterpart in Thomason 1990)

Since all of the questions in QUD are reflected in GQ, any rational, cooperative interlocutor should address the QUD (unless more important goals interfere):

- (33) A move *m* is **Relevant** to the question under discussion *q* iff *m* addresses *q*, directly or indirectly yielding a partial answer to *q* in CG. (Roberts 1996)

An utterance *m* addresses a question *q* iff *m* either contextually entails a partial answer to *q* (*m* is an assertion) or is part of a strategy to answer *q* (*m* is a question) or suggests an action to the addressee which, if carried out, might help to resolve *q* (*m* is a suggestion, introduced with utterance of an imperative).

To see the way in which this characterization differs from previous views, consider Sperber & Wilson (1985). Offering a modification of the vague notion of relevance in Grice (1967), their Relevance is a general constraint on felicitous utterance captured by two requirements: a requirement of sharing maximum amounts of information (close in spirit to Stalnaker's (1979) motivation for assertion), and a requirement of doing so in an optimally efficient manner—which they characterize as a cognitive constraint based on the nature and limitations of the human mind that engages in discourse. There is something intuitively right about the latter, and Sperber & Wilson offer a rich range of examples demonstrating its utility. But like a number of other theories of pragmatics following Grice, it fails to address a crucial question: Relevance is a relational notion. In order to guarantee felicity, what must an utterance be relevant *to*? Simply facilitating the maximum number of inferences while respecting optimal ease does not address this issue (any more than assuming that discourse must be cohesive—what constitutes a cohesive discourse?). In this respect Grice himself gives us some hints: Although the maxim of Relation itself is quite terse — “Be relevant” — Grice's maxims of Quantity suggest that he understood the felicity of an utterance to be relative to the conversational purposes of the interlocutors at that point in the discourse:

- Quantity:** (Grice 1967:27)
- 1) Make your contribution as informative as is required (for the current purposes of the exchange).
  - 2) Do not make your contribution more informative than is required.

More generally, assume that the conversational maxims and other commonly assumed guidelines for conversational felicity in the literature amount to rationally motivated rules for felicitous conversation, rules exploited by speakers to assist their interlocutors in grasping the intended meanings of utterances. Rules only make sense as part of a collective *endeavor*. Call such an endeavor a game. But a game is not a game without goals. What are these goals in a language game? What motivates us to make a move—to utter something?

Sperber & Wilson's characterization of Relevance makes our information sharing appear to be purely quantitatively driven: According to them, what matters is the sheer number of inferences one can draw easily—anything goes, the faster the better. In terms of the framework recommended here, this would amount to always addressing nothing more specific than the Big Question: *What is the way things are?*

The perspective I have offered is more qualitative and constrained: What matters is addressing a more limited, circumscribed goal, resolving the immediate question accepted for discussion. Quantity, too, has its natural limit, given this goal: We need just enough of the right kind of information to resolve the question; in his closely related work, Jonathan Ginzburg (1995,2012) explores what this means in some detail, and Thomason (1990) explicitly formulates Quantity in related terms. Further, I think it is quite plausible that the characterization of Relevance that I have given is motivated by cognitive efficiency in very specific ways: We share information in a constrained, focused way in order to optimize the interface between linguistic processing *per se* and both practical reasoning and information-retrieval and -storage. Just as work in psycholinguistics has shown that lexical access is facilitated by use of vocabulary in a particular encyclopedic domain (see recent work by Glucksberg et al. 1986, Baumgaertner et al. 2002, and Gennari et al. 2007, as well as Newman et al. 2009), it seems plausible that interlocutors' focus on a QUD activates general information in the encyclopedic domain pertaining to the QUD, making it easier and faster, on the basis of what is said, to (a) access the relevant information in that encyclopedic domain, (b) draw *relevant* inferences on the basis of that information and what is said, (c) use such information and inferences to reason practically about what the speaker means<sub>mn</sub> (in Grice's sense), and (d) efficiently store the resulting meaning<sub>mn</sub> (when accepted), not only in the Common Ground but in the relevant encyclopedic domain itself.

The other respect in which the proposal in Roberts (1996) differs from many other, informal characterizations of discourse context in interpretation is that the intention-based Scoreboard in (28), with its characterization of Questions in truth conditional terms should permit us to realize this notion of context in a dynamic theory of interpretation, e.g. an extension of Heim (1982) or Kamp (1981), which models the interdependence of context and formal compositional interpretation, permitting us to develop rigorous, falsifiable accounts in the tradition of Montague Grammar; see current accounts in this vein due to Ginzburg (2012) and Martin & Pollard (to appear). While sketching this would go beyond the scope of the present paper, its interest should be evident in the discussion in section 3.

Thus, I conclude, Relevance is a function of the QUD. This begins to hint at the centrality of Relevance in interpretation. In Roberts (1996) I offered a concrete example of its centrality, arguing that a discourse structure based on the QUD is generally reflected in the prosodic focus associated with an utterance. I illustrated this with a sketch of how English Focus conventionally reflects the QUD, via a requirement of congruence. If correct, this is evidence of the omnipresence of the QUD in interpretation, since prosodic Focus arguably is realized in most, if not all human languages (Roberts 1998).

## 2.2 Relevance and Salience

In the preceding sections, I have offered evidence for the following inter-related theses about the way in which interpretation proceeds in natural language processing:

- (a) **Dynamic interpretation:** Those aspects of an utterance which have already been interpreted bear on the interpretation of those still being processed. Hence, context changes non-globally.
- (b) **Simultaneous solution:** Pragmatic reasoning plays a crucial role in the course of this dynamic interpretation. This is evident not only in the existence of embedded implicatures, but in the fact that interpretation of any single element of an utterance which is underdetermined by its conventional content must be compatible with the resolution of all such elements in the utterance, as well as resulting in a plausible, contextually felicitous interpretation.
- (c) **The centrality of Relevance:** Interpretation is driven and constrained by the interlocutors' publicly evident intentions and goals, as reflected in the requirement of Relevance to the QUD. The interlocutors' recognition of and cooperative commitment to those intentions is essential to their collaboration in conveying and Retrieving meaning<sub>mn</sub>.

In this section, I will first sketch a functional explanation of (c) and suggest how we might approach a theory of Saliency based on this hypothesis. If the latter proved to be useful, that in turn might lay the foundation of an account of how, in processing an utterance in context, interlocutors can efficiently seek a simultaneous solution (b) in the course of interpretation (a).

Here is an outline of the explanation:

- (1) Human behavior generally is driven and constrained by intentions, those intentions for any given agent ranked according to the relative importance to the agent of realizing the intentions. (I will simply assume that (1) is true.)
- (2) What we intend constrains what we attend to, our attentional field.
- (3) Saliency (like commitment to intentions, a gradient notion) is a function of attention. I.e., something is salient to someone to the extent that they are attending to it. Thus, we might expect that some entities (those associated with more highly ranked intentions) would be more central in the attentional field than others.
- (4) Saliency facilitates the Retrieval of those aspects of the intended meaning of an utterance which are not explicitly given by the conventional content of the utterance.

From (1) – (4) it follows that it would generally be extremely useful at any point in discourse to have a publicly evident goal which the collaborative interlocutors jointly intend to achieve, and which is more highly ranked than any of their other joint intentions. Since we take the general function of discourse to be to contribute to the interlocutors' Common Ground, it would seem reasonable to take as a goal a circumscribed domain of inquiry. This is exactly what a question offers: a set of alternative possibilities from which one attempts to derive the one true answer, the realized possibility. Hence, on the reasonable assumption (Roberts 1995,2004, Ginzburg 1995,2012) that the default goal at any time in discourse is to address the QUD, a goal which all cooperative interlocutors intend to address insofar as possible, and that doing so is what constitutes Relevance (as captured in (33)), then (c) follows from (1)-(4). That is, we *predict* that the QUD will play a role in a wide range of phenomena involving interpretive resolution: *Inter alia* we predict that discourse saliency is a function of the QUD (at least when interlocutors are not distracted), which thereby constrains the Retrieval of the intended meaning of an utterance. Another way to put this is that the intentional structure of a discourse, especially the QUD, constrains the search for meaning<sub>nn</sub>. We seek a most-obviously Relevant way of yielding a simultaneous solution to the interpretive puzzles in an utterance, without necessarily working through all potential solutions in parallel.

To put some more meat on these bones, consider the following outline of a theory of saliency, based on the framework described in the preceding section. For concreteness, consider first the role of saliency in anaphora resolution. Though there is still debate about the meaning of definite descriptions, there is an emerging consensus that (a) they are anaphoric, presupposing an antecedent in prior discourse—along the lines proposed by Heim (1982), Kamp (1981) or van der Sandt (1992), and (b) their descriptive content is presuppositional, as well, in the sense that their presupposed antecedent is presumed by the speaker to bear the property denoted by that descriptive content.<sup>9</sup> These theories of discourse anaphora take the antecedents to be not NPs *per se*, but discourse referents—as that notion is spelled out in the Heim/Kamp/van der Sandt theories. In interpreting a definite, an addressee must determine exactly which antecedent the speaker intends, out of all those familiar to the interlocutor. The NP's descriptive content is both a constraint on and a clue to the intended antecedent (which must also satisfy that content).

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<sup>9</sup> See Roberts (2003), Elbourne (2005), *inter alia*.

The notion of the *descriptive content* of a noun phrase is complex and pragmatically subtle. For present purposes, here is a first approximation:

- (34) The **descriptive content** of a definite or demonstrative description is the denotation of the nominal complement of *the/this/those/those*. The descriptive content of a personal or demonstrative pronoun is the semantic content corresponding to its person, number, and gender, as morphologically marked. The descriptive content for a proper name *n* is ‘is called *n*’.
- (35) A definite noun phrase with descriptive content *np* is **informationally unique** relative to a given context *c* with domain DR just in case there is exactly one  $d \in \text{DR}$  s.t. the context entails that *np* holds of *d*.

The prevalence of so-called *incomplete descriptions*, illustrated in (36), argues that some kind of domain restriction generally plays a role in the satisfaction of (35):<sup>10</sup>

- (36) John has a cat and a dog. He walks the dog twice daily and lets the cat out at night.

In any reasonable common ground among ordinary speakers, there will be information about the existence of many cats and dogs. Hence, neither of the underlined definite descriptions in (36) has a descriptive content sufficiently rich by itself to satisfy informational uniqueness, picking out a unique discourse referent in that context which satisfies that content. The obviously felicitous use of these descriptions in this context argues that there is a regular way in which speakers reasonably assume that their addressees will, nonetheless, Retrieve the uniquely intended interpretation for these NPs. Here is a hypothesis about how we do that:

- (37) **The attentional restriction of the domain for Retrievability:** Even though a given definite NP is not informationally unique relative to the entire Domain of familiar Discourse Referents in the DR of the context of utterance, if a speaker can reasonably assume in advance that the addressee’s attention is restricted to some subset of DR, a subset in which the intended antecedent discourse referent *is* informationally unique relative to the NP’s descriptive content, then this guarantees that that antecedent is readily Retrievable.<sup>11</sup>

There is, it seems, a trade-off between the richness of a definite NP’s descriptive content and the required degree of salience of the intended antecedent in order for the NP’s use to be felicitous—i.e., for the intended antecedent to be readily informationally unique in the attentionally restricted domain, and hence Retrievable. To briefly illustrate, consider (38):

- (38) I was shopping in Kroger’s this afternoon when a guy asked me for help choosing vegetables. He had his little boy with him, and the child was fussy.
- a) He wasn’t sure which greens were kale.
  - b) The man wasn’t sure which greens were kale.
  - c) The man in Kroger’s wasn’t sure which greens were kale.

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<sup>10</sup> For example, one could take (37) to suggest how one retrieves the implicit domain variable in a definite, along the lines suggested in von Stechow (1994), or the descriptive content of a definite whose descriptive content has been deleted, as in the treatment of E-type pronouns in Elbourne (2003). That would not be my preference, but for reasons orthogonal to the present discussion.

<sup>11</sup> This presumes that the ideal case obtains, wherein the context is non-defective; i.e. all the interlocutors agree on the Score and have equal access to its content. Of course, this is not always the case. But this is how meaning conveyance works when it works, and cases involving defective contexts are to be explained in terms of the respects in which they depart from the ideal.

d) The man I met today wasn't sure which greens were kale.

In the context given, in order to convey anaphoric reference to the man mentioned in the first utterance, a speaker would be most likely to use either (a) or (b). It may be that (38a) is sub-optimal from a purely processing point of view, since when *he* is first encountered the addressee might take its antecedent to be the discourse referent for either the man or the boy. But in this context, plausibility makes the man be the more likely antecedent.<sup>12</sup> (c) or (d) would be odd, because their descriptive content is richer than required to pick out the uniquely most salient man. This oddness might reflect an implicature based on Grice's Quantity 2 maxim: Don't say more than is required for the purposes of the conversation. Thereby we are enjoined to use the leanest descriptive content that will guarantee Retrievability. But if we want to refer to someone other than the salient man or his son, even if the intended referent is familiar from prior discussion, we would be forced to use richer descriptive content:

(38) e) The man I met (last week) in Weiland's had a similar problem with rutabagas.

With contrastive accent on the subject of (38e), the speaker clearly intends to refer to someone other than the man at Kroger's—perhaps someone she and her addressee had discussed on a previous occasion. This impression is reinforced by the predicate, which doesn't plausibly hold of the Kroger's guy (first introduced in the first sentence), because of the anaphoric *similar*. With the Weiland's guy as intended antecedent, use of (38b) would of course be infelicitous, the antecedent nonRetrievable as a function of the descriptive content and the relative salience of familiar discourse referents.

How is the attentional restriction of the domain affected? Recall the definition of Relevance in the previous section, characterized in terms of the propositional content of an utterance. We can extend that notion to talk about the Relevance of (discourse) entities to the QUD:

(39) **The set of Relevant discourse referents:** In a discourse with scoreboard *S*, discourse referent *d* (in DR) is Relevant to the QUD *q* just in case for some property *P*, the question of whether *d* has *P* is evidently Relevant to *q*.

Then:

(40) **Salience** is a partial order of the elements of DR (the set of Discourse Referents), determined by the degree to which those entities would be immediately in the attentional field of anyone cooperatively paying attention to that context.

(41) Factors in a **salience ranking** in discourse include the following, themselves ranked in descending order of importance:

1. High perceptual salience in the situation of utterance.
2. RELEVANCE to the evident current purposes of the interlocutors, especially the QUD (cf. Grosz & Sider 1986)
3. Coherence, reflected in felicitous rhetorical relations in a relevant strategy of inquiry, with consequent relations between thematic roles in the two utterances (Kehler 2009)
4. Relative recency (Terken & Hirschberg 1994)

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<sup>12</sup> To make the pronoun even more felicitous, change *a guy* in the first sentence to *this guy*. It has been noted (Prince 1981) that specific indefinite *this*, among other things signals the speaker's intention to make its referent be the Topic in subsequent discourse. As in (2) above, a pronominal subject is usually taken to refer to the Topic, if there is one. See Roberts (to appear) for discussion of what it is to be a Topic.



With respect to the first of these elements, high perceptual salience, this is a distracter, potentially trumping RELEVANCE to the discourse goals of the interlocutors. I have in mind cases where someone (not necessarily a speaker) points to draw another's attention to some entity or situation (*This is PJ Harvey's new album*); cases like Heim's (1982) donkey walking into a classroom room (*It stinks!*); or a situation where there is an explosion a few blocks away as one sits in a café in Costa Rica in 1982 (*That was a bomb!*). The first, deictic case arguably involves linguistic meaning<sub>mn</sub>: Deixis is coordinated by a speaker with the canonical use of a demonstrative in order to heighten perceptual salience. But such heightening also arises non-linguistically, especially if in response to an unusual or immediately threatening situation. We can characterize the events in the other cases as distracting from the interlocutors' Discourse Goals because they bear on over-arching Domain Goals—the attentiveness brought on by oddity in a particular kind of situation, alertness associated with survival, reproduction, etc.—which goals are typically ranked higher than the goal of participating cooperatively in a discourse by addressing the QUD. That these cases are ranked more highly than Relevance to the QUD, then, is expected under the intentional characterization of context suggested by (28).

When a discourse referent is Relevant under (39), then it is more highly ranked than any other familiar discourse referents (in DR). Hence, in (38), the Relevant man in Kroger's is salient, whereas the man from Weiland's is not.

With respect to the relative ranking of the third and fourth factors in (41), there is empirical evidence that mere recency of mention is not highly ranked where salience is concerned. Terken & Hirschberg (1994) provide clear evidence that parallelism is more important in determining likely antecedence than recency; and Smyth (1994) offers experimental evidence for the preference for antecedents with the same grammatical role as the pronominal. But, in turn, one might speculate that Relevance is an important factor promoting parallelism between antecedents and anaphoric elements, for two reasons.

First, there is cross-linguistic evidence that surface order is constrained by discourse factors, and Centering Theory has long assumed that there is a preference across utterances for entities under continued discussion to persist in the same grammatical and/or thematic roles, especially in subject position. Also cross-linguistically, Topicality (Roberts to appear) pertains to entities which are in some sense under discussion or (as with English specific indefinite *this*) about to be under discussion.<sup>13</sup> Hence, Topics are Relevant and usually definite. Moreover, Topical NPs are typically ordered before less Topical ones referred to in the same utterance—though this is not absolute across all utterances even in a relatively topic-oriented language. Given the persistence of surface order and the way that it reflects Topicality, it seems reasonable to speculate that the role of parallelism observed by Terken & Hirschberg (1994) may partly reflect Topic continuation. Topicality may also play a role in explaining an apparent bias toward taking subjects as antecedents (Stevenson et al. 1994, Arnold 2001).

Perhaps even more interesting, Kehler (2009) calls into question the utility of grammatical role parallelism *per se* in predicting anaphora resolution. Kehler (2002) pointed out some confounds in Smyth's materials, raising doubts about his argument for parallelism as an independent factor in anaphora resolution. Kertz, Kehler & Elman (2006) and Kehler, Kertz, Rohde & Elman (2008) did experiments to control for these confounds, and their results argue that coherence, as reflected in felicitous rhetorical relations, is more successful than grammatical role parallelism in predicting the preferred resolution. E.g., if the understood rhetorical relation between the two utterances containing target and potential antecedent was Result, as in (42b,d), the intended resolution of the anaphora was statistically far more likely to involve a non-parallel relation between antecedent and anaphor (95% for subjects, 94% for

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<sup>13</sup> See also Büring (2003) on Contrastive Topics, though as Roberts (to appear) notes (and I think Büring would concur), not all Topics are Contrastive Topics.

objects) than if the rhetorical relation was Parallel, as in (42a,c), where, on the preferred resolution, antecedent and anaphoric trigger were more parallel 98% of the time for subjects, 90% for objects).

- (42) Samuel threatened Justin with a knife, and
- a. ...Erin blindfolded him (with a scarf) [Parallel]
  - b. ...Erin stopped him (with pepper spray) [Result]
  - c. ...he blindfolded Erin (with a scarf) [Parallel]
  - d. ...he alerted security (with a shout) [Result] (Kertz et al. 2006)

Kehler (2009) captures the relevant generalization about how contextually-conditioned expectations play a role in anaphora resolution:

...at any point during comprehension the hearer will have expectations about how the discourse will be continued with respect to coherence, and...the difficulty in interpreting the linguistic material to follow will be conditioned in part on those expectations. These expectations will then evolve based on subsequent linguistic input.

So he concludes there really isn't a "grammatical role parallelism bias"; instead, that's an epiphenomenon of a certain kind of data.

Experimental results in subsequent work with Rohde (Rohde et al. 2006, Rohde et al. 2007; Rohde & Kehler 2008a, Rohde & Kehler 2008b) support the thesis that coherence relation is the central factor in predicting anaphora resolution. But as Kehler (2009) points out, in many of their experimental materials Rohde and her associates used different types of questions to bias to different coherence relations—e.g., *What happened next?* to bias to the relation Occasion, or *Why?* to bias to Explanation. Kehler (2009) then agrees with Roberts (2004) that we can understand different coherence relations as reflecting different strategies of inquiry in a QUD-based discourse structure. Hence, he argues that the relation of the target utterance to the QUD, reflecting the speaker's adopted strategy, is the central factor in predicting anaphora resolution. And he shows that this constraint is not specific to pronoun resolution, but can be seen in full NPs, as well, as reflected in prosody.

From all this, we might conclude that it is not parallelism, but coherence in a strategy of inquiry, which should be the third factor in (41). One might even subsume the observations about Topicality under the third factor, noting that Topicality is often a reflection of an Elaboration sequence. This approach deserves more careful investigation.

Finally, entities which are neither perceptually salient, obviously Relevant nor recently mentioned are not at all salient.

For the time being, take the factors in (41) to be ordered as given. Now we can characterize the way in which anaphora resolution proceeds as a function of salience, Relevance and plausibility, as follows:

- (43) **Attentional Masking Hypothesis:** The search for an anaphoric antecedent among the accessible discourse referents proceeds as follows:<sup>14</sup> Look first to the most salient entities, then to all those that are less salient but still Relevant, and finally to all elements of DR, the domain reflecting all familiar entities in the Common Ground. The antecedent is the first discourse referent you encounter which is informationally unique among the discourse referents ranked at its level of

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<sup>14</sup> Accessibility is a constraint on antecedence that depends upon the scopes of logical operators in discourse. See Heim (1982), Kamp (1981), and Chierchia & Rooth (1985). Following Roberts (2003), I would include in the potential set of antecedents for a definite all discourse referents which are accessible and *weakly familiar* (in her

salience in satisfying the NP's descriptive content (while being plausible in view of what is predicated of the NP).

- (44) **Descriptive content condition:** To guarantee Retrievability in using a definite NP, a speaker should choose one whose descriptive content is just sufficiently rich to uniquely identify the intended discourse referent among all those which are at least as salient.

Hence, (43) and (44) entail that from the addressee's point of view, the **alternative possible antecedents for a definite NP** are those discourse referents which are at least as salient as the most salient discourse referent(s) satisfying the NP's descriptive content. In (38), assuming that the most salient discourse referent is that for the man in Kroger's, *he* in (38a) will correctly lead to Retrieving that discourse referent as antecedent. If we take the son to be (nearly) as Relevant as the father, then *the man* in (38b) would be preferable. But the descriptive content of the subjects in (38c) and (38d) is richer than necessary. Since the intended antecedent of the subject of (38e) is not salient, the richer descriptive content is motivated and successful.

Examples like (1), repeated here:

- (1) [Context: You and I are sitting in a café discussing how to understand Sperber & Wilson's (1985) definition of Relevance, and I say:]  
*I see it now!*  
[Even though I'm holding a coffee mug by the handle right under your nose and shaking it for emphasis, you don't take *it* to refer to the mug.] (Roberts 2010)

and the examples involving deixis in (3) and (3') argue that what is important for salience is not just that something be in the immediate visual field of the addressee, perhaps as directed by deixis, but that s/he be attending to it, hence that it be Relevant to her immediate goals and associated intentions. In (1), there is nothing intrusive or unusual about the mug and other visually accessible entities, so the interlocutors' attention is arguably focused on the QUD, here about the definition. I would argue that this is the same kind of attentional salience as what licenses the use and interpretation of the pronoun in examples like (2):

- (2) A: What's up with John<sub>i</sub>?—I saw him talking with Mac<sub>k</sub> earlier.  
B: He<sub>v/#k</sub> found a dent in his fender.

Addressing A's question requires attending to John, with the follow-up assertion by A about Mac serving only as a sidenote—presumably only Relevant to suggest a motivation for the question (and hence perhaps clarify the kind of explanation of John's behavior being sought). Hence both A and B, on the assumption that they are collaboratively attending to the question, can assume that John is more salient than Mac: The QUD effectively restricts the interlocutors' attentional field and ranks the entities in it.

So long as the descriptive content of a definite NP, along with what is predicated of it, is sufficiently rich to uniquely determine one element in the interlocutors' QUD-limited attentional field, in accordance with Attentional Masking (43) and the Descriptive Content Condition (44), there is no sense that the NP's descriptive content is incomplete. So, short definite descriptions like *the dog* make perfect sense when there is no more than one dog under discussion, as in (36).

- (36) John has a cat and a dog. He walks the dog twice daily and lets the cat out at night.

But, of course, the attentional field can change quite quickly in discourse, as in Lewis' (45), where *the cat* in the last clause is readily understood to have a different intended referent than *the cat* in the first sentence:

- (45) The cat is in the carton. The cat will never meet our other cat, because our other cat lives in New Zealand. Our New Zealand cat lives with the Cresswells. And there he'll stay, because Miriam [Cresswell] would be sad if the cat went away. [David Lewis 1979]

and also, of course, in the examples that argue for dynamic update of the context in the course of interpretation of a single utterance, like the classic donkey sentences and the bridging versions in (8) and (21).

Domain restriction seems to work quite similarly. Roberts (1989,1995) and von Stechow (1994), *inter alia*, argue that Relevance and/or Topicality are crucial factors in domain restriction, as they are in anaphora resolution generally (and von Stechow argues that domain restriction just *is* anaphoric). For a given operator, an intended domain consisting of those entities, events or situations which are obviously Relevant to the QUD (and perhaps subject to other pragmatic restrictions, as well) is the default assumption. If that is not the case, the speaker needs to be more explicit about the domain intended. E.g., in (5), it is possible to restrict the domain even more, to the salient and Relevant set of circumstances in which the speaker forgets to fill the birdfeeder (5'), but this requires additional explicit restriction, as with the *if*-clause in (5''):

- (5) The birds will get hungry (this winter).  
(5') If Edna forgets to fill the birdfeeder, she will feel very bad.  
The birds will get hungry. (Roberts 1989)  
(5'') If Edna forgets to fill the birdfeeder, she will feel very bad.  
And then if Frank forgets too, the birds will get hungry.

Also see Roberts (2010b) for extension to the resolution of prosodic Focus. In yet another realm, Kehler (2009) offers an argument that “a source-target pair in VP-ellipsis will only be felicitous under a particular interpretation if a suitable QUD can be inferred to which both provide partial answers”, showing how this can provide answers to outstanding problems in the analysis of VP-ellipsis: Dahl’s puzzle and illusory sloppy readings. And Roberts (in preparation) argues that Retrievalability and Relevance to the QUD are empirically superior to Merchant’s (2001) *e-Givenness* in explaining constraints on ellipsis resolution.

### **3. Psycholinguistic evidence: Attention-direction, intention-recognition and practical reasoning interact with interpretation**

In the preceding section, I argued that Relevance to the QUD in the intentional structure of discourse is central in providing an explanation for how we so quickly and accurately solve for interpretation, given the scope of the problem illustrated by the examples in Section 1. In support of this proposal, and of the related principle of Retrievalability, I alluded to several experimental studies which seemed to offer positive evidence in favor of this approach. In this section, I will review additional experimental work in psycholinguistics which can be construed as supporting the proposed framework. This section is by no means intended as an adequate review of the relevant literature in psychology and psycholinguistics, a literature with which I have (alas!) only a very partial acquaintance. Rather, it seems to me that the literature cited here does bear on questions raised by the theoretical perspective proposed in this paper, and so I discuss it in the hope of spurring a dialogue with experimental psycholinguists on these issues.<sup>15</sup>

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<sup>15</sup> This was certainly one of the aims of the organizers of the workshop in Oslo, one which I enthusiastically applaud.

The explanation for the role of Relevance proposed in section 2.2 hinged on a hypothesized relation between attention and intention. There is a large literature on attention in psychology which supports the general picture of that relationship that I assume. For example, in the well-known experiments on *inattentional blindness* of Simons & Chabris (1999), when experimental subjects were directed to attend to groups of people passing a basketball in a video, over 50% completely missed a woman in a gorilla suit walking through the middle of the scene. This striking result has subsequently been replicated in other carefully designed experiments.

Of course, under the proposal in Section 2.2, it isn't just the intentions associated with task-specific domain goals which guide attention, and hence play a role in salience and the resolution of context-dependence. I claim that the QUD plays an especially important role in constraining the behavior of a cooperative, non-distracted interlocutor. A number of recent experimental studies also argue that the QUD plays an important role in a range of interpretive processes of the relevant sort.

For example, in work in progress on the interpretation of ellipsis, Frazier & Clifton (in progress) offer experimental evidence for a generalization of their Main Assertion Principle (Frazier & Clifton 2005, Clifton & Frazier 2010): "Antecedents [for ellipsis] which are part of the main assertion are preferred, especially across sentence boundaries". Their new principle takes the QUD to be central in the interpretation of an utterance:

**General interpretation principle:** The comprehension system favors interpretations of an utterance which permit the utterance to comment on the QUD.

The Main Assertion Principle follows from this generalization, and hence, like anaphora, ellipsis resolution can be seen to depend on the QUD. This is consonant with the proposals about ellipsis and the QUD of Kehler (2009) and Roberts (in preparation), mentioned at the end of the previous section.

Gualmini, Zondervan and their colleagues (Hulsey et al. 2004; Gualmini et al. 2008; Zondervan 2008; Zondervan et al. 2008; Gualmini & Schwarz 2009) have carried out a number of experimental studies using a truth value judgment task to investigate two *prima facie* unrelated phenomena, scope disambiguation and the calculation of scalar implicatures. They take their results to strongly support the hypothesis that the QUD plays a central role in each, in both children and adults. For example, Hulsey et al. conclude:

[C]hildren are sensitive to the context when they are interpreting a sentence containing a scope ambiguity. The contextual property they take into account is the question that was raised in the context, usually referred to as the *Question Under Discussion* (QUD, Roberts 1996).

....

[Accordingly, they propose the Question Answer Requirement:]

The Question Answer Requirement:<sup>16</sup> The selected interpretation of an ambiguous sentence, whether true or false, is required to be a good answer to the Question Under Discussion. (A good answer is an interpretation that at least *entails* an answer to the QUD.)

(Hulsey, Hacquard, Fox & Gualmini 2004)

In yet another domain, several recent studies offer experimental evidence that presupposition projection is constrained by the QUD, along lines proposed by Simons et al. (2010). Amaral, Cummins & Katsos (2011), Smith & Hall (2011), and Xue & Onea (2011) all conducted experimental studies which provide empirical support for the QUD-based account of puzzles in presupposition projection, as illustrated in examples (9) – (14) above.

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<sup>16</sup> See Kadmon & Roberts (1985), who argued along similar lines.

There is another very large body of work in contemporary psycholinguistics which, while it is not generally discussed in terms of the QUD, bears directly on the plausibility of the framework and proposals in section 2: This is the work involving eye-tracking in the investigation of language processing, especially in processing utterances involving anaphora and/or prosodic focus. The framework in section 2.1 predicts that the relation between intention and attention is a central factor in interpretation in any task-oriented discourse. It seems quite likely that the utility of eye-tracking in psycholinguistic studies derives from that relation, so that preferred interpretations reflect the intentional structure of the interaction, just as in those studies that directly control for an overt QUD. When you sit someone down in a laboratory with a camera on their head and direct their gaze to a visual array, with respect to which you then ask them questions or direct them to perform tasks, you can expect that cooperative subjects will not only passively see the array, but actively attend to objects in it which pertain to the assigned task(s). That is, I assume that the intentions adopted by a cooperative subject in an experimental task reflect the intentional structure of the experimental interaction, and hence what a subject takes to be at issue (Relevant) in interpreting a particular utterance that directs him to perform a given task. Then in keeping with the Relevance-based view of salience sketched in section 2.2, when tracking the gaze of an alert, cooperative subject in such an experiment, it seems plausible that we can track which elements of the array the subject considers to be potential referents for definite (anaphoric) noun phrases in those instructions. That is, I hypothesize that Relevance with respect to a task one intends to perform plays the same role in attentional salience as the Relevance to the QUD that licenses the use and interpretation of the definite NPs in examples like those discussed in the previous section—(2), (36), (45) and the donkey sentences (8) and (21).

A number of experimental studies using eye-tracking over the past two decades support this general view. The work of Tanenhaus and his associates is especially notable in this regard. Chambers, Tanenhaus, Eberhard, Filip & Carlson (2002) provide evidence that in the course of the identification of the intended denotations of potentially ambiguous short definite descriptions, subjects dynamically restructure their attentional field as sentence comprehension proceeds, in accordance not only with the visual array, but with task-relevant pragmatic information about the intended referents made available in the utterance itself: “[C]andidate referents are evaluated in terms of their relevance to the immediate task and...this information is used in tandem with linguistic information to incrementally define referential domains,” so that otherwise potential competitors in the visual field are not attended to by subjects when they are pragmatically irrelevant. They also argue, partly using the timing of saccades as an on-line measurement, that “our findings cannot be straightforwardly captured in a processing model...that uses this [pragmatic] information at a relatively late point in processing” (p.17). More recently, Brown-Schmidt & Tanenhaus (2008) provide evidence that even in unscripted conversation:

...we observed typical lexical competitor effects for expressions uttered by the experimenter outside the context of the conversation...[but] decreased competition from lexical competitors when interpreting expressions within the conversation because of conversationally constrained referential domains. . .[The experimental evidence argued that] two factors—proximity and relevance to the task—did significantly predict whether speakers would modify their expressions with respect to the entire sub-area, suggesting that these factors played a role in the speaker’s decision as to what was in the referential domain... [and that] the addressee interpreted expressions with respect to similarly constrained referential domains. The same factors that predicted whether the speaker disambiguated his expressions with respect to the competitor blocks predicted whether the addressee fixated these competitors as she interpreted the same expressions.

A number of other studies by this group, including Chambers, Tanenhaus & Magnuson (2004), and Tanenhaus, Chambers & Hanna (2004), also offer evidence that relevance to a task constrains the referential domain for experimental subjects, as measured by eye gaze.

These results on joint attention in reference intuitively support the informal account sketched earlier of the use of the QUD and domain task in examples like (1) and (3) - (3'). In the last pair, the use of deixis and the QUD work together to narrow the attentional field sufficiently that there is no more than one plausible intended referent.

Hanna & Brennan (2007) give evidence that tracking a confederate's gaze can be used not only to recognize, but even to anticipate referential intention. Their paired subjects were separated, with visual displays of identical objects before each of them, but only their eyes visible to each other:

...Directors instructed matchers to move targets, which were unique or had a competitor nearby or far away. When mirrored displays held for competitors, matchers used directors' eye gaze to identify targets before the linguistic point of disambiguation. Reversed displays caused substantial competition, yet matchers still identified targets before the linguistic point of disambiguation, showing an ability to rapidly re-map directors' eye gaze.

We would expect this on the present account: Given an addressee's theory of mind (implicitly grasping, I would assume, the posited relation between intention and attention, and the way that eyes reflect attention in a visual field), we might expect that the addressee will tend to track a speaker's attention when possible, as a means of recognizing their referential intentions.

Something similar is useful in determining how best to convey one's referential intentions to an addressee. In production studies, Rohde & Frank (2011), studying child-directed speech, use their results to argue that "Speakers use reduced referring expressions such as pronouns when topical entities are easily retrievable and listeners show signs of engaging in joint attention to entities that have become part of the common ground." Directed attention can also have a bearing on subjects' unscripted speech. In production experiments involving perspective predicates (*give/take*) and active/passive pairs, Gleitman et al. (2007) used subliminal attention-capture manipulation of entities in a visual field—for example "a sudden onset, which is undetectable to the speaker but nevertheless influences initial saccades to characters..." (550). Then they immediately asked the speaker to describe the depicted action. Subjects showed "a reliable relationship between initial looking patterns [induced by the subliminal attention-capture manipulation] and speaking patterns [which of two arguments would be more likely to be chosen as subject of the subsequent description of the scene]."

However, none of the work just cited clinches the case for the proposed attentional masking hypothesis in (43) and the related descriptive content condition (44), at least in their strongest, most interesting forms. The masking hypothesis presumes that Relevance and salience narrow the search space for an antecedent. I take it that some such narrowing is very plausible from a processing point of view, as it radically simplifies the task of Retrieving the intended interpretation, at whatever point in processing such resolution takes place. I take the interesting form of such a hypothesis to be that this masking limits the search space from the very outset, prior to utterance of the target anaphoric item, so that initially only the most salient entities are considered, gauged in accordance with the requirement of informational uniqueness in the Descriptive Content condition (44). This may be plausible when we consider the static context for a single-clause utterance whose antecedent is in the previous clause, as in (2). But what can we say about anaphora resolution in examples like donkey sentences, where anaphora resolution involves dynamic update of the context, including new potential anaphoric antecedents, in the course of interpretation of a single utterance? A strong version of attentional masking would predict that restriction of the search space, the Relevant domain, can take place rapidly in the course of processing a single

utterance (in at least some utterance types, say those with complex structures involve multiple clauses and/or multiple intonational phrases). Then the dynamic re-calculation of pragmatic factors like (43) and (44) would influence interpretation on-line, prior to the determination of the proposition expressed.

Even more interesting, recall that prior attentional salience (e.g., on the basis of Relevance) is not sufficient to resolve anaphora; for example, it does not suffice in examples like (4), where reasoning on the basis of what's predicated of the NPs and non-linguistic information about the context—here a visual array—are crucial:

- (4) [Context: visual array with (among other things) two hats and two rabbits, exactly one of which is in a hat:] Remove the rabbit from the hat. [Stone & Webber 1998]

In (4), clause-internal presuppositions (triggered by *remove* and *from*) are essential to satisfactory resolution of anaphoric triggers in the same clause. In the same vein, I argued that anaphora resolution in bridging cases like (21) also involves complex pragmatic reasoning:

- (21) If I give an extension to some of my students, the others will be upset. (Simons 2011)

Here we have a donkey sentence where bridging resolution of the anaphoric trigger *the others* (the donkey NP, as it were) must be abductively inferred partly on the basis of a conversational implicature generated in the antecedent of the conditional, i.e. utterance-internal. (One might even wonder whether the conversational implicature is *forced* as a way of resolving the anaphora.) Is attentional masking at work in such cases, with the masking updated utterance internal? Do subjects process such utterances as easily and quickly as they do classical donkey sentences, where the anaphoric element has an overt coreferential antecedent? To try to tease apart attentional masking and plausibility factors and characterize their potentially independent behavior in the course of processing, compare (21) with (46) and (47):

- (46) My colleagues on the Linguistics faculty have been concerned about fairness in grading.  
If I give questionable grades, the others will be upset.
- (47) My colleagues on the Linguistics faculty have been concerned about fairness in grading.  
If I give an extension to some of my students on questionable grounds, the others will be upset.

We would expect that addressees will take *the others* in (46) to mean 'the other Linguistics faculty', so that like (21) anaphora resolution involves bridging via a non-coreferential antecedent plus a certain amount of pragmatic reasoning. Is anaphora resolution as fast and reliable intrasententially in (21) as intersententially in (46)? And what about (47)? There, an addressee will expect that the proposition expressed by the conditional must be Relevant to the same QUD addressed by the first utterance (in order for the discourse to be coherent). If that's the case, we might expect that attentional masking in (47) offers two potential antecedents for *the other*, 'the other Linguistics faculty' and 'the other students'. Complex pragmatic reasoning may be involved in resolving the anaphora: The concern mentioned in the first utterance might be taken to occasion the distress in the second, pragmatically suggesting resolution of *the others* to 'the other Linguistics faculty' despite the closer competitor *some of my students*. Would subjects' judgments reflect this pragmatic factor in resolving the anaphora? Could it be over-ridden by putting contrastive accent on *some* in the conditional antecedent, using prosodic Focus to heighten attention to it as a plausible antecedent? These examples are just intended to suggest some of the subtleties that might be involved. It would be interesting to see how subjects treat such cases.

If there were evidence to suggest that attentional masking could be triggered in the course of interpreting (21), then because it consists of only a single utterance, this might be taken to argue that at least some kinds of complex pragmatic reasoning takes place in parallel with first-pass interpretation, influencing



context on-line, utterance-internal. I know of no one who has tried to investigate such complex cases experimentally (and I confess I do not immediately see what kind of methodology would be appropriate, unless it would perhaps involve eye-tracking in reading, or response times at various junctures). But note that the question is not just *Do attentional masking and other pragmatic factors in interpretation play a role in initial processing, or do they only come into effect afterwards, as Gricean icing on the cake (the latter “baked” with relatively independent non-pragmatic processes)?* That’s already hard enough. But there are intermediate possibilities. For example, it might prove to be the case that some broad masking is in place at the outset or at clause boundaries (in complex sentences), yielding first pass masking in interpretation of direct (non-bridged) anaphoric relations utterance- or clause-internal, with additional pragmatic factors coming into play later. Can experimental evidence be adduced for one or the other of these roles for reasoning in interpretation?

In this general vein, Chambers & Tanenhaus (2004) argue that consideration of various “affordances”—basically preconditions—is crucial in resolving anaphora on-line (though as one might expect, their methodological set-up doesn’t facilitate investigating the very complex examples just discussed). In order to investigate whether addressees can make immediate use of speaker-based constraints—involving pragmatic reasoning—during reference resolution, Hanna & Tanenhaus (2004) monitored participant addressees’ eye movements as they helped a confederate cook follow a recipe. Here is their description and summary of results:

Objects were located in the helper’s area, which the cook could not reach, and the cook’s area, which both could reach. Critical referring expressions matched one object (helper’s area) or two objects (helper’s and cook’s areas), and were produced when the cook’s hands were empty or full, which defined the cook’s reaching ability constraints. Helper’s first and total fixations showed that they restricted their domain of interpretation to their own objects when the cook’s hands were empty, and widened it to include the cook’s objects only when the cook’s hands were full. These results demonstrate that addressees can quickly take into account task-relevant constraints to restrict their referential domain to referents that are plausible given the speaker’s goals and constraints.

Tanenhaus and his associates consistently argue, partly on the basis of the length of time between the utterance of a triggering pronoun (for example) and the onset of visual saccades to the intended referent, that their results argue for direct on-line use of pragmatic information in the course of interpretation.

However, other experimental work might be taken to call such conclusions into question, at least in their strongest form. For example, in work on relative clause attachment, Desmet, deBaecke & Brysbaert (2002) look at cases in Dutch where preference for low vs. high attachment of a relative clause may depend partly on whether there is more than one potential antecedent in prior context—presumably both equally salient. E.g., consider the English (48):

(48) Someone shot the servant of the actress who was on the balcony. (Desmet et al. 2002)

If (in their Dutch examples) context contained two equally salient actresses, subjects showed a preference in the ultimate interpretation for early closure, so that in (48) the relative clause would modify *actress*, the resulting NP *the actress who was on the balcony* differentiating between the two potential antecedents, and thereby respecting the descriptive content condition (44). One might argue that these results already presume some attentional masking, since the interlocutors presumably knew of other, irrelevant actresses in their broader domain, say Marylyn Monroe, but that didn’t seem to influence interpretation. However, crucially, on-line reading times in a completion experiment were only slightly influenced by the number of salient potential antecedents for either of the NPs, and there was an overall significant preference for high-attachment/late closure, independent of context. This might be taken as evidence of a first-pass

parsing strategy which ignored anaphora resolution and the associated pragmatic factors, which then came into play on a subsequent pass when attentional masking (43) and the descriptive content condition (44) would bias to the “corrected” early closure reading.

Venditti, Stone, Nanda & Tepper (2002) used eye-tracking to study the interpretation of accented pronouns in discourse contexts where there were two potential antecedents. They take their results to argue that “both potential antecedents are evoked immediately upon hearing the accented pronoun. A preference for one referent over the other only emerges once propositional information is encountered which lends support for the inferred discourse relation.” At first glance, this might seem to provide evidence *against* attentional masking, but that would be a premature conclusion. Recall that the hypothesis in (43) is that we begin our search for anaphora resolution in the sub-domain of familiar entities which are most salient. If in the contexts offered by Venditti et al., the two potential antecedents were equally salient by that metric, their findings would still be consistent with attentional masking. The interesting case would involve two recently mentioned potential antecedents, which differed with regard to whether they are equally Relevant to the QUD. Grosz (1977) argued that such relevance to discourse goals is in principle independent of recency<sup>17</sup> In some of her examples, the most recently mentioned of two antecedents pertained to a goal which had just been satisfied, hence was no longer Relevant in the sense defined here, while the earlier potential antecedent pertained to a question still not completely resolved. In such cases, the earlier, more Relevant antecedent was clearly the one intended by the speaker. Hence, to really get at the role of the QUD and domain goals in attentional masking, one would have to construct experimental materials which controlled for recency in something like this way.

Besides the work on the QUD and task-orientation in processing, there is another body of work in psycholinguistics which also arguably bears on the hypotheses in section 2: This is work on the role of prosody in processing and interpretation. Speer & Blodgett (2006) offer an excellent recent overview of the work on prosody in processing and discuss its significance. They review a great many studies which support the contention that both phrasing and prominence play a role in syntactic disambiguation and reference resolution.

To some extent, the significant role of phrasing in disambiguating, say, PP or RC attachment strikes one as reflecting some sort of prosodic correlation with syntactic constituency. This is reflected in two models of the role of prosody in processing discussed by Speer & Blodgett, that of Schafer (1997) and that of Blodgett (2004). Both of these are prosody-first accounts, wherein (as in Speer, Kjelgaard & Dobroth 1996), the phonological processing builds on an abstract prosodic representation, which serves as input to the syntactic and semantic processors. “Processing is incremental at this level (as at all levels), so it’s constantly updated and available to influence processing at other levels.” (Speer & Ito 2006:529) Most importantly, in these models intonation phrase boundaries trigger wrap-up of any outstanding processing, including interpretation and (according to Blodgett 2004) syntactic parsing. The evidence they offer seems to strongly support this view in some form, against the view that first-pass parsing is entirely driven by syntactic factors (though I note that the simultaneous view needn’t preclude some of the syntactic factors operating independently to some extent). But what has this to do with pragmatics?

The phenomenon of prosodic prominence in psycholinguistic studies is taken in the theoretical literature to bear on prosodically cued Focus. I have noted above that many theories of Focus require congruence between the prosodically cued focal structure of an utterance and the contextually given QUD to which it is intended to be Relevant. In the psycholinguistic literature, according to Speer & Blodgett (2006) “...numerous past studies have shown robust effects of intonation [prominence] on discourse comprehension in adults with tasks, such as phoneme detection, discourse verification, and speeded utterance acceptability judgments (Bock and Mazzella 1983; Birch and Clifton 1995; Cutler 1976; Cutler

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<sup>17</sup> See also detailed discussion of one of Grosz’ examples in Roberts (1998b).

and Foss 1977; Terken and Nootboom 1987; Davidson 2001; Ito 2002).” It is noteworthy that many of these psycholinguistic studies ignore the literature in pragmatics and semantics on Focus, instead inquiring into the role of prosodic prominence in marking “new” vs. “given” information or referential NPs (for example, this is the case in Bock & Mazzella 1983 and in Terken & Nootboom 1987). However, there are at least three different notions of “givenness” in discourse. Prince (1992) discusses two of these: Discourse old/new vs. Hearer old/new. But the notion which is arguably Relevant in Focus is that sense of *given/new* which we might characterize in terms of the QUD: What is thematic with respect to the QUD (thematically-given—part of the question but not the answer), vs. what is rhematic (rhematically-new—roughly, that part of the utterance intended to be the answer)? Moreover, arguably pragmatic Focus as reflected in prosodic prominence does constrain phrasing, in that under most theories of prosodic constituency and their relationship to Focus (e.g. Selkirk 1996), there can be no more than one pragmatic Focus per intermediate intonational phrase. Hence, the complement of prosodically reflected Focus, prosodic backgrounding is also phrasally constrained. Again, taking the Focus to be the rheme, and backgrounded content to serve as the theme with respect to the understood QUD, both prominence and phrasing play a role in reflecting the QUD addressed by an utterance (Roberts 1996,1998,2010b; Féry & Samek-Lodovici 2006; Beaver & Clark 2008).

A full exploration of the relevance of the theme/rheme distinction and the attention-direction function of prosodic Focus in the interpretation of the experimental results goes beyond what I can hope to accomplish here. But I will at least attempt to enunciate what might serve as a guiding question in such an inquiry: Assume the following hypotheses, for each of which I have offered evidence above independently:

- Prosody plays a role in processing at the very outset.
- Prosody, including phrasing and, especially, prominence (or prosodic Focus), play a role in guiding attention in processing and interpretation.
- Attention-recognition guides intention recognition.
- Prosodic Focus is correlated with the QUD (via the theme/rheme distinction).

Then it seems entirely reasonable to inquire whether one of the central roles of prosody in those languages in which it is used to mark Focus is to help track what is Relevant to the QUD on the scoreboard at the moment of utterance (Roberts 1996,1998,2010b). We might then consider in some detail whether the range of results reported in the study of prosody in the experimental psycholinguistic literature can be illuminated and integrated under this hypothesis. And, especially, we might ask whether the early role of prosody in production might not reflect something even more general than attentional masking—the general orientation of processing towards what is Relevant to the QUD.

While considering empirical evidence for the hypotheses in section 2, I should also mention corpus studies. For example, many corpus studies on anaphora resolution have been conducted by computer scientists and computational linguists comparing rival algorithms for anaphora resolution. One of the most influential theories of anaphora resolution has been that of Grosz, whose work with Sidner on the intentional structure of discourse (Grosz & Sidner 1986) was one of the principal early influences in the development of the framework presented above. Corpus studies attempting to implement Grosz’ theory have had mixed results at best; see Poesio & DiEugenio (2001) for one fairly recent study and discussion of some others. Tetreault & Allen (2004) concluded that some semantic information (about events and situation types, object types, and other content that could be automatically retrieved) significantly improved pronoun resolution algorithm; but Tetreault (2005) looked “at naive versions of Grosz and Sidner’s theory and Kameyama’s intrasentential centering theories” and concluded that “Our results show that incorporating basic clausal structure into a leading pronoun resolution does not improve performance.” I might speculate that one of the difficulties involved in these studies is that there is no ready way of segmenting the discourse automatically to reflect the QUD structure of the text. In fact Grosz & Sidner did not conceive of the intentional structure of discourse in terms of a structure of

questions for discussion, so this particular development of their proposal has not, to my knowledge, been investigated in corpus studies or in the development of algorithms for discourse segmentation. However, this remains an important area for investigation.

Summarizing this section, it appears that there is quite a bit of support from the literature in psychology and psycholinguists for the proposal in section 2, both for the fundamentally intention-based structure of discourse, and for the role of the QUD (as a reflection of that intentional structure) in interpretation, to some extent on-line. As with any useful hypothesis, this raises new questions, very difficult ones in the present case. I am optimistic that they can be explored experimentally.

#### 4. Pragmatic principles in acquisition: the QUD and the LAD

Meaning Retrieval, whether the conveyance is linguistic or otherwise, is a question of intention recognition, as Grice understood. One important reason we can do such an effective, efficient job of it is that discourse is a collaborative task, a game with a constrained, mutually recognized structure, based on sets of mutually evident intentions. I take it that this is a universal feature of human language use. As such, it bears careful consideration as we attempt to understand not only how language is processed, but how it is acquired, indeed its very nature from a cognitive point of view.

Chomsky has argued, quite convincingly I think, that linguistics is a branch of psychology. Moreover, he has argued that the language faculty in the human mind is modular, with the relatively autonomous sub-components interacting in such a way as to optimize both efficiency and effectiveness in linguistic processing. The consensus among most psycholinguists working on acquisition is that development of this modular faculty is triggered and guided by a genetically given Language Acquisition Device (LAD), which leads very young infants to recognize and strive to reproduce the prosody, the phonemic units, and the phonotactics of their native language, this ability evolving in similar ways across languages and cultures.<sup>18</sup> From what we know about the human mind and brain, we would expect that both in their evolution and in their interaction on-line the different components of the language faculty (and its associated grammar) are each constrained by the others, and that the interfaces between these components also bear on the character and operation of the components individually. Evidence from the role of contextual information and practical reasoning in on-line processing and interpretation, of the sort reviewed above, argues that the language faculty interacts on-line with other, non-linguistic cognitive capacities. Then almost certainly, given our understanding of the nature of the mind and of the evolution of a nervous system (of which the human mind is a by-product), the components of the linguistic faculty evolved together with these other, related aspects of our cognitive capacity, each functionally expressing a particular set of inter-connected roles in the optimal design of a human signaling system (satisfying a particular type of coordination problem, as per Lewis 1969).

But there is something missing in this picture. The human linguistic capacity did not arise in a cognitive/neurological vacuum, but in a mind/brain which already reflected an advanced stage of development of a certain kind of group-oriented mammal. Chomsky has discussed (1979) the conditions and substrate for such a development: He speculates, for example, that the linguistic capacity could only have arisen in a mind/brain capable of exploring higher mathematics. There may very well be some truth to this; cf. Bach's (1989) characterization of Chomsky's central contribution as *Chomsky's thesis*: "... a natural language. ... can be described as a formal system [i.e., a set of explicit, unambiguous rules, specifying all and only the grammatical utterances of the language in question]." Bach characterizes the semantic counterpart of that insight as *Montague's thesis* (which Chomsky himself would, ironically, most likely reject): "Natural languages can be described as interpreted formal systems." A growing body

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<sup>18</sup> This view does not necessarily commit one to any particular theory of either the LAD or the grammar that results.

of evidence in formal semantics argues for the role cross-linguistically of abstract structures such as lattices, scales, and Euclidean vector spaces, the utility of characterizing quantification in terms of set-theoretic relations in generalized quantifier theory, and in general the logical underpinnings of meaning; these all suggest there may be something to Chomsky's conjecture—without a mind capable (albeit unconsciously) of grasping and manipulating such structures, humans would not have the capacity for the development and acquisition of a cognitive system which uses them. But I would argue that while this mathematical substrate for language development and acquisition may be necessary, it does not suffice.

It is my contention that studying pragmatic phenomena at work in interpretation also sheds light on the nature of the interface between our linguistic competence and other cognitive faculties, and, accordingly, tells us something about the language faculty itself and the nature of a human grammar (in something related to Chomsky's sense). That is, I assume that however the language faculty processes an utterance, it is designed to do so in the context of a mind that recognizes an agent's meaning<sub>mn</sub> generally (and not just linguistic meaning) as a function of recognizing the agent's evident intentions in performing a meaningful act. Then the question is just how this interaction, between conventional content, as Retrieved by language-specific mechanisms, and some representation of the evident intentions of the speaker, is engineered. On the theory of pragmatics I propose, the interaction is mediated by a particular kind of organized body of information. I.e., the scoreboard is a model for the kind of information which must be available to the interface between linguistic processing, on the one hand, and cognitive processes like practical reasoning (Wallace 2008), and information storage and retrieval, on the other.

There is good evidence, as discussed in some detail in Bloom (2000), that intention recognition not only plays an on-going role in utterance processing, but is crucial in grasping meaning at the outset, in language acquisition.<sup>19</sup> This work argues that very young children first learn the meanings of words through tracking what their caregivers visually attend to, ultimately using that information about attention, in conjunction with their emerging theory of mind, to help Retrieve the caregiver's semantic intentions—a preliminary grasp of the meanings of the words. Whatever the LAD may be, it only begins to come to fruition when the child applies her emerging theory of mind to come to realize that the others' use of the phonological patterns that she has come to recognize is meaningful in Grice's sense. This is sadly evident in the fact that autistic children seem to have particular kinds of problems in language acquisition, arguably in part because of their difficulty in developing a theory of others' minds (Baron-Cohen 1988,2009; Boucher 2003, Rapin & Dunn 2003, de Villiers, Stainton & Szatmari 2007).

In the interest of clarity, let me put this another way. In a certain point in its development, that part of a child's mind which has been attuned to human language from its time in the womb has come to be able to recognize patterns in the vocalizations of its care-givers, already a remarkable ability and probably facilitated by some special capacities of the human mind. Instinctively, the child has also been working hard to learn to produce these vocal patterns itself—babbling to a purpose. Like all normal human children, the child is by nature attuned to the attentional states of its care-giver. As it grows, it begins to develop a theory of mind, in which it attributes to other humans the kind of psychological states and sensations which it experiences itself; it also begins to understand that just as in its own experience certain states are related—beliefs underwrite desires, desires foster the adoption of intentions, and intentions guide attention—so, the child begins to understand, these states and relations are found in the others it interacts with. Baron-Cohen (1991) identifies the infant's understanding of attention in others, usually well-developed by 9 months of age, as a “critical precursor” to the development of a theory of mind, leading to an understanding that deixis can be used to foster joint attention, and that this is related to directing interest, in turn a precursor to semantic reference. Tracking the care-giver's eyes to see what

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<sup>19</sup> Of course, the conclusions Bloom draws from the experimental work he discusses are not uncontroversial. See Akhtar & Gernsbacher (2007) for a critical discussion of Bloom's perspective. Nonetheless, I think it is hard to avoid the conclusion that attention-recognition plays a significant role in the normal acquisition of word meaning.

she is attending to then gives the child clues to what she intends. At a certain point in its cognitive development, the child recognizes that his care-giver is attending to some object and that the care-giver also bears some intention toward the child with respect to this object, an intention which she expects the child to recognize. Simultaneously, the care-giver repeats a verbal pattern which the child recognizes as used in the past in connection with this object, or with something of the same kind. In a moment of epiphany, the child grasps that the utterance itself is intended to convey a non-natural meaning—a complex set of communicative intentions which the speaker intends the child to recognize as such. For the first time, the child has grasped that the vocal patterns around him are semantic.

From that point on, the child gradually comes to grasp an (arbitrary, but intentionally mediated) semantic association between words and objects (or behaviors), Saussure's *significance* via Grice's meaning<sub>nn</sub>. This is the turning point, when acquiring the mere forms of a language and the kinds of rules that govern their combination (perhaps the realm of an LAD) becomes acquiring the language in the full sense—grasping its essential, semantico-pragmatic utility. From that point on, arguably, learning to recognize and articulate words and to parse and produce more complex utterances goes hand-in-hand with meaning<sub>nn</sub>-recognition.

Subsequently, the child learns that words not only have meanings in and of themselves but in patterned combination. To imagine that at that point pragmatics becomes irrelevant in the on-line production and processing of language strikes me as simplistic and, worse, as poor engineering (from an evolutionary point of view). Different faculties of the human mind work in parallel, not serially. As we saw in the previous section, the psycholinguistic evidence increasingly supports the contention that linguistic context is updated on-line, in the course of parsing and interpretation, and that it then in some (probably circumscribed) way comes to influence both lexical and compositional interpretation prior to the determination of the proposition expressed. Thus the question is not *whether* context interacts with content, but how, and precisely when, and to what extent. For intention-recognition is a crucial factor in the interface between language (a set of rules, and the constituents they generate) and the mind. Given a compositional derivation of the conventional content of (some portion of) an utterance—conventional content which, however, often radically underdetermines the proposition the speaker intends to express—the QUD and intentional structure of discourse are the key to how we solve for interpretation.

As in the discussion of prosody in processing in section 3, I think the view of acquisition just sketched gains support from psycholinguistic research on the acquisition of prosody. My discussion here is based on the excellent overview in Speer & Ito (2009). Again, they focus on work in two areas: the acquisition of prosodic phrasing and that of prosodic prominence. The experimental work on phrasing argues that newborns as early as 3 days old can discriminate between two spoken languages on the basis of their prosody (Mehler et al. 1988; Jusczyk et al. 1993), and that 6-month-olds use various aspects of prosody to determine the location of words in the stream of running speech (Jusczyk et al. 1993; Morgan and Saffran 1995; Morgan 1996; Johnson and Jusczyk 2001). By 6-months old, infants show sensitivity to whether speech is prosodically well-formed: Artificial pauses were introduced into recordings of naturally occurring speech, and infants preferred to listen to passages with the pauses inserted at prosodic boundaries over the same passages with pauses inserted in the middle of prosodic phrases (Jusczyk et al. 1995; see also Hirsh-Pasek et al. 1987). And Snow (1994) provides evidence from longitudinal observation of children's spontaneous speech for the hypothesis that acquisition of the control of prosodic phrasing corresponds to the acquisition of verb argument structures, the two appearing around the same time in development.

With respect to the acquisition of prosodic prominence, recordings of event-related potentials in 4-month-old German and French infants showed differences in electrophysiological brain responses to native vs. non-native stress patterns (Friederici et al. 2007). Schmitz et al. (2006) presented evidence that German infants develop sensitivity to the location of the accent in prosodic phrases by 8 months of age. But there

has been a very interesting problem in much of the literature on how children interpret contrastive prosodic cues. Preschool children generally seem to have no difficulty in producing appropriate contrastive intonation in their utterances (Hornby and Hass 1970; Hornby 1971; Wieman 1976; Macwhinney and Bates 1978; Culter and Swinney 1987; Wells et al. 2004). But in several experimental studies involving comprehension tasks, preschoolers and even older children often failed to demonstrate a correct interpretation of contrastive prosodic cues in simple oral interactions, contra the expectations of the researchers, performing worse than adults in the same kinds of studies (Solan 1980; Cruttenden 1985; Culter and Swinney 1987; Wells et al. 2004). However, Speer & Ito (2009) point out that in these studies the problem may have arisen as a function of the nature of the experimental set-up: “We suspect that the past findings of children’s inaccurate interpretation of prosody may have been the artifact of the context-free picture selection task...A recent eye-tracking study with Japanese [6 year old] children suggests that discourse context is crucial for the proper use of contrastive intonation in reference resolution. Ito et al. (2007, 2008, forthcoming).” That is, children do not capably interpret contrastive intonation out of context. Presumably adults do better at such tasks because they are better at imagining discourse contexts in which the prosody in question would be felicitous. But that doesn’t mean that the prosody itself *has* a determinate meaning out of context; and in fact most of the contemporary work on the interpretation of Focus—e.g., Rooth 1992, Schwarzschild 1999, Féry & Samek-Lodovici 2006, Roberts 2010b, etc., *op.cit.*—would argue that it does not. Hence, young children are competent at using prosodic prominence to mark the Relevant alternatives in discourse, and may be sensitive to prosodic well-formedness in this respect, but they aren’t able to interpret it in and by itself, out of context.

All this is to suggest that basic prosodic structure is among the first aspects of a language acquired by an infant, and that refinement of prosodic skill in processing and production evolves in tandem with the acquisition of increasing sophistication in other components of the grammar. I would argue that although the early acquisition might be partly explained by the fact that prosody is (arguably) easier to acquire than more complex structures associated with other components of linguistic competence, there is more to it than that: It is central in both acquisition, and processing both (a) because phrasing plays an important role in guiding parsing, and (b) because of the vital role that prosodic prominence plays in indicating the attentional structure, or Focus of the utterance. Thereby, via the correlation between that attentional structure and the intentional structure of discourse context, through congruence to the QUD, prosody is key to Retrieving the speaker’s intended interpretation.

In conclusion, I have argued that interpretation is dynamic, the resolution of multiple variables must be simultaneously satisfied on-line, and in all of this, Relevance to the QUD plays a central role by onstraining what is Relevant and salient at any given point in discourse. The fact that intention-recognition is apparently one of the central requirements for early acquisition of meaning and that it plays a central role in so many interpretive processes on-line, as reviewed in the previous sections, gives strong experimental support to the proposed framework for pragmatic analysis. We Retrieve implicit elements of the intended meanings of utterances with a view to Relevance to the QUD and the interlocutors’ evident domain goals and associated intentions. Recognizing and tracking such intentions is, then, central to solving for interpretation.

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