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On unidirectionality in precisification

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Abstract This paper provides a formal pragmatic analysis of (im)precision which accounts for its essential properties, but also for Lewis's (J Philos Logic 8(1):339–359, 1979) observation of asymmetry in how standards of precision may shift due to normal discourse moves: Only up, not down. I propose that shifts of the kind observed and discussed by Lewis are in fact cases of underlying disagreement about the standard of precision, which is only revealed when one interlocutor uses an expression which signals their adherence to a higher standard than the one adhered to by the other interlocutor(s). This paper shows that a modest formal pragmatic analysis along the lines of many prior optimality-theoretic and game-theoretic accounts can easily capture the natural asymmetry in standard-signaling that gives rise to Lewis's observation, so long as such an account is dynamic and enriched with a notion of relevance.

Keywords Imprecision · Implicature · Pragmatics · Formal pragmatics · Game theory · Optimality theory

Introduction

This paper provides a formal, pragmatic analysis of (im)precision which accounts especially for the phenomenon which I refer to as *precisification*. An example of precisification is in (1).

- (1) a. Alys: Craster arrived at 3.
- b. Brienne: No, he arrived at 2:59.

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c. Alys: Uh, well, yes, that's technically true...

In (1a), Alys makes an *imprecise* utterance—one that is strictly false, but is (at least from her own perspective) a felicitous and cooperative thing to say. Brienne's response contradicts this imprecise utterance, which results in Alys's agreement. Special properties distinguish this discourse from others—the disagreement is not factual, Alys's agreement is only partial, and as Lewis (1979) pointed out, such discourses are asymmetrical.

One way to understand (1) and other discourses like it is in terms of a *standard of precision* (Lewis 1979; Lasersohn 1999). After Unger (1975) argued that any utterance of (2) must be false, since no human-made table can truly be flat, Lewis responded by positing the *standard of precision*.

(2) This table is flat.

Lewis imagines the standard of precision as a part of the *conversational score*, that is, a parameter of evaluation which is both fixed by context prior to each utterance and alterable by further discourse. For Lewis, truth depends on the score, so (2) can be true in contexts where the standard of precision is sufficiently low. In Lasersohn's terms, on the other hand, the standard of precision determines how close a sentence must be to strict truth in order to count as *pragmatically true* (given a notion of closeness). On this conception, something can be semantically false, but still pragmatically true.

Lewis famously discusses cases like (1) and concludes that they involve a shift in the standard of precision. In other words, the standard (at least for Alys) is low enough to make her utterance in (1a) true. But when Brienne utters (1b), she alters the conversational score by forcing accommodation to a different standard—a higher one which makes (1a) false. Something Lewis concludes about cases like these is that while standards move easily upward—Alys is more or less forced to go along with the accommodation—they do not nearly so easily move downward. I refer to this property as *unidirectionality*. Lewis leaves open the question of why unidirectionality holds, and no explanation has yet been given in the literature.

The main goal of this paper is to provide a pragmatic analysis of precision and precisification which accounts for unidirectionality. I argue that cases of precisification like (1) are not simply cases of accommodation, although they bear certain similarities to presupposition accommodation. Unlike presuppositions, which may be a product of compositional semantics, I argue that precision is fundamentally a matter of Gricean pragmatics, and that therefore precisifications are the product of pragmatic reasoning rather than semantic conventions.

Moreover, I will argue that precisifications are not typical implicatures, but rather cases of *flouting* (Grice 1975); because they are not the result of straightforward inference premised on the assumption of cooperativity. Rather, they are the resolution of disagreements about how to be cooperative in the first place. In other words, Brienne in the example above does not simply alter the score by making her utterance—rather, she had been operating under a consistent idea about the score the entire time, which was at odds with Alys's.

Lewis's asymmetry comes from an asymmetry built into the nature of imprecision. It is an inherent property of the kinds of utterances that give rise to precisification (like (1b)) that they signal to someone operating under a low standard (Alys in (1)) that their partner has actually been assuming a high standard all along. But there are no utterances that inherently signal to someone operating under a high standard that their partner has had a low standard all along, barring explicit metalinguistic negotiation. I show that a conservative theory of discourse dynamics (following Stalnaker 1984; Roberts 2012 and many others), together with a simple optimality theoretic analysis of pragmatic inference optimization (à la Blutner 2000; Krifka 2002; Aloni 2007 and many others), models this and captures important properties of precisification, including unidirectionality, while other theories of imprecision fail to adequately do so.

The paper proceeds as follows. In Sect. 1, I lay out my grounding perspectives on imprecision and precisifications. In Sect. 2, I informally lay out the analysis. In Sect. 3, I provide a formal model for pragmatic inference, and show how it works on some examples. In Sect. 4, I apply this model to imprecision, show how it spells out the ideas from Sect. 2, and show how this approach compares to previous formal approaches to imprecision. In Sect. 5, I conclude.

1 Grounding perspectives on imprecision

1.1 Imprecision and vagueness are different

Lewis (1979) uses the term *vagueness* to describe imprecision, though it's unclear to what extent he really meant to conflate the two. Following many recent authors, I consider vagueness and imprecision to be distinct (but possibly related) phenomena. Pinkal (1995) argues that imprecise terms are subject to what he calls natural precisifications, while vague terms are not. Thus while in some contexts, both (3a) and (3b) admit borderline cases (cases where it is difficult to tell whether the sentence is true or false), it is possible to construct a natural context in which (3a) does not admit borderline cases, while the same is not possible for (3b).

- (3) a. That rod is 10 meters long.
 b. That rod is long.

Thus if we utter (3a) in a context where the rod in question is 9.99 m long, in some contexts we may have difficulty deciding whether to count (3a) as true or not. Likewise, in many contexts involving the exact same rod, we may encounter the same difficulty regarding (3b). But as Kennedy (2007) discusses, if we consider a context in which we are building a spacecraft, we find it perfectly easy to assign (3a) a truth-value, namely *false*, and moreover we will be able to neatly provide a truth-value for the same sentence applied to any rod of any length. But even in spacecraft construction scenarios, there will always be some length of rod for which we have difficulty assigning a truth-value for (3b). So *long* is vague, but *10 meters long* is not; the indeterminacy sometimes witnessed by (3a) is instead imprecision. See also Lasersohn (1999), Kennedy and McNally (2005), and Kennedy (2007) for further discussion.

1.2 The standard of precision is an unusual parameter

Another way in which I want to sharpen Lewis's original discussion is to point out that the standard of precision does not behave like other elements of the conversational score. As Lewis pointed out, this standard is subject to shifting within a given discourse. But the nature of this shifting is peculiar. Consider another example.

- (4) *Bates and Anna peruse tables.*
- a. *Anna:* This table is flat.
 - b. *Bates:* Cool. This one is flat too.
 - c. *Anna:* Well, nothing made by humans can truly be flat.
 - d. *Bates:* Oh. Well then, I guess what you said isn't true either.

Anna makes an utterance which causes the standard of precision to shift up, so that the immediately preceding utterance (4b) is false. But what's more, her original utterance in (4a) is now also judged false in retrospect.

Now, compare this to another case where truth judgments depend on an element fixed by context, namely, domains of quantifiers.

- (5) *The servants at Downton Abbey sit down to eat in the servants' quarters.*
- a. *Carson:* Is everyone here?
 - b. *Daisy:* No.
 - c. *Daisy:* Thomas and O'Brien are not.
 - d. *Carson:* Well we'll have to proceed anyway.
 - e. *Carson:* I heard a complaint about the dinner last night.
 - f. *Daisy:* We were having some trouble in the kitchens.
 - g. *Carson:* Why? Were you shorthanded?
 - h. *Daisy:* No, everyone was there: Me, Mrs. Patmore, and Ivy.
 - i. *Edna:* But Daisy, Mrs. Patmore, and Ivy are all here now!
 - j. *Edna:* #So what Daisy said before was untrue.

Here is a case where an element of the conversational score (the salient domain for the quantifier *everyone*) shifts in a discourse—it begins wide (5a), and becomes narrower (5h). But this narrowing doesn't affect earlier parts of the discourse, namely Daisy's elliptical use in (5b). Subsequent conversational moves change the conversational score, but this effect is not retroactive. Indeed, if such changes to the score were ever retroactive, context sensitive expressions of all kinds would become absurdly useless.

Lauer (2013) discusses this oddity concerning the standard of precision and points out that changes to it often require retractions. In other words, to be cooperative, Anna has to retract (4a) in the face of (4d), while (5j) imposes no such requirement. It is uncontroversial that context sensitive expressions have the context sensitive part of their meaning fixed forever at the time of utterance, allowing no future negotiation

and requiring no future retractions.¹ But the standard of precision doesn't work this way.

There are three more ways in which the standard of precision behaves differently than elements of the conversational score. I now discuss two of them briefly, before discussing the third in greater detail in the next subsection. Consider a slightly simpler case of precisification:

- (6) *Katie and Lelia stand around a table at a flea market.*
- a. *Katie:* This table is flat.
 - b. *Lelia:* Not really. Nothing made by humans is *actually* flat.
 - c. *Katie:* Uh, well, technically that's true...

Contrast this with a disagreement over the standard of comparison, a different element of the conversational score, at play in the interpretation of relative adjectives.

- (7) *Katie and Lelia stand around a table at a flea market. They are speaking over speakerphone to Martina, who they are shopping for.*
- a. *Katie:* This table is big.
 - b. *Lelia:* No it isn't. That table over there is big.
 - c. *Katie:* #Uh, well, technically that's true...

The first point on which I want to contrast (7) with (6) is that the *technical concession* by Katie in (7c) is distinctly odder than that in (6c). It's not to say that Katie couldn't concede to Lelia and adopt the standard of comparison that Lelia insists on. But (7c) is not an acceptable way to do it.²

The second point on which (7) and (6) contrast is that (6b) comes with a distinct judgment of *pedantry*. I take pedantry to be an intuition of mild uncooperativity. On the one hand, Lelia's rebuttal in (6b) seems not entirely appropriate for the context at hand and may annoy the speaker of the loose claim.³ On the other hand, (6b) is also not totally *inappropriate*, in the way that, for example, (5j) is.

But contrasting with (6), (7) suffers from no such intuition. Lelia may seem somewhat combative in (7b), but she is not pedantic. In (6) she seems to entirely misunderstand the purpose of the task at hand (or, alternately, Katie does). But in (7b) there is no distinct feeling that she does.

¹ An exception is so-called assessment-sensitive expressions. Subjective predicates are argued by some to be assessment sensitive (Lasnik 2005), and MacFarlane (2008) argues that the predictive expression *will* is sensitive to the time of assessment, so that its meaning gets saturated in different ways as time goes on. But this is quite different from being context sensitive in a way that is subject to future negotiation. Even on MacFarlane's analysis of *will*, the role that context will play in its interpretation as time goes on is perfectly predictable from the moment it is uttered—it cannot be manipulated arbitrarily by future discourse moves the way that the standard of precision apparently can.

² Relative adjectives are vague, so this example treads onto somewhat unsteady ground, since there is some controversy over whether vagueness and imprecision are really distinct (see, e.g., Burnett 2012). However, the clear contrasts between (6) and (7) only stand to further demonstrate that they are distinct.

³ Of course, depending on how we flesh out this context, it may be entirely appropriate. But crucially there are plenty of specifications of this context in which it is not.

1.3 Precisification is unidirectional

The most important property that precisifications have, which distinguish them from other cases of parameter-shifting, and was originally pointed out by Lewis (1979), is *unidirectionality*. This can be subdivided into two important but distinct observations. First, raising a standard is *difficult to resist*—in other words, raising a standard is easier than other kinds of discourse moves. Second, lowering a standard is *difficult to do*—it's harder than raising a standard.

So on the one hand, Katie seemingly has to go along with Lelia's shift in (6). But if we try in the other direction, this won't work.

- (8) *Katie and Lelia stand around a table made by humans.*
- a. *Lelia*: Nothing made by humans is truly perfectly flat.
 - b. *Katie*: #Nuh-uh, this table is flat.

We can construe Lelia as expressing a *metalinguistic disagreement* in (6b)—disagreeing not about the facts, but about the standard of precision. See Barker (2002) for discussion of metalinguistic disagreements about standards of comparison with vague adjectives. But there's no way to construe what Katie says in (8) the same way, as pushing for a lower standard. We cannot take her to be telling Lelia that she ought to cool her jets and not speak so precisely. Rather, Katie does seem to be disagreeing with Lelia on the *facts* by stating that this table does indeed meet the platonic ideal for flatness, contrary to Lelia's claim. So while Lelia's (6b) following Katie's (6a) results in an increase in the standard of precision, a discourse in the opposite order does not have the opposite effect.

Compare this now to a disagreement over the standard of *comparison* at play in relative adjectives.

- (9) a. *Lelia*: This table isn't big.
b. *Katie*: Sure it is.

It's perfectly easy to understand Katie's utterance not as a disagreement about the size of the table (which is perhaps sitting right in front of them, and therefore manifest), but about what we ought to consider *big*.

Barker (2002) discusses exactly this kind of metalinguistic use of adjectives in non-disagreement discourses, and finds no unidirectionality. As his discussion makes clear, while the standard of comparison can be disagreed over and negotiated (or not), there is no sense in which one direction of movement of the standard is privileged over the other. So the standard of precision is subject to unidirectionality, but everyday standards of comparison are not. Syrett et al. (2010) provide experimental support for this notion, showing that children are happy to accommodate changes to the standard of comparison in any direction, but that they do not accommodate downward changes to the standard of precision.

It is important to pause here and really make clear what is meant by *unidirectionality*, and what is not meant by it. Unidirectionality does *not* mean that standards can be raised but *never* lowered, nor does it mean that moves to raise a standard can *never* be resisted. Certainly, both are possible.

- (10) *Lowering the Standard of Precision*
- a. *Alys*: I need to know when everyone arrived. Can you tell me?
 - b. *Brienne*: Okay. Let's see... Craster arrived at 2:59.
 - c. *Alys*: Uh, okay, I don't need to know the exact minute he arrived. Let's just say he arrived at 3.
 - d. *Brienne*: Okay. Davos arrived at 4...
- (11) *Resisting Precisation*
- a. *Katie*: I'm the prop master for our play, and I need a table that's not level, so a bottle can roll off of it in a scene.
 - b. *Lelia*: Okay, I'll help.
 - c. *Katie*: Hmm... this table is level.
 - d. *Lelia*: Nothing made by humans is perfectly level.
 - e. *Katie*: Uhhh, riiight, so, like I said, it's level. Moving on...

The important point, rather, is that standards can be increased *incidentally to the content of an expression*, like in (6b), but they cannot be decreased in the same way. (10c) succeeds at lowering the standard, but only by making an explicit metalinguistic move to do so. (11e) succeeds at resisting a move to a higher standard, but only because the speaker goes out of her way to make it clear that she is not disagreeing factually and that she did not mishear the original move to raise the standard, but is rather willfully resisting this move, witnessed by *Uhhh, riiight, so, like I said...* and *Moving on*. In other words, while *explicit metalinguistic negotiation* can result in a change in the standard in either direction, *implicit metalinguistic negotiation* only works in one direction: Up. This is what I refer to with the term *unidirectionality*.

To summarize, the standard of precision differs from other elements of the conversational score. Cases where the standard is changed over the course of a discourse make this especially clear. Four differences pertaining to such changes are: The necessity of retracting prior assertions after the change has been effected, the feeling of pedantry associated with such changes, the presence of technical concessions in response to such changes, and most importantly, unidirectionality.

1.4 Imprecision is pragmatic

The standard of precision is really unlike other contextual parameters of evaluation—elements of Lewis's score—in how it behaves. Lewis argues that the score is, akin to a scoreboard, a means for keeping track of arbitrary parameters which may be altered in a rule-governed way. It doesn't particularly matter what the standard of comparison is, for example; as long as we all agree on it, we know whether to put something into the positive or negative extension of a relative adjective.

But the standard of precision isn't arbitrary, and it can't be shifted or accommodated arbitrarily; not easily, anyway. The standard of precision is an artifact of how agents reason about language use in particular contexts. To continue with Lewis's analogy, saying that the standard of precision is an element of the score is akin to saying that the scoreboard at a baseball game ought to also say how much cheating is allowed; or to tell fans how much to care about the outcome. These are questions about how

to understand the total set of rules and conventions that make up the game, and how to understand how the game fits into a larger social context; they do not guide plays within the game. Likewise the standard of precision is not an element of the score to be pushed higher and lower by arbitrary moves. This is an argument for treating imprecision as a fundamentally pragmatic, rather than semantic, phenomenon.

Another argument for this comes from the extremely wide distribution of grammatical expressions affected by imprecision and therefore also subject to precisifications. We have already seen numerals and absolute gradable adjectives, which have been well-discussed in the literature. Lasersohn (1999) has also pointed out that certain nouns (12), and definite noun phrases (13) are subject to imprecision.

- (12) a. This is a sphere.
b. Well, I'm sure there are some tiny imperfections...
- (13) a. The townspeople are asleep.
b. Well, I'm sure one or two are awake...

Morzycki (2011) and Anderson (2013) argue that imprecision is a broadly cross-categorical phenomenon, affecting predicates of all kinds, including verbs (14).⁴

- (14) a. He was break-dancing when I walked in.
b. Well technically that wasn't break-dancing, because...

Modals and conditionals may be subject to imprecision; cases like (15) were first noted by Lewis (1979), though as discussed above he conflated ordinary context dependence with imprecision, and so treated such cases as due to the ordinary context sensitivity of modals (cf. Kratzer 1977); see Klecha (2014, 2015) for arguments treating such cases as true cases of imprecision.

- (15) a. This must be a pen! I'm looking right at it.
b. Not so! You could be the victim of a deceiving demon.

Finally, some other expressions which I do not believe have been discussed in the imprecision literature are clearly subject to the phenomenon as well, including quantifiers (16) and the progressive (17).

- (16) a. Everyone in this stadium is singing!
b. Not everyone! The babies aren't singing, I'm sure.
c. Well, okay, yes...
- (17) a. Would you stop doing that, I'm talking to Bill!
b. That's not true! Right now, you're talking to me.
c. Yes, technically that's true, however...

If precision were narrowly a semantic phenomenon we might expect to see it have some arbitrary distribution. But it does not; nearly every non-vague expression is subject to imprecision. This smacks of a pragmatic solution, rather than a semantic one.

⁴ Both Anderson and Morzycki focus on the effect on imprecision by modifiers of various kinds, which are for the most part not discussed in this paper, but see Sect. 1.5.

None of this is to say, however, that this paper presents the distinction between semantics and pragmatics as a cut-and-dry matter. Nor do the contrasts between the standard of precision and other elements of the score necessarily guarantee that the standard of precision is not an element of the conversational score. Clearly, as the existence of precisifications attest, the standard of precision is at least somewhat arbitrary and therefore subject to at least some shifting in discourse. And the existence of the explicit metalinguistic negotiations discussed above is enough to show that compositional semantics does sometimes intrude on pragmatics. Unlike in the case of sports, in language, there is no sharp dividing line between the game and the larger social reality that embeds it; language can be used to modify and negotiate any aspect of the social conventions that constitute language communities and discourse. I only want to make this point: The unique properties of imprecision, as they compare to the properties of other varieties of context dependence, set it apart from them, and demand an analysis that appeals more to the pragmatic conventions that guide reasoning about language, than to arbitrary lexical semantic conventions.

Next, I will sketch out an analysis of precision and precisification which does just this. But first, I say a few words about a highly relevant phenomenon which I do not have space to discuss in any greater detail.

1.5 A note on slack regulators

Lasersohn (1999) discusses *slack regulators*, like *exactly* or *all* below.

- (18) a. John is exactly 5 feet tall.
b. All the townspeople are asleep.

Lasersohn proposes that such expressions modify the standard of precision compositionally, causing the potentially imprecise expressions *5 feet tall* and *the townspeople* to be interpreted in a more precise way than they otherwise would. Importantly, Lasersohn contrasts slack regulators with approximators like *about*, which he treats as having a weakening effect on the actual semantic truth-conditions, rather than manipulating the standard of precision.

- (19) John is about 5 feet tall.

See Lauer (2012) for an analysis of this asymmetry, which also falls out from the approach presented here.

Slack regulators are analyzed by Lasersohn as expressions whose compositional semantic function is to manipulate the standard of precision, for purposes of local interpretation. As outlined above, and explained in great detail just below, the analysis I provide of imprecision is pragmatic. But this is not a problem. While I take issue with certain aspects of Lasersohn's approach (see Sect. 4), there is no reason that compositional semantics cannot have an effect on pragmatic interpretation, by conveying information about (e.g.) the speaker's conversational interests, as is exactly the case in the cases of explicit metalinguistic negotiation discussed above. I don't have space to provide a full analysis of slack regulators, but I suggest two possible analyses in Sect. 4.3.

2 A pragmatic account of precision and precisification

I propose that precisifications have the properties that they do simply because they are the product of human reasoning about cooperative language use. In order to show this I develop a model of interpretation which combines standard devices for discourse dynamics with a model of pragmatics inspired by abundant prior work in optimality-theoretic and game-theoretic pragmatics.

There are two features that this pragmatic apparatus must have. First, it must make it acceptable to utter false things in certain contexts—namely, contexts where the difference between the false thing and something true is negligible for current purposes; this is what makes it sometimes *possible* to be imprecise. Second, it must be that people have consistent preferences about which expressions to use. Given that false things can sometimes be felicitously uttered, such false things may actually become the best thing to say in light of these preferences; so it is this second point which is what makes it sometimes *desirable* to be imprecise. Below, I sketch these ideas in more detail, and explain how they can capture the relevant facts, before turning to the formal analysis in the next section.

2.1 It's okay to say false things, sometimes

Suppose I have a choice between two expressions, ϕ and ψ . Suppose ϕ and ψ are mutually exclusive, and it is ψ which is strictly speaking true (as far as the speaker knows). This first point says that ϕ is still a felicitous thing to utter, as long as it wouldn't cause anything that is relevant to our present concerns to be different than if I uttered ψ instead.

When we turn to formalize these notions, this will require two things: First, we will have to establish a notion of “relevance to present concerns”. We will do so in terms of Roberts's (2012) *domain goals*, i.e., the set of goals that interlocutors have when conversing, and their choices for attaining those goals. Second, we will have to establish a constraint against false utterances which is sensitive to this notion of relevance.

One way to do this would be in the style of Lauer (2012) who proposes that the inconsequential nature of such false utterances is what makes them felicitous to utter. Whatever our concerns, what matters is that you induce behaviors in your interlocutors that are appropriate given those concerns, and the facts. If that involves something other than simply getting your interlocutors to accurately believe the facts, so be it. So if the train gets in at 3:02, I can tell you it gets in at 3, thus leading you to believe it gets in at exactly 3. I have caused you to believe something false, but in this case it's okay, because your false belief will serve your needs as well as the correct belief would have—you'll still leave in time to catch your train.

But, importantly, imprecision is usually recognized as such by the hearer.

(20) This table is flat.

When the speaker of (20) utters it to the hearer, it's not that the speaker tricks the hearer into believing that the upper surface of the table is a perfect geometrical plane, knowing

that such a belief will accomplish all the same things as the true belief. Rather, the hearer is typically aware that the speaker is being imprecise. So what the hearer comes to believe (i.e., what's communicated) *is* true—it's just that what's communicated isn't a perfect reflection of the conventional meaning of (20). I discuss Lauer's proposal in greater detail in Sect. 2.5.

Another way would be to abide by a more classically Gricean treatment of pragmatics, and either weaken the pragmatic convention that requires honesty (e.g., Grice's (1975) Quality) or allow for it to be a kind of weighted constraint, which can be overcome in the right circumstances, when adherence to other conventional constraints (e.g., Grice's Relation and Manner) requires it; this is what Lasersohn (1999) suggests. Similarly, Sperber and Wilson (1986a) argue that under the Relevance Theory framework for pragmatics (Sperber and Wilson 1986b) a proposition can be asserted if it 'resembles' a proposition that the speaker believes to be true; this could also be seen as a kind of weakening of Quality.

A standard view of communication says that we use conventional utterances to update the common ground (e.g., Stalnaker 1984; Heim 1982; Kamp and Reyle 1993), but that hearers then may or may not make the inference that what is supported by the common ground is in fact true. A simple way to understand Grice's Maxim of Quality in view of frameworks like this is that it says that the speaker's discourse commitments (her updates to the common ground) should reflect her beliefs. As Lauer (2013) sketches, if the hearer believes Quality to be operative (believes the speaker to be honest), and believes the speaker to be well-informed, he can then infer the truth of the asserted proposition, and come to believe it himself. So one way of fitting imprecision into this picture along the lines suggested by Lasersohn would be to say that the Maxim of Quality allows for some wiggle room—that being honest doesn't preclude certain falsehoods.

But I argue that the speaker is never committed to a falsehood in the first place, because the hearer recognizes the imprecision in the first place. So it's not the honesty convention that needs to be weakened to permit imprecision; it's the rule that associates the conventional meaning of the expression to the discourse commitments of the speaker. I'll call this rule Faithfulness, it being inspired by the class of rules of the same name in optimality theoretic phonology (Prince and Smolensky 1993/2002). I formalize this rule below, but briefly, Faithfulness says that the differences between conventional meaning of an expression and the update to the common ground that its articulation effects should be negligible, given what is relevant in the current discourse.

Note that in this proposal the term *standard of precision* does not appear. But it is still useful to think and speak of a standard of precision. When I say the standard of precision in a given discourse is high, relative to a second discourse, I simply mean that the participants in that discourse are making more distinctions in it than in the other. When I say that the standard is low, I simply mean that participants are making fewer distinctions.

One reason to *not* take this terminology too seriously is the fact that even within a single speech act, a speaker may take care to make a very fine distinction (relative to typical casual conversation) in one domain, while not bothering to do so in another.

(21) *Two chemists, Sue and Hal, are working in their lab.*

Sue: I bet you a Coke that there is more than .0005g of precipitate.

It is perfectly easy to imagine that Hal will not admit defeat if there are only .000499 g of precipitate, but that Hal will also accept a Pepsi in lieu of a Coke as his reward in that case. So there is no single standard of precision governing any given discourse; there is just the question of whether .000499 g is worth distinguishing from .0005 g, and the distinct question of whether Pepsi is worth distinguishing from Coke. For both questions there is a high standard answer and a low standard answer, but there is no reason to think that the two are perfectly correlated; because there is no reason to think that my goal of resolving the winner of the bet entails a goal of enjoying a Coke as opposed to a Pepsi. This is contrary to some recent authors (e.g., Morzycki 2011; Anderson 2013) who assume a unitary standard of precision parameter.⁵

2.2 Certain expressions are more costly to utter than others

Simply showing that imprecision is possible is not the same as showing how or why it is desirable. As mentioned above, people must have preferences for certain expressions over others, to explain clear and consistent patterns of lexical choice in low-standard contexts. People have a general impulse to avoid saying certain things, even when those things are true, relevant, and informative, as long as there is something better to say which is also true and at least as relevant and informative. What's more, this notion of "better" is not something left to grammar or to subjective whims—this preference is predictable by all participants in any given discourse. Following authors like Krifka (2007), Jäger (2012), Kao et al. (2014) and many others, I assume that this preference can be couched in terms of *cost*.

Cost is supposed to be inversely correlated with preference. If I say that XP is more costly than YP, it can simply mean that XP is phonetically more complex, and therefore requires more physical effort for a speaker produce, and is thus dispreferred. Consider an example like (22).

- (22) a. This table is flat.
b. This table is as close to flat as any human-made object can be.

(22b) requires much more effort than (22a) to utter. There are plenty of situations in which (22b) is strictly true, (22a) is strictly false, but we may avoid (22b) because it is simply a lot of work to utter. The contexts in which it is okay to avoid effort in this way are exactly the contexts in which the difference between (22a) and (22b) is not relevant.

Zipf (1949) presented minimization of effort as a key principle of human behavior, including linguistic behavior. Grice (1975) formulated it as a pragmatic convention in the form his Maxim of Manner, which in part says, "Be brief." Krifka (2002) first made use of such a convention (his BRIEFEXPRESSION) in the explanation of imprecision.

⁵ I don't assume that this does damage to those proposals, which well may be easily modifiable to accommodate my proposal.

Consider also numerals. As Krifka (2007) argues, some numerals are rounder than others. Intuitively, *three hundred* is rounder than *two hundred fifty*, which is in turn rounder than *two hundred forty-seven*, which is rounder than *two hundred forty-seven point five*, etc. Clearly, the roundness scale correlates with the phonetic complexity scale. But not always—*two hundred-fifty* is rounder than *two hundred-forty*.

This point is important; cost isn't always about physical effort. Krifka (2007) argues for this when noting that, intuitively, *fifteen* is rounder than *twenty* when speaking of time. As Krifka points out, cost may just as well be about the mental difficulty of retrieving or attending to a concept. Less-often-used concepts are more difficult, in a sense, to bring to mind, so they incur a higher cost than frequent ones. See Sperber and Wilson (1986b), Solt et al. (2017), Kao et al. (2014) for more discussion of this.

In this paper I will not provide a formal model of cost, but simply depend on other authors who have discussed this notion, and leave to future research the empirical business of sorting out which expressions have which exact costs.

2.3 Deriving unidirectionality

These two proposals—allowance for loose talk, and avoidance of unnecessary effort—combine to predict that imprecision should be not only possible, but attested in situations where being imprecise saves effort but does not inhibit interlocutors' ability to attain the domain goals. What's more, the properties of precisification fall out naturally from this, with only a few other additions to the theory. Most crucial of these is the theory that interpretation is an optimization procedure by which interlocutors reason about each others' beliefs and intents. This theory has its roots in Zipf (1949) and Grice (1957, 1975), and underlies the frameworks of optimality theoretic pragmatics (e.g., Blutner 1998, 2000; Aloni 2001, 2007; Krifka 2002, 2007) and game-theoretic pragmatics (e.g., Benz and van Rooij 2007; Franke 2009; Frank and Goodman 2012; Kao et al. 2014). Thus rational interlocutors weigh both what is permissible by the principle of Faithfulness, and what is preferable by the principle of cost, to determine the optimal form-interpretation pairing in any given discourse situation.

Consider (23).

(23) *Helena knows that Julian arrived at 2:59.*

- a. *Helena*: Julian arrived at 3.
- b. *Itamar*: No, he arrived 2:59.
- c. *Helena*: Well, okay, whatever.

Earlier I identified four notable properties possessed by precisifying discourses: Pedantry (Helena judges Itamar's response as mildly uncooperative), need for retraction (she has to utter (23c) to play along), the technical concession ((23c) counts as a retraction but doesn't admit factual wrongness) and unidirectionality (she was forced to go along with what he said, but he would not have been forced to go along with what she said, had the order of their utterances been reversed). The existence of pedantry judgments and technical concessions fall out rather naturally from the proposals made above. The reason Helena finds Itamar's response mildly uncooperative is that she

made her original round utterance believing it to be the pragmatically ideal thing to say. When Itamar disagrees, and in doing so makes it clear he desires a higher standard of precision, he behaves contrary to what Helena takes to be pragmatically ideal behavior.

But she does not find his response *totally* uncooperative, because it does not crash the discourse. It's perfectly easy to continue the discourse, even without resorting to any overt metalinguistic negotiation. In order to do this, all Helena has to do is adopt a higher standard of precision—in other words, a less permissive notion of which expressions are indistinguishable. By simply making more distinctions (granted, more distinctions than Helena believes necessary), the conversation can roll on. By making her reluctant concession, Helena signals her alignment with Itamar, but without admitting any real factual wrongness.

But what about unidirectionality? Once the existence of a disagreement about the appropriate standard of precision has been revealed, why is it Helena, and not Itamar, who must give way? Just modeling imprecision as a trade-off between honesty and effort avoidance is not enough to totally answer this question, but it provides a start: When Itamar utters a non-round expression, 2:59, he causes Helena to reconsider the premises on which she was reasoning about the discourse. That's because, given Helena's assumptions about the standard of precision, she takes 2:59 to be ineffable. In other words, given her assumption that a difference of one minute in Julian's arrival time is not relevant to any question or concern at issue in the discourse, there is simply no set of beliefs that Itamar could have that could make him want to utter 2:59 instead of the less costly 3:00. So Helena revises her assumption about the standard of precision.

But the same reasoning could in principle never run in the other direction.

- (24) a. *Itamar*: Julian arrived at 2:59.
b. *Helena*: #No, he arrived at 3.

When Helena utters 3:00, Itamar is not forced to reconsider his premise that differences of one minute *do* matter. That's because 3:00 is *not* ineffable on Itamar's assumption about the standard. It is a perfectly reasonable thing to utter if one believes that the time of the relevant event was in fact *exactly* three o'clock. So Itamar is never lead to reconsider his assumptions about the discourse—he merely thinks that Helena's utterance is false.⁶ This is true no matter what order the two utterances are made in—the disagreement will become clear to Helena as soon as the non-round utterance is made; and whether or not Helena makes her round utterance, the disagreement never becomes (publicly) clear to Itamar.

Helena therefore has two choices: She can acknowledge the lack of common ground (or common domain goals) and metalinguistically negotiate the parameters of the discourse (possibly to the point of abandoning it altogether), or she can adopt Itamar's version of the context, as in (24), which involves admitting to having uttered something technically false in the past, even if it was true relative to what Helena thought the

⁶ It could be that Itamar is aware of Helena's belief about the standard, and is simply imposing his will on the conversation by using a more costly utterance. But Helena has no way to know this; Itamar has plausible deniability. On the other hand, Helena cannot even pretend to be unaware of Itamar's conception of the standard after hearing him make a costly utterance.

standard of precision was at the time. Of course, the former may be the outcome of many such discourses. But crucially, she also has the option of *going quietly* with the shift in the standard. The fact that this paper seeks to explain is that it is impossible to go quietly in the other direction.

And the explanation is this: There is an asymmetry built into the logic of imprecision—the higher the standard, the more costly utterances are permitted to be. But an increase in the standard never has an effect on the permissibility of cheap utterances. So costly utterances indicate a high standard, but cheap utterances don't indicate a low one.

2.4 Varieties of disagreement about the standard

It's important to note that Krifka (2007) makes a point of arguing that round expressions make a low standard context *more likely*; see also Jäger (2012) who provides the same essential analysis in the context of his Iterative Best Response model. Consider a discourse like (25).

- (25) a. *Steve*: How many students were there?
b. *Karen*: Twenty.

Imagine a context in which Steve's expectations here make any response between 1 and 100 all just as likely as *twenty*. Thus the odds of *twenty* being the exact truth are relatively low. However, if Steve assumes a low standard of precision, the expectedness of this answer is considerably greater. More carefully, if Steve is totally uncertain about the standard (say he thinks there's a 50% chance it's high, and a 50% chance it's low), and also assigns a probability of 1% to each answer between 1 and 100, then the prior probability that the answer is *exactly twenty* and that the standard is high is 0.5%, whereas the prior probability that the answer is between 17 and 23 and the standard is low is 3.5%. So if Steve assumes Karen to be cooperative, then conditional on Karen's response of *twenty*, the probability that the standard is low is 87.5%. This may be even more pronounced in natural and/or continuous domains.⁷

I endorse this game-theoretic analysis for some cases, namely, those in which the hearer (Steve in (25)) is actually uncertain about what the standard of precision *should* be, or is not but for some reason is actively entertaining the idea that the other interlocutor has a different idea about the standard than they do. The former possibility could arise in a case where the hearer is unsure what the point of the conversation even is, or acknowledges the speaker to be the 'goal-authority'—the person who for whatever reason has the authority to unilaterally determine what the domain goals are in the discourse.⁸ This opens the door to potentially a great variety of discourse types in which the domain goals are uncertain or in which there is asymmetry in

⁷ For example, (ib) is much more likely to be used imprecisely than (ia).

(i) a. A hundred students were accepted to the conference.
b. There turned out to be a hundred ants in the colony.

⁸ Thanks to a reviewer for raising this point, and suggesting this terminology.

terms of the interlocutors' authority over the domain goals, certainty about them, or both. The present proposal doesn't necessarily make uniform predictions about such cases. Approaches like that of Kao et al. (2014), which allows for pragmatic inferences regarding communicative goals, are useful for dealing with such scenarios, and the present theory could be expanded in such a way as to better account for them.

But I argue that cases along the lines of Lewis's (1979) are cases where speakers both have clear but conflicting ideas about the standard. Correspondingly, I focus on such cases in this paper. In such cases, the use of round expressions, like round numerals, does not give rise to low standards. Of course, in the case of numerals, high standards may often result in the use of precisifiers like *exactly* which may mean that unmodified round numerals usually do only appear in low standard contexts.

(26) There were exactly 50 people at the party.

But this doesn't mean that unmodified round numerals are actually unacceptable in high standard contexts. Moreover, in domains besides numerals, it can be seen easily that round expressions are permissible in high standard contexts.

- (27) a. If anybody is left inside that building, they'll die when the construction crew detonates the explosives.
b. Don't worry, there's no one left inside the building.

Although (27b) could be altered by changing the round expression *no one* to something like *not a single person* or *precisely zero people*, the bare use of *no one* does not trigger a move to a lower standard, even though the same kind of reasoning could apply as in the numeral cases.

While Krifka's analysis is an important antecedent to this one, developing the notion that expression cost can signal information to the hearer about imprecision, he ultimately derives imprecision itself by a principle by which a number is always interpreted with the lowest precision possible. My proposal improves on this by both making the model dynamic, and by deriving imprecision from relevance.

2.5 Retraction and commitment

One last point before moving to the formal model—consider (28), due to Lauer (2013).

- (28) #Mary arrived at three, but she did not arrive until a few minutes after three.

Even though (28) witnesses a shift in the right direction (the first clause being less precise and the second clause being more so), my analysis *does* account for its infelicity. If a high standard is operative when (28) is uttered, then the first clause plainly contradicts the second clause. On the other hand, if a low standard is operative, then (28) requires a shift to a high standard between the two clauses; but this kind of mid-stream shifting of standards is not possible on my analysis.

All the cases of "shifting" we have seen have been across discourse participants, involving disagreements between said participants. A single speaker can't cooperatively disagree with herself, except in a case where the speaker genuinely has a change of heart.

Note that although I am arguing that these putative cases of shifting are not really shifting, but rather resolutions of disagreements, the standard of precision *can* actually shift in a discourse—that is, it can happen that both interlocutors jointly develop a new idea about what the standard of precision should be, without ever disagreeing about it. Such true shifts are necessarily accompanied by some metalinguistic negotiation, but don't necessarily require retraction.

- (29) *The facts: Julian arrived at 2:59; Gallagher arrived at 2:58.*
- a. *Itamar:* Gallagher arrived at 3.
 - b. *Helena:* Right, Julian also arrived at 3.
 - c. *Itamar:* Oh, no, he arrived at 2:59.
 - d. *Helena:* Uh...
 - e. *Itamar:* Sorry, I forgot that it matters when they showed up down to the minute.
 - f. *Helena:* So when did exactly Gallagher arrive, then?
 - g. *Itamar:* At 2:58.

So what distinguishes (28) from (29) is the failure to indicate that a new standard is necessary, and why.

On Lauer's model the speaker is not actually committed to implicatures; at least not the same way as semantic entailments. For him, this is what derives the special nature of loose talk—that it conveys the loose assertion but nonetheless commits the speaker to the strict truth, requiring a retraction when the standard is raised. In Lauer's view, the badness of (28) stems from his proposal that literal meaning is what determines discourse commitments. While we may commit ourselves to something false when it makes no difference, we can never commit ourselves to a contradiction.

But on my account, what the speaker commits to is the same as what is conveyed—the fully pragmatically enriched (or in the case of imprecision, weakened) meaning. Although implicatures are cancelable, they have to be explicitly canceled for the speaker to not be committed to them. To act otherwise is uncooperative.

- (30) a. *It is common ground that Bill knows who was at the party.*
 b. *Bill believes every student was at the party.*
 c. *Bill:* #Some students were at the party.

Someone who makes a loose utterance is therefore on the hook only for the loose inference. What requires retraction (i.e., the technical concession) in the case of precisification is not an underlying commitment to the strict truth that always exists alongside the loose meaning—but rather, the fact that in retraction contexts, someone else in the discourse has understood the standard of precision differently all along. It's always possible to abandon a discourse with such a person, or to metalinguistically negotiate, and third parties may readily view such behavior as reasonable and therefore not uncooperative. But if one wants to appease this other interlocutor, this requires adopting their vision of the discourse—which requires retraction.

Next, I formalize the intuitions presented here.

3 Formal model

Formally, I treat imprecision as a kind of implicature. What makes this viewpoint notable is that it means that imprecision is the rare case of implicature which is in fact weaker than the literal content, a point made also by Lauer (2012). In this section I provide a formal model for reasoning about language and deriving implicature, especially imprecision. I then use this formal model to show that my proposal derives the right predictions about unidirectionality.

3.1 Basics

I assume a very simple dynamic semantics which has its roots in the work of Stalnaker (1984), Heim (1982), Kamp and Reyle (1993), among many others. This view identifies the meanings of sentences in terms of their context change potential, i.e., how they update the context. I assume that declaratives function to update a speaker's discourse commitments (Gunlogson 2008; Farkas and Bruce 2010; Lauer 2013), and questions serve to update the question-under-discussion (Roberts 2012), among other kinds of updates that may be done. These aspects of the context for which updating-conventions exist I will call the *semantic context*. But other aspects of the discourse context may also govern interpretation without being subject to automatic update, though they could be negotiated through metalinguistic means. I will refer to this as the *pragmatic context*.

The relevant aspect of the pragmatic context for the present discussion is what Roberts (2012) calls the *domain goals*.

Of course, questions in discourse are generally more specific, and hence more manageable, than the Big Question ["What is the way things are?" -PK]. Besides the discourse goal of inquiry in its most general sense, we usually have goals in the real world, things we want to achieve quite apart from inquiry, domain goals. And our domain goals, in the form of deontic priorities, generally direct the type of inquiry which we conduct in conversation, the way we approach the question of how things are. We are, naturally, most likely to inquire first about those matters that directly concern the achievement of our domain goals. Hence, domain goals tend to dictate which subquestions of the Big Question we take up at any given point. (Roberts 2012, 7)

Domain goals are crucial to imprecision—they are what determine the standard of precision. I assume that the domain goals determine a partition on the common ground according to what distinctions are relevant to those goals—I will occasionally conflate the domain goals with the partition that they determine.

To keep things as streamlined as possible, I will ignore such elements of discourse as QUD and discourse referents. An individual's discourse commitments is an information state, which I will represent here as a set of possible worlds. Idealizing to discourses between two individuals, a semantic context can then be defined as a pair of discourse commitments:

- (31) a. Σ is the set of semantic contexts.
 b. $\Sigma \subset \mathcal{P}(W) \times \mathcal{P}(W)$

I will simply take the common ground C_c at context c to be just the information state that is entailed by the disjunction of the interlocutors' discourse commitments. To simplify I will also assume that the pragmatic context consists *just* of the partition determined by the domain goals.⁹

- (32) a. P is the set of pragmatic contexts
 b. $P \subset \mathcal{P}(\mathcal{P}(W))$

(33) just says that a pragmatic context, ρ_c , is a partition on the common ground at c , C_c , as in Roberts (2012).

- (33) $\rho_c \in \{X \subset \mathcal{P}(C_c) \mid \forall w \in C_c [\exists! y \in X [w \in y]]\}$

A set of domain goals is shared by all the participants in a discourse. This of course gives rise to the possibility of dysfunctional discourses in which interlocutors disagree about the domain goals—precisifications are an example. But the unitariness of the domain goals despite the possibility of divergent individual interests is part of what captures unidirectionality.

3.2 Inference as optimization

This paper presents an optimization model of pragmatic inference, following recent authors (Blutner 1998, 2000; Aloni 2001, 2007; Krifka 2002, 2007; Benz and van Rooij 2007; Franke 2009; Frank and Goodman 2012; Lauer 2013; among many others). Such proposals, including this one, argue that drawing pragmatic inferences (implicatures) is the result of a reasoning process which seeks to balance several (possibly competing) conventional constraints on linguistic behavior. These conventions were first proposed by Grice (1975), and have been much discussed since.

The model I present is an optimality theoretic (OT) one.¹⁰ OT pragmatics has a long tradition beginning with Blutner (1998, 2000). The dominant framework within OT pragmatics has been Bidirectional OT, wherein optimal form-meaning pairs are determined by separately deciding the optimal meaning for each form (the hearer's perspective) and the optimal form for each meaning (the speaker's perspective). How-

⁹ Something else that the pragmatic context should also represent is the extent to which interlocutors are considering each other to be cooperative; but I will leave this out of the formalism for simplicity. See Lauer (2013) for some discussion of how contexts can vary in these terms.

¹⁰ There is a particular narrow sense in which this model is not optimality theoretic—i.e., it is not the OT of Prince and Smolensky (1993/2002). Prince & Smolensky's theory is a theory of Universal Grammar, it concerns the crosslinguistically variable ranking of universal constraints to explain typological phenomena, and it establishes relations between arbitrary pairs of input forms and output forms—none of these things apply to this model. Thanks to Ken Safir (p.c.) for enlightening discussion on this topic. All this being said, however, the term *optimality theory* has long since been adopted by practitioners of ranked-constraint-based theories of inference optimization, so there is little point in denying that the present account is an OT-pragmatic one in the relevant sense.

ever, see Franke (2009) for criticisms of Bidirectional OT as a model of implicature in discourse.

The present model is a Unidirectional OT model, taking only the speaker's perspective, and determining optimal forms given particular belief states (i.e., meanings). However, the implicature generating procedure proposed here takes into account all possible belief states that the speaker might have, given the information that the speaker has publicly committed to in the discourse at hand. This makes it possible for the hearer to identify implicatures because all the information needed to determine an implicature from a given utterance is available to the hearer.

Game-theoretic approaches to language stretch back to Lewis (1969), and applications to pragmatics have recently become numerous (Dekker and van Rooij 2000; Parikh 2001; van Rooij 2004; Benz and van Rooij 2007; Franke 2009; Frank and Goodman 2012 among many others; see Jäger (2012) for an overview). Such models are like the Unidirectional OT approach I follow in that they assume a speaker's perspective grounds interpretation. But they elaborate on this picture in several ways which aren't necessary to capture the present phenomenon. I assume that a game-theoretic model could be made to capture the same facts by way of the same general strategy presented here, but for reasons of simplicity I present only an OT model. In Sect. 4 I further discuss some game-theoretic approaches and their differences with the present account.

3.3 Components for pragmatic interpretation

First, define semantic and pragmatic interpretation in the following way:

- (34) For any discourse context c
- $\llbracket F \rrbracket^c$ is the *semantic interpretation* of F ,
 - $c + \llbracket F \rrbracket$ is the *pragmatic interpretation* of F .

Semantic interpretation is determined only with reference to the semantic context (for the valuing of pronouns, etc.) and to grammatical convention (i.e., lexical meaning).¹¹ Pragmatic interpretation must be derived by a pragmatic interpretation process. The process requires the following inputs: A form, its semantic interpretation, a set of alternatives to the form, a set of information states representing what private beliefs the speaker might have, and a pragmatic context.

Recall that the pragmatic context (i.e., the domain goals) determines a partition on the common ground. Any given information state can be *coarsened* with respect to this partition; see Swanson (2006), de Jager (2009) who make use of notions like this. The coarsening $K_q(i)$ of an information state i with respect to a partition q is just the set of cells in the partition which are consistent with that information state. Note, for all i , $i \subseteq \bigcup K_q(i)$.

- (35) $K_q(i) = \{j \in q \mid j \cap i \neq \emptyset\}$

¹¹ This is akin to the interpretation on a 0-level speaker strategy in Iterated Best Response models (Jäger 2012) and the like.

Let \mathcal{B} be the set of relevant possible belief states that the speaker S could be in—which is identical to the set of possible meanings that the speaker could honestly convey—given the discourse commitments that she has made so far. Below let σ be the set of worlds representing the speaker's discourse commitments.¹²

$$(36) \quad \mathcal{B} = \{ \bigcup K_{\rho}(\text{BEL}_w^S) \mid w \in \sigma \}$$

This set is constructed by first taking each world in the speaker's discourse commitment set σ and determining what the speaker's beliefs are at each of those worlds (BEL_w^S , a set of worlds). Each of those possible belief states is then coarsened according to the domain goals (ρ).

The result is that these are the relevant belief states for the speaker which are *possible* given what the speaker has publicly committed to—the contents of this set can therefore be determined by all members of a discourse. These are only the *relevant* belief states, because they have undergone coarsening relative to the domain goals. Note that, because of coarsening, a situation may arise in which it is known that the speaker knows the answer to a particular question, but where that question is irrelevant, and therefore all parties know that none of the elements of \mathcal{B} actually do correspond to the speaker's real belief state.

Importantly, \mathcal{B} is the set of possible *meanings* that an utterance could have, assuming the speaker is, and has been, cooperative. For example, if Al tells Bo that she went to a party last night, Al becomes committed to the fact that she went to a party last night, and by contextual entailment, other facts, like that she knows at least some of the people who were there. If Al additionally tells Bo that she talked with every person at the party, then she will additionally become committed to the fact that she knows exhaustively who was at the party (given various commonplace assumptions). This informs the possible meanings that a future utterance of *Some of your students were there* could have.

But if Al has not committed herself to the proposition that she is in a belief state which exhaustively identifies who was at the party, then the possible belief state in which some of Bo's students were definitely at the party, and maybe all of them were, is on the table. Therefore the proposition that some and maybe all of Bo's students were at the party is a candidate meaning for that sentence (and in fact ends up being the optimal one). On the other hand, if Al has committed herself to the proposition that she is in a belief state which exhaustively identifies who was at the party, then the proposition that some and maybe all of Bo's students were at the party cannot be entailed by any of the belief states that she might be in, and so cannot be a candidate meaning for *Some of your students were there*.

¹² All of this should be relativized to a given context c ; this is suppressed for clarity. The precise version is (i), where $\sigma_c(X)$ is X 's discourse commitments at c (a set of worlds).

$$(i) \quad \mathcal{B}_c = \{ \bigcup K_{\rho_c}(\text{BEL}_w^{S(c)}) \mid w \in \sigma_c(S(c)) \}$$

Note that if ever the $S(c)$ is assumed to have total knowledge to the questions induced by the domain goals of c , then $\mathcal{B}_c = K_{\rho_c}(\sigma_c(S(c)))$.

I do not provide an analysis of how \mathcal{F} , the set of utterance alternatives, is determined. Minimally, we could say that admissible alternatives are those that address the domain goals. It can also be said that the particular utterance that is made may, by its semantic interpretation, carry some information about its alternatives (Krifka 1999). But how utterance alternatives are determined is a difficult, open question in the field of formal pragmatics, and I don't make any progress on it here.

3.4 Definition of pragmatic interpretation

Given the set of things that the speaker might believe, \mathcal{B} , the hearer will then reason, upon hearing utterance F , that the speaker is in one of the belief states in \mathcal{B} , such that if the speaker were in that belief state, F is the thing that it would make the most sense for her to utter. In other words, the pragmatic interpretation of F , as uttered by the speaker $S(c)$, is the disjunction of the relevant possible belief states in \mathcal{B} for which F is *optimal*. The proposed definition of optimal, (OPT in (37)) is what the next subsection will elucidate.¹³

- (37) For any utterance of F , if $\exists B \in \mathcal{B}[\text{OPT}(F|B)]$,
 $c + \llbracket F \rrbracket := \sigma \cap \bigcup \{B \in \mathcal{B} \mid \text{OPT}(F|B)\}$

This says that if there is a belief state B for which F is the optimal thing to utter, then the speaker uttering F results in the speaker becoming committed to $\sigma \cap B$. If F is the optimal form for multiple meaning-candidates/belief states, then F conveys the disjunction of those meaning-candidates instead, similar to Blutner (1998).

One novel aspect of this proposal is the addition of a flouting procedure. Flouting (Grice 1975) occurs when there is no candidate message B for which F is optimal. In that case, interlocutors may rescue the discourse by essentially trying pragmatic interpretation again with a different pragmatic context. Let $c^{F!?$ denote the pragmatic context that a speaker adopts, having earlier taken c to have been the operative pragmatic context, but having encountered an apparently suboptimal utterance of F .

- (38) For any utterance of F , if $\neg \exists B \in \mathcal{B}[\text{OPT}(F|B)]$:
 $c + \llbracket F \rrbracket := c^{F!?} + \llbracket F \rrbracket$

I do not define $^{!?$ here. For simplicity I assume there is a function from c to $c^{F!?}$ but it's entirely possible that there is not; for any given c , there may be multiple possible values for $c^{F!?}$, and determining them may involve complex higher order reasoning. But however $c^{F!?}$ is determined, I assume it always differs minimally from c . In other words, c is altered in order to make F acceptable, but in every other way

¹³ (37) simplifies by suppressing reference to the context c in most of the terms, and also by treating the context only as consisting of the speaker's commitments. While it is indeed true that typical assertions affect only the speaker's commitments, the unabridged version of (37) in (i) fully specifies the context.

- (i) For any utterance of F in c , if $\exists B \in \mathcal{B}_c^{S(c)}[\text{OPT}_c(F|B)]$,
 $c + \llbracket F \rrbracket := (\langle \sigma_c(S(c)) \cap \bigcup \{B \in \mathcal{B}_c^{S(c)} \mid \text{OPT}_c(F|B)\}, \sigma_c(H(c)) \rangle, \rho_c)$

it is as similar to c as possible. Note that it may be that for some discourse states c , $c^{F!}$ is undefined, meaning that flouting results in a true crash, i.e., rejection of the discourse. See Kao et al. (2014) who provide a game-theoretic model which allows for not only uncertainty in the pragmatically enriched meaning of an utterance but also in the domain goals. What is important for present purposes is just that, in cases of precisification, for any c , the *only* contexts that $c^{F!}$ can successfully resolve to are ones where the standard of precision is high, but which is otherwise just like c . I show this below.

3.5 Definition of optimality

Optimality is defined by reference to ranked constraints, as in classical Optimality Theory (Prince and Smolensky 1993/2002) and in OT pragmatics (Blutner 2000). Many constraints may ultimately be desired, but for the purposes of this paper I will consider just three, which I refer to as FAITHFULNESS, INFORMATIVITY, and MANNER.

FAITHFULNESS says that the relevant belief state entails the coarse semantic interpretation of the relevant utterance.

- (39) For all F, F', c, B , $\text{FAITHFULNESS}_c(F|B) \geq \text{FAITHFULNESS}_c(F'|B)$ iff $B \subseteq K_{\rho_c}(\llbracket F \rrbracket^c)$

Recall that B above is a relevant possible speaker belief state, i.e., a meaning that the speaker might be able to communicate without contradicting her own discourse commitments. FAITHFULNESS is what allows for imprecision: Even if the literal content of F is stronger than the meaning-candidate B , F is an acceptable bearer of B if its literal meaning would achieve the same result as an utterance of an expression whose literal content was B .

Note that what this definition of FAITHFULNESS achieves is the fact that upon uttering *There were 20 people there* in a low precision context, I become committed to the proposition that there were *around* 20 people there (the coarse interpretation). This does not actually require that the speaker truly believe this; an additional convention requiring the speakers are honest (that their discourse commitments reflect their actual beliefs) is needed; but this constraint does not factor into the implicature determination process.

The next constraint is INFORMATIVITY, a straightforward implementation of Grice's (1975) Quantity.

- (40) For all F, F', c , $\text{INFORMATIVITY}_c(F) \geq \text{INFORMATIVITY}_c(F')$ iff $C_c \cap K_{\rho_c}(\llbracket F \rrbracket^c) \subseteq C_c \cap K_{\rho_c}(\llbracket F' \rrbracket^c)$

One form F is judged superior to another F' if the coarsening of F asymmetrically contextually entails the coarsening of F' , given context c .

Finally, consider MANNER, the constraint which punishes complex or costly expressions.

- (41) For given forms F, F' :
 $\text{MANNER}(F) > \text{MANNER}(F')$ iff $\text{cost}(F) < \text{cost}(F')$

This constraint says that F is preferred to F' if F is less costly than F' . As discussed above, this of course glosses over the considerable question of what exactly constitutes cost.

For F to be optimal in terms of a single constraint CON just means that it is ranked no lower than any other alternative form for that constraint.¹⁴

$$(42) \quad \text{opt}_{\text{CON}}(\mathcal{F}) = \{F \in \mathcal{F} \mid \forall F' \in \mathcal{F} [\text{CON}(F) \geq \text{CON}(F')]\}$$

The alternative set for any given constraint CON_n is determined by $\text{opt}_{\text{CON}_{n-1}}$, where CON_{n-1} is the constraint ranked just above CON_n . The rankings of the constraints discussed here is given below; this order is debatable (see e.g., Aloni 2007 for a different relative ranking of INFORMATIVITY and MANNER) but all that really matters for present purposes is that FAITHFULNESS is highest.

$$(43) \quad \text{FAITHFULNESS} > \text{INFORMATIVITY} > \text{MANNER}$$

The following definition of OPT implements these ideas.

$$(44) \quad \text{OPT}(F|B) \leftrightarrow F \in \text{opt}_{\text{MANNER}}(\text{opt}_{\text{INFORMATIVITY}}(\text{opt}_{\text{FAITHFULNESS}(B)}(\mathcal{F})))$$

Below I present several examples of this system at work, before turning to imprecision.

3.6 Example 1

First, an abstract example. Assume the speaker's commitments and the domain goals make the following meanings possible:

$$(45) \quad \begin{aligned} B &= \{B_1, B_2, B_3\} \\ \text{a. } B_1 &= \{w_1, w_2\} \\ \text{b. } B_2 &= \{w_1, w_3\} \\ \text{c. } B_3 &= \{w_1, w_4\} \end{aligned}$$

Add the following assumptions about the possible utterances.




$$(46) \quad \begin{aligned} \mathcal{F} &= \{F, G, H\} \\ \text{a. } \llbracket F \rrbracket^c &= \{w_1, w_2, w_3, w_4, w_5\} \\ \text{b. } \llbracket G \rrbracket^c &= \{w_1, w_2, w_3, w_4, w_5\} \\ \text{c. } \llbracket H \rrbracket^c &= \{w_1, w_2, w_4, w_5\} \end{aligned}$$


$$(47) \quad \text{cost}(F) > \text{cost}(G) = \text{cost}(H)$$

Table 1 illustrates a possible pragmatic derivation, the results of which are summarized in (48). The table below presents each candidate in a row and each constraint in a column. A violation of a constraint is indicated with an asterisk (*). An exclamation

¹⁴ The definition in (42) breaks down if any of the constraints induces a partial order on possible expressions—and in many cases, INFORMATIVITY as defined will do just this. While something more needs to ultimately be said about INFORMATIVITY, it will not be relevant here, and we'll consider only cases where INFORMATIVITY happens to induce a total order.

Table 1 Illustration of an example pragmatic derivation

<i>B</i>	<i>F</i>	FTH	INF	MNR
<i>B</i> ₁	<i>F</i>		*!	*
	<i>G</i>		*!	
	 <i>H</i>			
<i>B</i> ₂	<i>F</i>		*	*!
	 <i>G</i>		*	
	<i>H</i>	*!		
<i>B</i> ₃	<i>F</i>		*!	*
	<i>G</i>		*!	
	 <i>H</i>			

point (!) marks the ‘fatal’ violation for any given candidate; the hand () indicates the optimal candidate.

Here and in other cases below I suppress reference to the full context *c*, and substitute the speaker’s commitments σ for simplicity.

(48) *Possible Inference-Form Pairs, based on Table 1.*

- a. $\sigma + \llbracket F \rrbracket = \sigma^{F! ?} + \llbracket F \rrbracket$
- b. $\sigma + \llbracket G \rrbracket = \sigma \cap B_2$
- c. $\sigma + \llbracket H \rrbracket = \sigma \cap (B_1 \cup B_3)$






If the speaker’s belief state is B_1 , then, the optimal utterance is H; if it is B_2 , then G. If it is B_3 , then H. Since the speaker knows that the hearer does not know her belief state, the speaker knows that from an utterance of *H*, the hearer will infer that the speaker believes either B_1 or B_3 ; thus, if the hearer believes the speaker is honest and well-informed, the hearer will infer $B_1 \cup B_3$. Likewise from an utterance of *G*, the hearer will infer B_2 . Since F is not optimal for any information state, an utterance of F would constitute a case of flouting and would require the hearer to alter his assumptions about the pragmatic context.

3.7 Example 2: scalar implicature

For a more concrete example, consider a scalar implicature. We have a context where there are three dogs—Moneypenny, Bandit, and Reggie—and it is mutually known that the speaker knows of each dog whether they barked. For simplicity of representation, let’s arbitrarily add the presupposition that the number of dogs that barked is not exactly two.

- (49)
- $w_1 \models$ All three dogs barked.
 - $w_2 \models$ Only Moneypenny barked.
 - $w_3 \models$ Only Bandit barked.
 - $w_4 \models$ Only Reggie barked.
 - $w_5 \models$ None of the dogs barked.

Table 2 Derivation of a scalar implicature with quantifiers

B	F	FTH	INF	MNR
$\{w_1\}$	 All of the dogs barked.			
	Some...		!*	
	None...	!*		
$\{w_2\}$	All of the dogs barked.	!*		
	 Some...		*	
	None...	!*		
$\{w_3\}$	All of the dogs barked.	!*		
	 Some...		*	
	None...	!*		
$\{w_4\}$	All of the dogs barked.	!*		
	 Some...		*	
	None...	!*		
$\{w_5\}$	All of the dogs barked.	!*		
	Some...		!*	
	 None...			

Some discourse parameters.

- (50) a. $\mathcal{F} = \{ \text{all of the dogs barked, some of the dogs barked, none of the dogs barked} \}$
 b. $\mathcal{B} = \{ \{w_1\}, \{w_2\}, \{w_3\}, \{w_4\}, \{w_5\} \}$
- (51) a. $\forall w \in \sigma$:
 (i) The number of dogs that barked in w is not two.
 (ii) For all dogs x , x barked in all or no worlds in BEL_w^S
 (iii) $\rho = \text{Who, if anyone, barked?}$

The implicature for the utterance in Table 2 is computed as below.

- (52) *Possible Inference-Form Pairs in c , Based on Table 2.*

- a. $\sigma + \llbracket \text{all of the dogs barked} \rrbracket = \sigma \cap \{w_1\}$
 b. $\sigma + \llbracket \text{some of the dogs barked} \rrbracket = \sigma \cap \{w_2, w_3, w_4\}$
 c. $\sigma + \llbracket \text{none of the dogs barked} \rrbracket = \sigma \cap \{w_5\}$

- (53) $\llbracket \text{some of the dogs barked} \rrbracket^c = \{w_1, w_2, w_3, w_4\}$

As is typically the case, the pragmatic inference (52b) is stronger than the semantic content (53). This is because while *some of the dogs barked* satisfies FAITHFULNESS for belief state $\{w_1\}$, the hearer knows that the speaker would have been able to utter something stronger given said belief state. And because ignorance does not factor in, since it is mutually known that the speaker knows the status of each dog, no possible belief state of the speaker on which *some* is optimal contains w_1 .

In the usual terminology, we might say that the utterance gives rise to a conventional inference (some of the dogs barked), with an additional Gricean inference on top of it

(not all of the dogs barked). However, in this set-up, there is just a single inference.¹⁵ Thus nothing about this set-up requires that the pragmatically generated inference is stronger than conventional meaning; they could in fact be weaker. This is what allows for imprecision, wherein the pragmatically generated meaning is weaker than the semantic meaning, as pointed out by Lauer (2012).

3.8 Example 3: Flouting

Flouting occurs, from the perspective of the hearer H , when a form F is uttered by S despite the fact that F is not optimal for any of S 's possible belief states, according to H 's model of the conversation. This forces H to revise their model of the context so that it is optimal for at least some belief state. I model precisification as flouting. In order to first spell out how this is intended to work, I provide an example of flouting which is not a case of precisification.

(54) *Set up.*

S and H both know that S went to a particular produce stand at the farmer's market, where the only two kinds of products are tomatoes and watermelons. H wants to know what S got at the stand. Some of the watermelons at the stand were yellow, but H assumes that all the watermelons for sale at this stand are green (having forgotten that there is even such a thing as yellow watermelons).

We'll use the following set of worlds.




- (55) $W = \{w_1, w_2, w_3, w_4, u_1, u_2, u_3, u_4, v_3, v_4, v_5, v_6\}$
- $\{w_1, w_2, w_3, w_4\} \models$ There were no yellow watermelons
 - $\{w_1, u_1\} \models$ S didn't buy anything.
 - $\{w_2, u_2\} \models$ S only bought tomatoes.
 - $\{w_3, u_3\} \models$ S only bought green watermelons.
 - $\{w_4, u_4\} \models$ S only bought tomatoes and green watermelons.
 - $\{v_3\} \models$ S bought only yellow watermelons.
 - $\{v_4\} \models$ S bought only tomatoes and yellow watermelons.
 - $\{v_5\} \models$ S bought only yellow and green watermelons.
 - $\{v_6\} \models$ S bought tomatoes and yellow and green watermelons.

The fact that H makes a (relevant) assumption which S does not lead the two of them to have different ideas about the context, especially the common ground. Let h be H 's conception of the context, while s is S 's. Let's also further stipulate that S finds the distinction between green and yellow watermelons to be important to the discourse.

- (56)
- $C_h = \{w_1, w_2, w_3, w_4\}$
 - $\mathcal{F}_h = \{\text{nothing, watermelons, tomatoes, watermelons and tomatoes}\}$
 - $\mathcal{B}_h = \{\{w_1\}, \{w_2\}, \{w_3\}, \{w_4\}\}$
 - $\rho_h =$ Did you buy tomatoes, and did you buy watermelons?

¹⁵ Speakers may of course still be able to track and distinguish between the literal inference (i.e., the effect of updating without any of the constraints except FAITHFULNESS and with maximum standard of precision) and the Gricean one. But only the Gricean inference is relevant to normal communication.

Table 3 Derivation of (58)'s inference given s

B_s	F_s	FTH	INF	MNR
$\{u_3\}$	 I bought green watermelon.		*	*
	...yellow watermelon.	!*	*	*
	...watermelon.		*!*	
	...tomatoes.	!*		
	...green and yellow watermelons.	!*		**
$\{v_3\}$...green watermelon.	!*	*	*
	 ...yellow watermelon.		*	*
	...watermelon.		*!*	
	...tomatoes.	!*		
	...green and yellow watermelons.	!*		**
$\{v_5\}$...green watermelon.		!*	*
	...yellow watermelon.		!*	*
	...watermelon.		!***	
	...tomatoes.	!*		
	 ...green and yellow watermelons.			**

- (57) a. $C_s = W$
 b. $\mathcal{F}_s = \{\text{nothing, watermelons, green watermelons, yellow watermelons, tomatoes ...}\}$
 c. $\mathcal{B}_s = \{X \mid \exists w \in C_c[X = \{w\}]\}$
 d. $\rho_s = \text{Did I buy tomatoes, did I buy watermelons, and if so, are they yellow, green, or both?}$

Suppose S utters (58) given the set-up in (54).

- (58) I bought green watermelons.

Given s , the pragmatic procedure can be summarized as in Table 3. For convenience, I abbreviate \mathcal{F}_s and \mathcal{B}_s .

- (59) *Possible Inference-Form Pairs in s , based on Table 3.*

- a. $\sigma_s + \llbracket \text{I bought green watermelons} \rrbracket = \sigma_s \cap \{u_3\}$
 b. $\sigma_s + \llbracket \text{I bought yellow watermelons} \rrbracket = \sigma_s \cap \{v_3\}$
 c. $\sigma_s + \llbracket \text{I bought watermelons} \rrbracket = \sigma_s^{\dots!??} + \llbracket \text{I bought watermelons} \rrbracket$
 d. ...

This all goes very smoothly. But consider H 's expectations about what sentences should be utterable, and what those sentences should mean. Clearly, since *I bought yellow watermelons* is not in \mathcal{F}_h , it is impossible for it to be optimal for any possible belief state. So even without doing the derivation for h , we can conclude:

- (60) $\sigma_h + \llbracket \text{I bought green watermelons} \rrbracket = \sigma_h^{\dots!??} + \llbracket \text{I bought green watermelons} \rrbracket$

The first thing we can say about $h^{\dots!??}$ is that (61) must be true of it.

Table 4 Derivation given h'

$B_{h'}$	$F_{h'}$	FTH	INF	MNR
{ w_2 }	...watermelon.	!*		
	...green watermelon.	!*		*
	...tomatoes.			
{ w_3 }	...watermelon.			
	...green watermelon			!*
	...tomatoes.	!*		

(61) $I\text{ bought green watermelons} \in \mathcal{F}_{h \dots ?}$

Simply adding the uttered expression to \mathcal{F} is not enough, however. Let’s suppose that h' is a context which is just like h , except that (61) is true of it as well. This gives rise to a competition whose relevant details are summarized in Table 4. (Both \mathcal{B} and \mathcal{F} have been abbreviated.)

Two facts about h' conspire to make it so that *green watermelon* can never be optimal if *watermelon* is also a form candidate.¹⁶ The first is that the common ground still reflects that there are no yellow watermelons. The second is that the domain goals do not reflect that the distinction between yellow and green watermelons is worth making. Because of this, although *green watermelon* is more informative in absolute terms than *watermelon*, it is not contextually more informative, and therefore, can never beat *watermelon* on INFORMATIVITY; but it will always lose on MANNER. If $h \dots ? = h'$, then another round of flouting is in store.

The only successful resolution must be one which results in the domain goals distinguishing between green and yellow watermelons, and in which it is common ground that the speaker could have bought non-green watermelons. This will be the case if $h \dots ? = s$ (or if $h \dots ? = s$ in the first place).¹⁷ Thus the hearer ‘receives’ these two implicatures:

- (62) a. S could have bought non-green watermelons.
b. S cares about the distinction between green and non-green watermelons.

Note that (62a) is not an informative update to the common ground, but rather constitutes a case of belief revision. For simplicity, we can assume this is done by adding worlds where there are non-green watermelons to the common ground. Such a move would in fact be the right way to model a slightly different version of this discourse,

¹⁶ In principle, it’s possible that flouting could sometimes lead to reduction of \mathcal{F} . I assume that this is not what occurs here or in cases of precisification. The earlier stipulation that flouting lead to minimal changes is not enough to guarantee this. I assume something about the similarity of the forms *watermelon* and *green watermelon*, and the fact that the former is strictly less complex than the latter make it impossible for \mathcal{F} to contain the more complex form without also containing the simpler one.

¹⁷ Of course, if we were to tweak s slightly so that the S does not think that the distinction between green and yellow watermelons matter, or perhaps so that S does not think the distinction matters in light of the fact that S bought green watermelons, then *watermelons* will in fact win out over *green watermelons*.

where the hearer has the active, conscious belief that all watermelons are green, and where that belief is challenged by the speaker's implicature. As stated, however, the scenario involves the hearer being actually unaware, i.e., not believing that she does not believe that there are non-green watermelons. See Swanson (2006), de Jager (2009), Franke (2014) for detailed discussion of unawareness and the role it plays in pragmatic reasoning. Below I briefly discuss unawareness again, as it relates to imprecision.

4 Imprecision and precisification

The interpretation of *fifty* in (63) as precise or imprecise depends on the pragmatic context. Consider two such contexts, *hi*, where the difference between fifty and forty-nine matters, and *lo*, where it does not.





- (63) There were fifty people.
- (64) $W = \{\dots, w_{37}, w_{38}, w_{39}, w_{40}, w_{41}, w_{42}, w_{43}, \dots, w_{47}, w_{48}, w_{49}, w_{50}, w_{51}, w_{52}, w_{53}, \dots\}$
- a. $\{w_{40}\} \models \text{There were 40 people there. (etc...)}$
- (65) $\mathcal{F}_{hi} = \mathcal{F}_{lo} = \{\text{There were 40 people, ... There were 49 people, There were 50 people, ..., There were about 40 people, ..., There were about 49 people, There were about 50 people...}\}$
- (66) a. $\rho_{hi} \models \text{It matters exactly how many people there were.}$
b. $\mathcal{B}_{hi} = \mathcal{P}(W)$
- (67) a. $\rho_{lo} \models \text{It only matters to the nearest 10.}$
b. $\mathcal{B}_{lo} = \{\dots, \{w_{35}, w_{36}, w_{37}, w_{38}, w_{39}, w_{40}, w_{41}, w_{42}, w_{43}, w_{44}\}, \{w_{45}, w_{46}, w_{47}, w_{48}, w_{49}, w_{50}, w_{51}, w_{52}, w_{53}, w_{54}\}, \dots\}$ ¹⁸

I include among the candidate utterances versions of the utterance with approximators. Note the tableaux below do not include the *at least* readings of any of the relevant utterances as meaning candidates; in any case these readings would be ruled out by scalar implicature as in Example 2.

- (68) *Inferences with High Precision, based on Table 5.*
- a. $\sigma_{hi} + \llbracket \text{There were 40 people.} \rrbracket = \sigma_{hi} \cap \{w_{40}\}$
b. $\sigma_{hi} + \llbracket \text{There were 49 people.} \rrbracket = \sigma_{hi} \cap \{w_{49}\}$
c. $\sigma_{hi} + \llbracket \text{There were 50 people.} \rrbracket = \sigma_{hi} \cap \{w_{50}\}$
d. $\sigma_{hi} + \llbracket \text{There were about 49 people.} \rrbracket = \sigma_{hi}^{\approx 49!} + \llbracket \text{There were about 49 people.} \rrbracket$
e. $\sigma_{hi} + \llbracket \text{There were about 50 people.} \rrbracket = \sigma_{hi} \cap \{\dots, w_{49}, w_{51}, \dots\}$

¹⁸ Lewis (1979) notes that membership in a set like this one is itself a vague matter, i.e., there may be some uncertainty in a given context about whether to treat a world in which 45 people come to the party as a world where *40 people came* is roughly true, or as one where *50 people came* is roughly true. Lasnik (1999) discusses this idea more skeptically. In any case, I am not committing myself to the idea that the partition on the logical space relevant to precision is not vague, but I am assuming that it is not, for simplicity.

Table 5 Numerals in a high-precision context

\mathcal{B}_{hi}	\mathcal{F}_{hi}	FTH	INF	MNR
$\{w_{40}\}$	 There were 40 people.			
	There were about 40 people.		!*	*
	There were 49 people.	!*		*
	There were about 49 people.	!*	*	**
	There were 50 people.	!*		
	There were about 50 people.	!*	*	*
$\{w_{49}\}$	There were 40 people.	!*		
	There were about 40 people.	!*	*	*
	 There were 49 people.			*
	There were about 49 people.		!*	**
	There were 50 people.	!*		
	There were about 50 people.		!*	*
$\{w_{50}\}$	There were 40 people.	!*		
	There were about 40 people.	!*	*	*
	There were 49 people.	!*		*
	There were about 49 people.		!*	**
	 There were 50 people.			
	There were about 50 people.		!*	*
$\{\dots, w_{49}, w_{50}, \dots\}$	There were 40 people.	!*		
	There were about 40 people.	!*	*	*
	There were 49 people.	!*		*
	There were about 49 people.		*	*!*
	There were 50 people.	!*		
	 There were about 50 people.		*	*



(69) *Inferences with Low Precision, based on Table 6*

- a. $\sigma_{lo} + \llbracket \text{There were 40 people.} \rrbracket = \sigma_{lo} \cap \{\dots, w_{40}, \dots\}$
- b. $\sigma_{lo} + \llbracket \text{There were 49 people.} \rrbracket = \sigma_{lo}^{49! ?} + \llbracket \text{There were 49 people.} \rrbracket$
- c. $\sigma_{lo} + \llbracket \text{There were 50 people.} \rrbracket = \sigma_{lo} \cap \{\dots, w_{49}, w_{51}, \dots\}$
- d. $\sigma_{lo} + \llbracket \text{There were about 50 people.} \rrbracket = \sigma_{lo}^{\approx 50! ?} + \llbracket \text{There were about 50 people.} \rrbracket$

In all contexts, non-round numerals incur a penalty to MANNER. Under high standards of precision, FAITHFULNESS is enough to eliminate competing unmodified numerals, while approximated numerals are defeated on INFORMATIVITY (they would lose out on MANNER too, if it got that far), with the one exception being the ignorance case, where the approximated round numeral wins over the unmodified numerals on FAITHFULNESS and over the other approximated numerals on MANNER.

When the standard of precision is low, the situation is much like the ignorance case for the high standard, in that MANNER becomes relevant in many cases. Note that this is in part because of the definition of the belief-state alternatives, \mathcal{B} ; in the low precision case, the more informed belief states are excluded, thus possibly excluding even the speaker’s actual belief state. So even if it is common ground that the speaker knows the exact value, if the standard is low, only the less informative belief states

Table 6 Numerals in a low-precision context

B_{low}	F_{hi}	FTH	INF	MNR
{ ..., w_{39} , w_{40} , ... }	 There were 40 people.			
	There were about 40 people.			!*
	There were 49 people.	!*		*
	There were about 49 people.	!*	*	**
	There were 50 people.	!*		
	There were about 50 people.	!*	*	*
{ ..., w_{49} , w_{50} , ... }	There were 40 people.	!*		
	There were about 40 people.	!*	*	*
	There were 49 people.			!*
	There were about 49 people.			!**
	 There were 50 people.			
	There were about 50 people.			!*

are considered. But this move is motivated simply by a desire to reduce the size of B . Even if, for example, the belief states $\{w_{49}\}$ and $\{w_{50}\}$ were included in the derivation in Table 6, the round expression *There were 50 people* will be optimal for both of those states as well; the implicature of *There were 50 people* will therefore remain unchanged.¹⁹

Precisification can be modeled then as a case where speaker A's understanding of the context is *lo* (or another context like it) and speaker B's is *hi*. Upon utterance of a non-round expression like *There were 49 people* by speaker B, speaker A will be forced to adjust to a new context, as shown in (69b). In the ideal case, $lo^{49!} = hi$. And in fact, any way of resolving of $lo^{49!}$ must involve an increase in the standard of precision, so that the non-round expression *There were 49 people* is no longer equivalent to the round expression *There were 50 people* in terms of INFORMATIVITY—otherwise, it will always lose to it on MANNER.

Conversely, however, if A utters a round expression like *There were 50 people*, speaker B is *not* forced to make any move to a lower standard. That's because round expressions are perfectly admissible on high standards. In principle, there can be no expression which is admissible on a low standard but not a high one, so there is no indirect way to force a shift to a low standard from a high one.

Again, unidirectionality does not mean that standards cannot be lowered through other, more direct means. Metalinguistic expressions may do so. And other non-linguistic behaviors may cause speakers to reason to the conclusion that their interlocutor is operating on a lower standard than they are. But the kind of precisification discussed here is purely a *side-effect*—it comes along for free with an utterance the semantics of which does not make any explicit mention of the domain goals. And such side effects only result in an increase in the standard of precision.

This concludes my analysis. Below I compare it to alternatives.

¹⁹ Similarly, we might imagine that \mathcal{F} for the low precision case should not include the non-round expressions like *There were 49 people*. Regardless, the result is the same.

4.1 Unawareness and iteration

Franke (2014) provides a game-theoretic analysis of pragmatic reasoning about unawareness, and although he does not discuss imprecision explicitly, he does treat a case of scalar granularity which is similar. de Jager (2009) also speculates that imprecision could be modeled purely as an (un)awareness phenomenon; see also Rawlins (2010). These approaches would suggest a treatment of precisification as an awareness update, i.e., that precisification involves making someone aware of a distinction they were not previously aware of. I do not know whether imprecision is ever a result of unawareness as opposed to just disinterest, but importantly this paper focuses only on cases in which imprecision arises because of disinterest. This raises the question of whether imprecision and its kin should be analyzed as a singular linguistic phenomenon with perhaps two underlying epistemological causes – disinterest and unawareness²⁰—or whether imprecision-due-to-disinterest and imprecision-due-to-unawareness should be modeled as distinct phenomena linguistically as well. But addressing that question is another project.

Jäger's (2012) account is a game-theoretic one, similar to Franke (2014). This approach makes use of iterated reasoning, which is not part of the present model. Iteration is meant to capture certain kinds of inferences, among them the free choice inference in (70).

- (70) a. You can have an apple or an orange.
 b. You can have an apple.
 c. You can have an orange.

(70a) implicates that the speaker can have an apple *and* that the speaker can have an orange; but this implicature can only be derived by reference to what would have been *implicated* by uttering (70b) or (70c), not just by reference to their literal meanings, as is the case with scalar implicatures for example. So one round of reasoning is required to determine what (70b) and (70c) implicate (this round determines (70a) to not be associated with any inference, as with flouting on my analysis). Another round then determines that (70a) gives rise to the free choice interpretation because any other intended interpretation would have resulted in a different utterance.

The approach by Jäger (2012) applies exactly the same kind of iterated reasoning protocol to the analysis of precisification. And indeed, the multi-step process which involves an intermediate step whereby the relevant expression is determined not to be associated with any inference is akin to my flouting procedure. But notice that precisification is quite different from free choice inference; it gives rise to pedantry, technical concessions, and unidirectionality. In other words, free choice inference is not contentious in the way that precisification is.

²⁰ Presumably there is at least one other cause: Garden variety ignorance, as opposed to unawareness in the technical sense.

So while it may well be that my model needs an iterative element to match the progress made by Iterative Best Response models on free choice inferences and other cases of re-rationalizing of a surprising signal, and while it may even be that the flouting procedure modeled here could be repurposed to account for free choice inferences and the like parallel to Jäger and others, there is still an important distinction between precisification and these other cases. The crucial difference is that while the latter may involve the hearer revising their understanding of the speaker's beliefs, adding uncontroversial information to the common ground, or revising understanding of arbitrary discourse parameters, in the case of the precisification what is revised is the understanding of the discourse goals, which the speaker (typically) does not have unilateral authority to revise. It is this fact which gives rise to the contentious nature of precisification, witnessed by intuitions of pedantry, and by the ever lurking possibility of total discourse abandonment, which are never consequences of an attempted free choice inference.

4.2 Precisification as accommodation

Lewis's (1979) original discussion of precisification unifies it with accommodation of presuppositions (and other phenomena). To a certain extent, I support this. It would be very natural to extend the present account of flouting to account for presupposition accommodation—in these cases, what is different about $c^{F!}$ is that the presupposed information has been added to its common ground, $C_{c^{F!}}$.

But presupposition is itself, I assume, an inherently semantic phenomenon, whereas (im)precision is a pragmatic one, as discussed in Sect. 1. Moreover, objections to faulty presuppositions look different than objections to precisifications. Consider (71).

- (71) a. I was driving to work when the steering wheel in my car started to malfunction.
b. I was driving to work when the machine-gun turret on my car started to malfunction.

(71b) is a classic case of an unlikely-to-be-accommodated presupposition, compared to (71a), which is readily accommodable. The objection to (71b) is likely to be something like (72).

- (72) a. What!? You have a machine-gun turret on your car!?
b. Hey, wait a minute! You never told me you have a machine-gun turret!

In both cases, the hearer is demanding that the speaker assert what the speaker is acting as if she already asserted: That the presupposition is true. But (faulty) precisifications don't proceed this way; even in cases where the non-pedant chooses to metalinguistically negotiate, their objection does not consist of asking the pedant to *explicitly* raise the standard of precision.

- (73) a. A: He got here at 3.
b. B: No, he got here at 2:59.
c. A: #Hey, wait a minute! You never told me we were being precise!

In other words, the non-pedant doesn't typically take issue with the particular utterance which results in precisification, nor the manner of precisifying—they take issue with the pedant's conception of the domain goals.

This is not to suggest that there are not important similarities between presupposition accommodation and precisification; they may yet be given a common analysis. But that analysis should respect their differences.

4.3 Compositional approaches

Lasersohn (1999) represents the first serious attempt to formalize a notion of imprecision. Lasersohn argues that expressions are interpreted with respect to a *halo* of alternative denotations which differ from the semantically specified meaning in only ignorable ways; i.e., the halo of an expression is the set of meanings that are close enough to its lexical meaning that the difference doesn't matter in the current pragmatic context. Halos are calculated for each individual expression in an LF and then are composed pointwise. So when an expression like *3* in (74) composes with other elements in the sentence, the result (simplifying greatly) is a set of propositions, including the proposition that Julian arrived at 2:59, the proposition that he arrived at 3:00, the proposition that he arrived at 3:01, and so on.

(74) Julian arrived at 3.

Lasersohn's motivation for compositional (albeit pragmatic) computation is slack regulators, expressions mentioned above which in his analysis modify the halos of individual expressions.

(75) I bet you a Coke that there is exactly .0005 g of precipitate.

Even though .0005 is to be interpreted precisely, it may not be the case that *Coke* is. Thus the expression *exactly* seems to effect only the level of precision for the interpretation of .0005.²¹

However, as indicated in Sect. 2.1, the standard of precision may vary from domain to domain—there could be contexts where the difference between brands of cola is not important but very small differences of weights may matter. Thus, the effect of *exactly* need not be to act directly on the halo as it is computed, but rather to give rise to a metalinguistic inference that differences between alternatives to .0005 may matter.

Another problem with Lasersohn's (1999) account is that at the level of single lexical items, the proper standard of precision may not be determinable. Consider the following case.

²¹ A similar approach comes from Sauerland and Stateva (2011), who also develop a theory whereby precision is computed compositionally; their account, however, is fully semantic. As discussed in Sect. 1, semantic accounts fail to explain the pragmatic motivations of imprecision, and its profound ubiquity.

- (76) There should be fifty place settings. And we should have two hundred bottles of beer on hand.

How imprecisely these number terms are interpreted could be sensitive to fine details of context, but we can imagine at least one context in which the former is interpreted more precisely than the latter. If tables have already been set up, the guest list is known, and a particular aesthetic is desired by the speaker of (76), then presumably *fifty* should be interpreted very precisely, in fact, with maximum precision. However, with *two hundred* there may be room for error. Thus, it cannot be that the halo for *fifty* or *two hundred* is calculated with no other information besides the pragmatic context and their strict semantic denotations.

The issue that Lasersohn attends most closely to is an important one, however—the role of overt expressions which seem to affect the precision with which an expression is interpreted—things like *exactly*. Offering an analysis of such expressions is beyond the scope of this paper, but I will briefly raise two possibilities: One is that expressions like *exactly* have a meaning which results in expressly updating the domain goals, thus altering the standard of precision directly; this would constitute an adaptation of Lasersohn (1999). For example, (77a) could have the paraphrase in (77b).

- (77) a. John is exactly 5 feet tall.
b. John is 5 feet tall, and by the way I care a lot about differences of 1 inch when it comes to the heights of humans.

A second possibility is that slack regulators actually have meanings unrelated to precision—for example, *exactly* may simply have the function of ruling out an *at least*-reading for numerals—but they give rise to higher standards of precision in much the same way that non-round expressions do—as a side-effect, by flouting, due to the violations of MANNER that they incur. Either route would be compatible with my approach. Note also that expressions like *exactly* seem most appropriate in cases where the speaker is uncertain about whether or not the hearer has the same conception of the standard of precision—the present analysis isn't equipped to model cases like this, as discussed above, but expanding it to do so, perhaps à la Kao et al. (2014), may give it a better handle on slack regulators.

5 Conclusion

This paper provides a formal analysis of imprecision which treats it as a function of pragmatic reasoning. The primary support for this analysis is its handling of precisifications, which are analyzed as underlying disagreements about discourse goals—a special case of flouting—which (can) resolve by the hearer's revision of those goals to match the speaker's. The success of this approach further bolsters the program of optimality-theoretic and game-theoretic pragmatics, which have shown to be successful in providing formal analyses to problems long considered beyond the reach of formal analysis. This approach improves on prior approaches within the formal pragmatic tradition by implementing a richer model of discourse. A noteworthy remaining challenge is the treatment of slack regulators; it remains to be shown that the present account, which says nothing of composition, can be expanded to deal with them—but I am optimistic.

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