

Quantification, the Reprise Content Hypothesis, and Type Theory

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60. Robin H. Cooper (RCH): Quantification and Dialogue and Type Theory and CRification

Robin Cooper has always been interested in quantification (at least since 1972, we hypothesize). He has been interested in dialogue for more than 15 years (ever since he pushed the alphabetically first author to get working on it.), he has been working on Type Theory for slightly less (though it is of course a natural outgrowth of his 20 something year engagement with Situation Semantics), and he has been interested in CRification for almost a decade. We dedicate this piece in thanks to his encouragement over the years and with the wish for many productive years of quantification, dialogue, yoga, and Tippet.

1. Introduction

Generalized quantifiers (GQs) were brought to the attention of linguists by (Montague 1974) and a systematic study of them initiated by (Barwise and Cooper 1981) and (Keenan and Stavi 1986). Montague, who was not on the whole concerned with cognitive issues, was unperturbed by the complex denotations (properties of properties) he was bringing into the grammar. Barwise and Cooper, however, were and in order to explain how a hearer can process a GQ without having to determine the identity of this full set of sets, introduced simple counterparts to each GQ entity (*witness sets*). Somewhat coincidentally, witnesses also play an important role in Type Theory with Records (TTR), a framework Cooper has developed over the past decade (see e.g. (Cooper 2005a; Cooper 2005b)), showing in particular how GQ theory can be advantageously reformulated in TTR (Cooper 2004); see also (Fernando 2001) for a highly insightful synthesis between GQT and type theory.

Nonetheless, in this paper, following on from (Purver and Ginzburg 2004), we will argue against the Montogovian *tactic* of using higher-order properties-

of-properties as NP denotations. Our main argument derives from the claim that this tactic¹ is in conflict with the evidence provided by phenomena pertaining to clarification of NP utterances, and in particular with the *reprise content hypothesis* (RCH – on which more below).

(Ginzburg and Cooper 2004) provide an analysis for clarification requests (CRs) which includes a context-dependent account of utterance semantics and the grounding thereof. (Purver and Ginzburg 2004) examine the repercussions of this analysis for NP semantics, showing that considering CRification can provide semanticists with another adequacy criterion in an area full of theories. However, both essentially centre around *referential* semantics; our aim here is to examine how the same general approaches might be generalized to non-referential meaning and anaphora. We consider how to develop a semantics for NPs that fits with Montague’s overall *strategy* in assigning a well-defined denotation to NPs, while adhering to the RCH. We proceed to show that TTR provides attractive alternative means with which to analyze NP meaning.

In section 2 we provide some background needed for the remainder of the paper: first introducing the general view of meaning and context in dialogue that we assume, and then outlining (Purver and Ginzburg 2004)’s claims. Section 3 then sets out a new formulation of their (HPSG-based) approach using TTR, which yields a straightforward account of the dynamics of grounding, clarification, and anaphora for discourse involving both referential and non-referential NPs. In section 4, we extend the account to deal with so-called scope ambiguities—we say ‘so-called’ since we will suggest that CRificational evidence indicates these ambiguities are better analyzed as essentially *lexical*.

2. Grounding, CRification, and the RCH

2.1. Dialogue and the Structure of Context

Following (Ginzburg 1996; Poesio and Traum 1997; Larsson 2002; Ginzburg fcmg), amongst others, we assume that a suitable model of dialogue context is one in which we assume that each conversational participant is assigned their own gameboard, where they record their version of the public conversational action and relative to which they compute their possible reactions. We characterize this gameboard as a data structure whose primary attributes are

the following:

- FACTS: a set of commonly agreed upon facts.
- QUD ('questions under discussion'): a partially ordered set that specifies the currently discussed questions.
- MOVES: a list specifying the form and content of the moves made in the conversation.

Given such a structure, we can model many important dialogue phenomena such as asking and answering questions (introducing elements to QUD and discharging them); acceptance and confirmation (extension of FACTS); and many elliptical phenomena (by analysing context-dependent utterances as having their content further specified by the maximal question in QUD).

2.2. Grounding and CRification

(Ginzburg and Cooper 2004) show how a view of utterances as encoding *meaning* rather than *content* can lead to an explanation of the availability of CRs in dialogue. Various formalizations are possible: in (Ginzburg and Cooper 2004) the architecture used is HPSG with simultaneous abstraction; (Cooper and Ginzburg 2002; Ginzburg fcmg) instead take a type-theoretical approach, but the basic insight is the same. Context-dependent elements are labelled explicitly, and a hearer must be able to find suitable corresponding referents in context before the utterance can be *grounded*. Failure to do so for a particular element may then lead to clarification being sought concerning the phrase which contributed this problematic element to the original utterance; the *move* giving rise to the CR maintained until its grounding in the contextual repository PENDING. Generation and interpretation of CRs themselves, with their often highly elliptical *reprise* nature, can be modelled using a set of general context-update rules which license updating of QUD with CRificational questions in the presence of ungrounded elements.

Using an approach based on dependent record types (see (Cooper 2005a)), (1) shows a simplified version of the representation that might be assigned to type an utterance 'Did Bo leave?' together with that for the NP 'Bo':

$$(1) \quad \begin{array}{cc} \text{'Bo'} & \text{'Did Bo leave?'} \\ \left[\begin{array}{l} \text{c-params} : \left[\begin{array}{l} x : \text{Ind} \\ r : \text{named}(x, \text{"Bo"}) \end{array} \right] \\ \text{cont} = \text{c-params.x} : \text{Ind} \end{array} \right] & \left[\begin{array}{l} \text{c-params} : \left[\begin{array}{l} x : \text{Ind} \\ r : \text{named}(x, \text{"Bo"}) \end{array} \right] \\ \text{cont} = ?\text{leave}(\text{c-params.x}) : \text{Question} \end{array} \right] \end{array}$$

As (1) shows, utterance types are represented as record types; and the C-PARAMS field specifies a record type representing the context-dependent elements. Utterances are taken to be records—grounding involves linking an utterance with an appropriate type. In particular, a witness for the C-PARAMS record type must be found – i.e. a record which represents the speaker’s intended instantiation of C-PARAMS in context. Similarly, the truth conditions for propositions expressed by successfully grounded utterances depend on the existence of witnesses for the record type which constitutes the content of a declarative utterance.²

In fact, as certain types of CRs ask for repetition of the actual words and phrases used, rather than asking about their semantic content (these are the questions one asks in noisy cocktail parties, when unable to hear words correctly), we assume (following (Cooper and Ginzburg 2002)) that sub-utterances themselves, including their non-semantic information, must in fact be members of C-PARAMS – with inability to find witnesses for them resulting in CRs. We will leave this out of our analysis here for the most part, though, and concentrate on CRification of content.

2.3. Reprise Questions and the Reprise Content Hypothesis

Note that such an analysis suggests that CRs ask about a part of the antecedent’s semantic content – namely, that part which is contextually dependent. If so, examining what a CR actually asks about (and how it is answered) might give us some insights into the nature of that content. (Purver and Ginzburg 2004) note that *reprise questions* (a particular type of CR) seem especially suited to this kind of use as a semantic probe: a reprise question, by echoing an antecedent phrase, makes it clear which phrase is being asked about; and (when reprising sub-sentential phrases, at least) seem unable to ask about pragmatically inferred material but are restricted to semantic content. They propose the *Reprise Content Hypothesis*, phrased in both weak (2a) and strong (2b) versions:

- (2) a. *A nominal fragment reprise question queries a part of the standard semantic content of the fragment being reprised.*
- b. *A nominal fragment reprise question queries exactly the standard semantic content of the fragment being reprised.*

This provides us with a stronger constraint than sentential compositionality: by examining reprise questions, we can hold individual phrases to account, rather than merely ensuring that the overall sentential content to which they contribute is suitable.

They then apply this constraint to NP semantics, pointing out that NP reprises seem to be able to query individuals (3a), or, for plurals, sets of individuals; that in some cases, where the subconstituent N is focussed, that they can ask about the noun predicate, a property of individuals (3b); but that it is very difficult to imagine them as querying GQs (i.e. properties-of-properties):³

- (3) a. A: And er they X-rayed me, and took a urine sample, took a blood sample. Er, the doctor
B: Chorlton? [\leadsto *By 'the doctor' do you mean Chorlton?]*
A: Chorlton, mhm, he examined me, erm, he, he said now they were on about a slide [unclear] on my heart. Mhm, he couldn't find it.
- b. Anon 1: They'd carry the sack on their back?
George: On the back, the bushel, yes
Anon 1: The bushel? [\leadsto *What property do you mean by 'bushel'?*]

They apply this to many types of NP, arguing that most uses of proper nouns, demonstratives, pronouns and definite descriptions do seem to refer to individuals; but their evidence is less conclusive for non-referential NPs such as indefinites. (Purver 2004) also shows how this approach can be extended to other phrase types including verbs and verb phrases; however, here we confine ourselves to discussing NPs.

3. Referential vs. Non-Referential NPs: Wide Scoping Quantification

3.1. C-PARAMS and Q-PARAMS

Contrast (4a) with (4b) as uttered by Aaron to Belinda: the former is typically uttered with the strong expectation that Belinda can recognize who Jo is, whereas the latter involves use of the indefinite precisely because Aaron himself has at best only a relatively weak idea of the identity of the thief, and presumably does not expect Belinda to be in any more knowledgeable a position:

- (4) a. A: Jo arrived yesterday.
b. A: A thief broke in here last night.

These contrasting expectations are reflected in the differing clarificational potentials of the two utterances, as we see when we examine possible clarification requests and responses thereto. In (5a), Belinda's question can only be understood as concerning Jo's identity; while in (5b), the corresponding question is very hard to interpret as asking about the thief's identity, but rather seems to ask about the property predicated of them (that of being a thief):

- (5) a. A: Jo arrived yesterday.
B: Jo?
A: Yes, that's right. / Oh, you know, my friend Jo from school.
b. A: A thief broke in here last night.
B: A thief?
A: Yes, thief. / Well, burglar then, but certainly someone up to no good.

These differences can be captured by assuming that an utterance of the referential 'Jo' contributes to the C-PARAMS of the utterance (as in (1) above), whereas non-referential NPs such as 'a thief' do not. But, if they do not contribute to C-PARAMS, what do they contribute to semantically? In broad terms the answer is clear: non-referential NPs need to contribute their descriptive conditions to the sentential content, while any associated individuals are existentially quantified within the sentence. We introduce a Q-PARAMS field to indicate this existential quantification, and so the representation of (5b) becomes (roughly) as in (6a). In fact, as we want to account for the fact that the

subconstituent common noun ‘thief’ must be grounded, and can be CRified as in (5b) above, we wish to make the associated noun predicate a member of C-PARAMS, as shown in (6b) – but we will ignore this complication hereafter. Another notational simplification—an abuse to be precise—we adopt here is to factor out Q-PARAMS from the descriptive content, as in (6a). More generally, what is required is as in (6b), but the difference will be immaterial for current purposes:

$$(6) \text{ a. } \left[\begin{array}{l} \text{c-params} = [] : \text{RecType} \\ \text{q-params} : \left[\begin{array}{l} x : \text{Ind} \\ r : \text{thief}(x) \end{array} \right] \\ \text{cont} : \text{break_in}(\text{q-params}.x) : \text{RecType} \end{array} \right]$$

$$\text{b. } \left[\begin{array}{l} \text{c-params} : \left[\begin{array}{l} p : \text{Pred} \\ r1 : \text{named}(p, \text{“thief”}) \end{array} \right] \\ \text{cont} : \left[\begin{array}{l} \text{q-params} : \left[\begin{array}{l} x : \text{Ind} \\ r2 : \text{c-params}.p(x) \end{array} \right] \\ \text{nucl} : \text{break_in}(\text{q-params}.x) \end{array} \right] \end{array} \right]$$

Generalized Quantifier Theory (GQT) will allow us to arrive at a denotation like (6a), but only via a somewhat long winded way—the denotation (7a) is posited for the NP ‘a thief’, which via β -reduction given a V denotation (7b), becomes (7c) (see (Cooper 2004), p. 12). However, we could get to that route rather more directly by postulating (7d) as the NP’s contribution to content:

$$(7) \text{ a. } \lambda R : ([x : \text{Ind}]) \text{RecType} \left[\begin{array}{l} \text{par} : [x : \text{Ind}] \\ \text{restr} : \text{thief}(x) \\ \text{scope} : R(\text{par}) \end{array} \right]$$

$$\text{b. } \lambda r : ([x : \text{Ind}]) [c0 : \text{break_in}(r.x)]$$

$$\text{c. } \left[\begin{array}{l} \text{par} : [x : \text{Ind}] \\ \text{restr} : \text{thief}(x) \\ \text{scope} : [c0 : \text{break_in}(\text{par}.x)] \end{array} \right]$$

$$d. \left[\begin{array}{l} \text{c-params} = [] : \text{RecType} \\ \text{q-params} : \left[\begin{array}{l} x : \text{Ind} \\ r : \text{thief}(x) \end{array} \right] \\ \text{cont} = \text{q-params}.x : \text{Ind} \end{array} \right]$$

This allows us not only to arrive at a suitable overall representation, but to directly express the distinction between two types of NP via the distinction between inclusion in C-PARAMS or in Q-PARAMS. ‘Referential’ NPs (the reason for the scare quotes will become obvious shortly) help build up the contextual C-PARAMS component; ‘non-referential’ NPs help build the sentential content via Q-PARAMS; while both have contents of the same semantic type (individuals) and fill argument roles of a predicate uniformly.

A combinatory rule we would need to build sentences from NPs and VPs, while amalgamating their C-PARAMS and Q-PARAMS, is given in (8):

$$(8) \left[\begin{array}{l} \text{hd-subj-ph} \\ \left[\begin{array}{l} \text{Subjtype,SCP,SQP} : \text{Type} \\ \text{HCP,HQP} : \text{Type} \\ \text{dtrs} : \left[\begin{array}{l} \text{hd-dtr} : \left[\begin{array}{l} \text{cont} : (y : \text{Subjtype})\text{RecType} \\ \text{c-param} : \text{HCP} \\ \text{q-param} : \text{QCP} \end{array} \right] \wedge \text{sign} \\ \text{subj-dtr} : \left[\begin{array}{l} \text{cont} : \text{Subjtype} \\ \text{c-param} : \text{SCP} \\ \text{q-param} : \text{SQP} \end{array} \right] \wedge \text{sign} \end{array} \right] \\ \text{cont} = \text{dtrs.hd-dtr.cont}(\text{dtrs.subj-dtr.cont}) : \text{RecType} \\ \text{q-params} : \text{HQP} \cup \text{SQP} \\ \text{c-params} : \text{HCP} \cup \text{SCP} \end{array} \right] \end{array} \right]$$

In fact, our set up also allows for a fairly straightforward analysis of intensional verbs such as ‘seek’. (Cooper 2005b) proposes to treat sentences such as (9a) as relating an agent with a record type, as in (9b). This is because the witnessing conditions of the record type that fills the object argument role seem to describe well the success conditions of a search, as in Montague’s account:

(9) a. Jill seeks a unicorn.

b. $\text{seek}(j, \left[\begin{array}{l} x : \text{Ind} \\ r : \text{unicorn}(x) \end{array} \right])$

Cooper shows how to implement this analysis via a GQ analysis of NPs. On the current analysis, this would follow straightforwardly by having an intensional verb select for the Q-PARAMS type of its object.⁴

In comparing a GQT-based approach and the non-GQ approach sketched so far simplicity is not a good guide: GQT has, arguably, a somewhat simpler synsem interface, but its denotations are more complex. If we take a dialogical perspective, however, things are not so equal. For a start, the simplicity GQT provides is conditional: it is maintained only in so far as indubitably⁵ referential NPs are type raised to the type of GQs, a move that falls foul of the RCH. However, if a GQ-oriented theory buys into distinctness of types among NPs, other problems come up. The first is that the simplicity of the synsem interface is lost—composing NPs and verbs is no longer possible by a single rule.

The second is that reprise questions show no more evidence that GQ-like readings are available from non-referential NPs than they are from referential ones. (Purver and Ginzburg 2004) present reprise data for indefinites and other quantified NPs (see below), but none seem to permit anything other than the NP-referential or subconstituent readings we have already seen:

(10) a. Unknown: What are you making?

Anon 1: Erm, it's a do— it's a log.

Unknown: A log?

Anon 1: Yeah a book, log book.

b. Anon 2: Was it nice there?

Anon 1: Oh yes, lovely.

Anon 2: Mm.

Anon 1: It had twenty rooms in it.

Anon 2: Twenty rooms?

[\rightsquigarrow Is it **twenty** rooms you're saying it had?]

[\rightsquigarrow Is it twenty **rooms** you're saying it had?]

[\rightsquigarrow ??Which twenty rooms are you saying it had?]

Anon 1: Yes.

c. Richard: No I'll commute every day

Anon 6: Every day? [\rightsquigarrow *Is it **every** day you'll commute?*]

[\rightsquigarrow *Is it every **day** you'll commute?*]

[\rightsquigarrow *?Which days do you mean by **every day**?*]

Richard: as if, er Saturday and Sunday

Anon 6: And all holidays?

Richard: Yeah [pause]

Thirdly, and perhaps most importantly, there are a number of arguments that suggest that the referential/non-referential bifurcation is in fact a rather fragile one. It is to this that we now turn.

3.2. Referential Indefinites & Accommodation

So far, we follow (Purver and Ginzburg 2004) closely apart from the difference in framework. However, the advantage of the type-theoretic approach developed here becomes clear when considering examples like (11). Here, while Aaron knows that the arriver was Jo, he uses an indefinite because he assumes Belinda might not have a name for Jo:

(11) A: A friend of mine arrived yesterday.

B: A friend of yours?

A: Right – Jo, in fact.

Note that in such cases, it is perfectly easy to understand Belinda's question as asking about the friend being referred to – the reference of the NP 'a friend'. We can also imagine it as querying the appropriateness of the noun property 'friend', of course (in which case Aaron's response might be more along the lines of 'yes, I think I'd count her as a friend - certainly more than an acquaintance'). But while (Purver and Ginzburg 2004) offer an information-structure-based account of how both the NP-query and the noun-property query might be available, they must assume that indefinites are ambiguous (between referential and non-referential versions) to explain the difference between (5b) and (11).

However, we need make no such assumption. (Cooper and Ginzburg 2002) show how a type-theoretic approach lends itself to modelling the process of *accommodation* of a nominal reference – the process by which Belinda can process an example like (4a) even without knowing who Jo is, essentially by existentially quantifying Jo away. In current terms, what is needed is a simple coercion operation which allows (12b) to be produced from (12a):

- (12) a.
$$\left[\begin{array}{l} \text{c-params} : \left[\begin{array}{l} x : \text{Ind} \\ r : \text{named}(x, \text{“Jo”}) \end{array} \right] \\ \text{q-params} = [] : \text{RecType} \\ \text{cont} : \text{arrive}(\text{c-params}.x) \end{array} \right]$$
- b.
$$\left[\begin{array}{l} \text{c-params} = [] : \text{RecType} \\ \text{q-params} : \left[\begin{array}{l} x : \text{Ind} \\ r : \text{named}(x, \text{“Jo”}) \end{array} \right] \\ \text{cont} : \text{arrive}(\text{q-params}.x) \end{array} \right]$$

In the case of example (11), we merely require the opposite move: Belinda and Aaron, inferring or knowing that a particular friend is in fact being referred to, can coerce (12b) to (12a), allowing a referential CR to be asked and successfully interpreted. Note that this move is only available to us because the analysis maintains the same type (individuals) for both referential and non-referential versions. It is very hard to see how such a move would be possible given a GQ approach to NP representation: type-raised NP representations such as (7a) do not seem to lend themselves to this kind of analysis; and an approach which maintains lower semantic types for referential NPs and higher types for non-referential NPs must of course fare equally badly.

3.3. Anaphora

A related argument can be made from what has always been an important testing ground for any theory of NP meaning, namely anaphora. We consider for now ‘discourse anaphora’—anaphora that occur across sentential boundaries—returning to intrasentential anaphora, in particular its ‘bound variable’ variant in section 4. The vast literature on quantification and anaphora has, with very few if notable exceptions (e.g. (Groenendijk 1998; Asher and

Lascarides 2003; Poesio and Traum 1997)), been designed for monologue. Dialogue brings new challenges on this score: querying, disagreement, partial understanding.⁶ Both referential and non-referential NPs give rise to discourse anaphora—the challenge is to provide a uniform theory. An account like the one we develop here, where referential and non-referential NPs are of the same semantic type—the level of individuals which directly provide the referents for anaphora—is at an advantage compared to a theory where witnesses need to be ‘extracted’ independently from GQ denotations.⁷

The main challenge for a theory of meaning for pronouns is of course how to characterize their antecedency conditions. Dialogue takes us away quite quickly from certain received ideas on this score. (13) indicates straight off that antecedents are not going to be located in the contextual repository of shared assumptions, namely FACTS, given the possibility of anaphora out of questions:

- (13) A: Did John phone? B: He’s out of contact in Daghestan.

Another reason why FACTS is inappropriate relates to a more general issue: in theories like DRT and DPL (though not SDRT)—once an antecedent (for discourse anaphora), always an antecedent. This strategy of pooling all antecedents together once they become available is problematic in light of the fact, well noted in the AI literature on anaphora resolution (see e.g. (Grosz and Sidner 1986)) that changing the topic of conversation drastically changes anaphoric possibilities. Thus, in (14(5)) ‘he’ cannot felicitously refer to Jake, despite the fact that the equivalent utterance using a directly referential expression is perfectly coherent:

- (14) A: Jake hit Bill. / B: No, he patted him on the back. / A: Ah. Is Bill going to the party tomorrow? / B: No. / A(5): Is #he/Jake?

This leaves QUD, Moves, or Pending. QUD we can dismiss since its elements lack sufficient structure. So we are left with Moves and/or Pending. (15a) is an example of anaphora from an ungrounded utterance, whereas (15b) (from (Heeman and Allen 1999)) is an example of anaphora from a disfluent utterance:

- (15) a. A: Did John phone? B: Is he someone with a booming bass voice?
b. Peter was, well he was fired .

This suggests, then, that antecedents are to be located in both MOVES and PENDING. Where within the representation of an utterance? The obvious candidate is C-PARAMS, where after grounding reside at the very least entities that serve as values for referential utterances. Moreover, given the fact that C-PARAMS has fields for all sub-utterances, the antecedents of repetition CRs, we have a straightforward account of agreement between antecedent and anaphor, unavailable to standard dynamic theories (including SDRT), where the dynamics is defined on a purely semantic level. This is particularly important in grammatical gender languages (e.g. apparently all EU official languages apart from English), where gender is not well correlated with the intrinsic characteristics of a referent, as illustrated in (16): (16a) shows grammatical gender agreement in German across a number of turns, where crucially the intermediate turn is, on most plausible accounts, lacking in syntactic structure. Similarly, in (16b,c), we see examples from Hebrew, which lacks a neuter gender and correspondingly has no neuter pronouns. There exist two words which correspond to the English ‘car’, one is masculine, the other feminine. Subsequent pronominal reference must agree with the gender of the antecedent:

(16) a. A: Kommt jetzt ein Zug? B: Ja. Er kommt von Gleis 2.

b. ledani yesh Oto/mexonit yafe/yafa

Dany has car(m) /car(f) nice(m/f).

c. hu kana oto/ota beLod

he bought him/her in Lod

Nonetheless, there is one important difference between referential NPs and QNPs: the former will have referents/witnesses in place once grounding has taken place. For QNPs, however, this is not the case. Indeed in certain cases no witnesses will get introduced in line with the fact that for non-referential NPs anaphora is not generally possible from within a query (polar or *wh*), as originally pointed out in (Groenendijk 1998), or from an assertion that has been rejected:⁸

(17) a. A: Do you have a brother? B: Yes. A: What is he called?

b. A: Do you have a brother? B: No. A: # What is he called? B: I told you, no brother.

This means, naturally enough that witnesses to QNPs can only emerge in a context where the corresponding assertion has been accepted. A natural move to make in light of this is to postulate a witnessing process as a side effect of assertion acceptance, a consequence of which will be the emergence of referents for QNPs. For uniformity's sake, we can assume that these witnesses get incorporated into the C-PARAMS of that utterance. This means that C-PARAMS serves uniformly as the locus for antecedents of 'discourse anaphora'. The rule of witnessing is actually simply a minor add on to the rule that underwrites assertion acceptance (see (Ginzburg fcmg), Chapter 4)—we view it as providing for a witness for situation/event anaphora since this is what gets directly introduced into c-params. In cases where the witness is a record (essentially when the proposition is positive), NP witnesses will emerge.

(18) Accept move:

$$\left[\begin{array}{l} \text{preconds} \\ \text{effects} \end{array} = \left[\begin{array}{l} \text{spkr: } \mathit{Ind} \\ \text{addr: } \mathit{Ind} \\ \text{T1 : } \mathit{RecType} \\ \text{LatestMove.cont = Assert(spkr,addr,T1) : } \mathit{IllocProp} \\ \text{spkr = preconds.addr: } \mathit{Ind} \\ \text{addr = preconds.spkr: } \mathit{Ind} \\ \text{t : preconds.T1} \\ \text{w = preconds.LatestMove.c-params} \cup \left[\text{sit = t} \right] : \mathit{Rec} \\ \text{Moves = } \langle \text{m1, mo, \dots} \rangle : \text{list}(\mathit{LocProp}) \\ \text{m1.cont = Accept(spkr,addr,T1) : } \mathit{IllocProp} \\ \text{m0.c-param = w : } \mathit{Rec} \end{array} \right] \right]$$

We can now state the meaning of a singular pronoun as follows: C-PARAMS specifies an antecedent located in the C-PARAMS of an *active move*. The pronoun is identical in reference to this antecedent and agrees with it.

$$(19) \left[\begin{array}{l} m : \text{LocProp} \\ c1 : \text{ActiveMove}(m) \\ \text{c-params} : \left[\begin{array}{l} m.\text{c-params} : \left[\begin{array}{l} u2 : \text{PsCat} \\ u2.\text{cont} : \text{Ind} \end{array} \right] \\ x = m.\text{c-params}.u2.\text{cont} : \text{Ind} \end{array} \right] \\ \text{cat.agr} = m.\text{c-params}.u2.\text{cat.agr} : \text{SynAgrCat} \\ c1 : \text{gendernumber}^9(\text{cat.agr}) \\ \text{cont} = \text{c-params}.x : \text{Ind} \end{array} \right]$$

Here an *ActiveMove* is a element of *Moves* such that either (a) *m.cont*.qud-update-contribution is in qud or (b) *m.cont* is max-qud-specific or (c) *m* is in pending

For notational simplicity, we abbreviate the C-PARAMS type in (19) as (20a)—here *m* is the move and *a* the antecedent utterance. We can thereby rewrite (19), omitting the agreement specification, as (20b):

$$(20) \text{ a. } \left[\begin{array}{l} m : \text{LocProp} \\ a : \text{synsem} \\ c1 : \text{DiscourseAnt}(m,a) \end{array} \right]$$

$$\text{ b. } \left[\begin{array}{l} \text{c-params} : \left[\begin{array}{l} m : \text{LocProp} \\ a : \text{synsem} \\ c1 : \text{DiscourseAnt}(m,a) \end{array} \right] \\ \text{cont} = \text{c-params}.a.\text{cont} : \text{Ind} \end{array} \right]$$

How will this meaning aligned with the acceptance move rule enable us to explicate the cases we have seen? Consider (17a): accepting ‘yes’ will result in augmenting the C-PARAMS of ‘yes’ with a witness for $\left[\begin{array}{l} x : \text{Ind} \\ c1 : \text{brother}(x) \\ c0 : \text{have}(b,x) \end{array} \right]$.

In contrast, for (17b), the witness for T1 is not a record (it is a function mapping T to \perp , the witness for a negative type), so no referent for ‘a brother’ is provided. As far as (13) goes, a referent for ‘John’ is in c-params once the query is grounded, and this is available as an antecedent since the query is at

that point an active move. Finally, in (15) we assume that this is a case where CRification is performed not to *find* a missing contextual value but to *confirm* it. Hence, PENDING has a value for ‘John’. Finally, given their presence in C-PARAMS, we note also an explanation for examples like (21), where a pronoun is CRed and the answers mentioned are the possible antecedents:

- (21) A: A teacher gave a parent a book from the school library. He liked it a lot. B: The teacher or the parent?

This explanation though is incomplete as long as we have not said anything about ‘bound variable’ anaphora, let alone defended our non-unified account. As we will see in section 4 ‘bound variable’ anaphors are themselves clarifiable, despite their potentially non-referential antecedents.

3.4. Plural NPs

So far, our analyses have all involved singular NPs, both referential and non-referential. How does our approach carry over to plurals? With referential plurals, the transition seems clear: we simply need plural NPs to denote sets of individuals rather than individuals,¹⁰ and this seems perfectly in keeping with the RCH as long as this set is a member of C-PARAMS (see (22a)). Predicating the VP content directly of the set must result in a collective reading, as in (22b) where the set of students left together; distributive readings can equally be handled, as we discuss in section 4.

- (22) a. John: they’ll be working on the, they’ll be working on the kidnapper’s instructions though wouldn’t they? They would be working on the kidnapper’s instructions, the police?
 Sid: The police? [\rightsquigarrow *Who do you mean by ‘the police’?*]
 [\rightsquigarrow *Is it the police who you are saying would be working ... ?*]
 John: Aye
 Sid: On
 Unknown: [unclear]
 Sid: aye the, the senior detectives

- b. ‘The students met’

$$\left[\begin{array}{l} \text{c-params : } \left[\begin{array}{l} s : \text{Set}(Ind) \\ r : \text{student}'(s) \end{array} \right] \\ \text{cont : met}(\text{c-params}.s) \end{array} \right]$$

Turning to non-referential NPs, so far we have concentrated on indefinites, capturing their quantificational force implicitly by the witnessing relation between records and types. It seems clear that the same approach will work here: examples such as (10b) above can be expressed via a suitable set member of Q-PARAMS, and a witness for the record type will require the existence of a suitable set (here, of twenty rooms). And as before, a simple coercion operation between inclusion in C-PARAMS and Q-PARAMS can then account for any shift between truly non-referential and specific uses.

And in fact, we can apply exactly this approach to other quantified plurals. (Barwise and Cooper 1981) provide us with the notion of a *witness set* for a GQ, and show an equivalence (for monotone-increasing quantifiers) between a GQ holding of a verbal predicate and that predicate holding of the witness set. Examples such as (23)a can thus be analyzed—on its collective understanding—by taking the NP to denote its witness set directly (and for this to be a member of Q-PARAMS or C-PARAMS as the (non-)referentiality of its use demands):¹¹

(23)

Most students left

$$\left[\begin{array}{l} \text{q-params : } \left[\begin{array}{l} x : \text{Set}(Ind) \\ r : \text{most}(x, \text{student}) \end{array} \right] \\ \text{cont : left}(\text{q-params}.x) \end{array} \right]$$

here *most*(x, y) holds if x contains a majority of the y s

This approach is not sufficient, of course, for monotone-decreasing (e.g. ‘few students’) or non-monotone (‘exactly two students’) quantifiers: as (Barwise and Cooper 1981) point out, we must show not only that the verb predicate holds of the witness set, but that it holds of no other members of the restriction set. However, (Purver and Ginzburg 2004) propose an analysis of such QNPs as denoting *pairs* of reference set (the few students who left) and complement set (the students who didn’t), noting that this might also help

explain the phenomenon of complement set anaphora by providing suitable antecedents – and such an approach could equally be developed in the current approach.

3.5. Interim Evaluation

It is worth taking stock at this point: we have so far sketched a non-GQ-based analysis of NPs. At this point we stand to be accused of a number of possible crimes: we seem to have abandoned the Montogovian strategy of assigning NPs a well defined denotation since we break up the contribution of the NP into a C-PARAM, Q-PARAM or CONT contribution. And given this allegedly piecemeal approach how are we fulfilling our obligations to the RCH? With referential NPs, the content is identical to the C-PARAM contribution, apart from potentially certain presuppositional conditions (e.g. naming), which deserve to be factored out of content. With non-referential NPs, the situation is a bit trickier *vis à vis* the RCH—it can guide us less in that respect. Nonetheless, as we observed in section 3.2, given the actual fluidity of the C-PARAM/Q-PARAM divide, in many cases the Q-PARAM contribution can be ‘coerced’ to become a C-PARAM, in which case reprises give us some guidance. In other cases, we get evidence about the semantic contribution by abstracting away from sentential content (and getting additional evidence in this regard from anaphora and direct sluicing.).

4. Scope ambiguity

Scope ambiguities are among the most studied semantic indeterminacies. GQT provides a particularly simple analysis of these: the ambiguity is explained in terms of the distinct order of application of GQs.

We have already argued against one of the components of this account in section 3, pointing out that there is dialogue evidence against the higher order denotations GQT postulates for QNPs. A significant finding that has emerged from recent corpus studies of CRs in dialogue (see (Purver, Ginzburg, and Healey 2003; Rodríguez and Schlangen 2004; Rieser and Moore 2005)) is the complete absence of CRs that somehow relate to uncertainty regarding scope. One might draw a number of conclusions from this, but perhaps as significant is what emerges when one *constructs* CRs that relate to scopal

uncertainty: the ambiguity appears to be localized in an NP:

- (24) a. A: The boys kept a cat.
B: One cat for all the boys or different ones?
A: They each kept a cat.
- b. A: I'm going to give all you kids a present.
B: Will we need to share or do we each get something for ourselves?

Note that contrary to what underspecification theories (such as Minimal Recursion Semantics (Copestake et al. 2005) or Hole Semantics (Bos 1995)) would predict, this data indicates that the various scope possibilities *are* computed and can be localized with a single NP.¹² Disambiguation similarly proceeds by using distributive adverbs and adjectives ('each', 'the same/different cat' etc). GQT provides no help here since the meanings of QNPs are constant across distinct readings.

The alternative we sketch here is to distinguish between an independent use of an QNP and a *dependent* use. In the latter case, the NP contributes a function to Q-PARAMS, whose value on an antecedent fills the argument role associated with the NP. The resources of TTR are particularly well placed to explain this kind of ambiguity, as we shall see. We note that such uses have been argued to exist on a number of independent grounds so eliminating scope alternation as a mechanism has added attractions:

- **Functional readings in questions/answers:** ever since Engdahl first pointed out that interrogatives such as (25a) give rise to answers such as (25b) (see (Engdahl 1986)), it has been recognized that questions can specify *dependencies*. More controversially, some have argued that pair-list answers such as (25c) should be analyzed in similar terms (see (Ginzburg and Sag 2000)):

- (25) a. Which problem did each scientist solve?
b. The one his supervisor assigned him.
c. Dennett solved consciousness, Chomsky solved Plato's problem, Dawkins solved religion . . .

- **Dependent adjectives:** certain adjectives are intrinsically relational, requiring either a discourse antecedent or a QNP:

- (26) a. # (Requires a context establishing the existence of a prior book) Jo gave the girls a different book.
 b. (OK in neutral context) Each teacher gave the girls a different book.

- **Intrinsically narrow scope QNPs:** Certain QNPs like ‘at least N’ seem never to take ‘wide scope’, as exemplified in (27), which lacks a reading asserting that all linguists speak, say, English and German. Steedman (Steedman 1999) observes that this can be captured by assuming that such NPs are obligatorily dependent or at least can never serve as antecedents for dependent uses.

- (27) Every linguist speaks at least two languages.

Let us start with a simple example, as in (28a). We associate with this the content in (28b):

- (28) a. The boys each kept a cat.

$$\text{b. } \left[\begin{array}{l} \text{c-params : } \left[\begin{array}{l} s : \text{Set}(Ind) \\ r : \text{boy}'(s) \end{array} \right] \\ \text{q-params : } \left[\begin{array}{l} f : ([x : Ind]) \left[\begin{array}{l} z = f(x) : Ind \\ c1 : \text{cat}(z) \end{array} \right] \end{array} \right] \\ \text{cont: } \left[\begin{array}{l} r : ([x : Ind \\ c1 : \text{In}(\text{c-params}, s, x) \end{array} \right] \left[\begin{array}{l} c0 : \text{kept}(r, x, f(r, x)) \end{array} \right] \end{array} \right]$$

The content in (28), arises in a straightforward fashion, using rules like those postulated in section 3: ‘kept’ predicates of the content of ‘a cat’, ‘each’ acts as a distributive adverb on the VP, which then predicates of the set-valued subject.¹³ The Q-PARAMS values of the two NPs get ‘unioned’ into a joint record type, which is a constituent of the content.

$$\text{(29) a. kept a cat } \mapsto \left[\begin{array}{l} ([x : Ind]) \left[\begin{array}{l} \text{q-params : } \left[\begin{array}{l} f : ([x : Ind]) \left[\begin{array}{l} z = f(x) : Ind \\ c1 : \text{cat}(z) \end{array} \right] \end{array} \right] \\ \text{nucl : } [c0 : \text{kept}(x, f(x))] \end{array} \right]$$

$$\text{b. each} \mapsto (\mathbb{T}([\text{x} : \text{Ind}]_{\text{RType}}) (\text{z} : \text{Set}(\text{Ind})) (\text{r} : (\begin{bmatrix} \text{x} : \text{Ind} \\ \text{c1} : \text{In}(\text{z}, \text{x}) \end{bmatrix})) \mathbb{T}(\text{r}, \text{x}))$$

From this, it becomes clear in all but one respect how to specify the meaning of a dependent use of ‘a cat’. The one remaining issue, one which is typically abstracted away from, but which we cannot do so in TTR¹⁴—is how to specify x , the independent variable which appears in the content of the dependent NP? Cashing this out as a C-PARAM would involve relaying a message to the wrong audience, so to speak, since the antecedent must be resolved *intrasententially* and is constrained grammatically (e.g. by island constraints.). An option used in SDRT (see (Asher and Lascarides 2003) and within TTR (see (Cooper 2004)), which has been used for specification of pronoun antecedents is to use a metavariable for the antecedent and invoke some principle of resolution of DRSs or types. This is a viable possibility, which is combinatorially simple.

We believe though that a preferable solution, on methodological grounds,¹⁵ is to cash this out within the grammar for what it is—an unbounded dependency. One defines an additional field, call it ANT(ECEDENT)S, propagated in standard unbounded dependency fashion and terminating with a binder—a Q-PARAMS contributing NP. The dependency can also be terminated as the grammar requires, e.g. blocked from exiting relative or interrogative clauses.

(30) Dependent use of ‘a cat’:

$$\left[\begin{array}{l} \text{ants} : \left[\text{q-params} : \left[\text{x} : \text{Ind} \right] \right] \\ \text{q-params} : \left[\text{f} : \left(\left[\text{x} : \text{Ind} \right] \right) \left[\begin{array}{l} \text{z} = \text{f}(\text{x}) : \text{Ind} \\ \text{c1} : \text{cat}(\text{z}) \end{array} \right] \right] \\ \text{cont} = \text{f}(\text{ants.q-param.x}) : \text{Ind} \end{array} \right]$$

A similar analysis will work for (31a): the sole difference is that in such a case the distributive operator is implicit—(31b) suggests we do not want to build it into the NP meaning. A number of ways have been proposed how to incorporate distributivity into the combinatorial process, an issue we cannot resolve here. For discussion and a type logical account see (Winter 2006).

(31) a. Most villagers owned a cat.

- b. Most villagers own a cat and gathered in the square to listen to the visiting ghattologist.

Finally, we return to pronominal anaphora, which we believe can be analyzed by means of the mechanism of dependence sketched above. One cannot evade the fact that pronouns are, in principle, intrinsically context dependent, whatever the intentions of the speaker producing them, as illustrated by the examples in (32):

- (32) a. A: Everybody likes his sister. B: Whose sister? A: Everyone's.
 b. A: No woman thinks she is a genius. B: that who is a genius? A: Herself.

In contrast to the cases we discussed earlier, we do not wish anaphors such as these to be treated referentially. On the other hand, we need to make them CRifiable. We adopt a position that is somewhere in the middle between approaches that make a sharp distinction between bound variable and discourse anaphora (e.g. (Reinhart 1983; Chierchia 1995) and approaches in which all anaphora is bound variable (e.g. DRT, DPL, and their descendants.). In order to avoid necessary referentiality of all pronominal anaphora, we need to introduce an alternative meaning to the one introduced in section 3.3. And yet, the only difference that will obtain between the two meanings we propose is that the 'bound variable' meaning has a different contextual specification to the 'discourse anaphora' meaning. This will enable an underspecified entry for (English) pronouns, where the contextual parameter type is disjunctive. This would seem to accord with the intuition that typically pronouns have potentially two kinds of antecedents.

Formulating the bound variable meaning will require one slight modification to the treatment of the field ANTS introduced above: in order to be able to capture the constraint that *agreement* is required to hold with the antecedent, ANTS will be required to be of type *synsem*. This extends to provide a treatment of 'bound variable' anaphora, with the sole extra constraint that *agreement* is required to hold with the antecedent. We propose the following (33) as the meaning of 'bound variable' singular anaphora: here the contextual parameter is the antecedent utterance, restricted nonetheless to be a member of ANTS, hence an intrasentential antecedent:

$$(33) \left[\begin{array}{l} \left[\begin{array}{l} \left[\begin{array}{l} \text{q-params} : [x : Ind] \\ \text{a} : \left[\begin{array}{l} \text{cont} = \text{q-params.x} : Ind \\ \text{cat} = \text{NP} : SynCat \end{array} \right] \\ \text{ants} : \text{set}(SynSem) \\ \text{c1} : \text{Member}(\text{a}, \text{ants}) \end{array} \right] \\ \text{cat.agr} = \text{c-params.a.cat.agr} : SynAgrCat \\ \text{c1} : \text{gendernumber}(\text{cat.agr}) \\ \text{cont} = \text{c-params.a.cont} : Ind \end{array} \right] \end{array} \right] \end{array} \right]$$

For notational simplicity, we abbreviate the C-PARAMS type in (33) as (34a). Consequently, we can underspecify a pronoun, again omitting its agreement specification, as (34b):

$$(34) \text{ a. } \left[\begin{array}{l} \text{a} : \text{synsem} \\ \text{c1} : \text{IntrasentAnt}(\text{a}) \end{array} \right]$$

$$\text{ b. } \left[\begin{array}{l} \left[\begin{array}{l} \text{c-params} : \left[\begin{array}{l} \text{a} : \text{synsem} \\ \text{c1} : \text{IntrasentAnt}(\text{a}) \end{array} \right] \vee \left[\begin{array}{l} \text{m} : \text{LocProp} \\ \text{a} : \text{synsem} \\ \text{c1} : \text{DiscourseAnt}(\text{m}, \text{a}) \end{array} \right] \end{array} \right] \\ \text{cont} = \text{c-params.a.cont} : Ind \end{array} \right]$$

Given this, (35b) is a simplified representation of the meaning of (35a), where we use the underspecified meaning of ‘his’, which involves a C-PARAMS disjoining the ‘discourse’ and the ‘bound variable’ uses. The import of this meaning is to identify the content of ‘his’ either with ‘a thief’ (the sole possible member of ANTS in this case) or with a discourse antecedent.

(35) a. A thief abandoned his jemmy.

$$\text{ b. } \left[\begin{array}{l} \left[\begin{array}{l} \text{q-params} : \left[\begin{array}{l} x : Ind \\ r : \text{thief}(x) \end{array} \right] \\ \text{c-params} : \left[\begin{array}{l} \text{a} : \text{synsem} \\ \text{c1} : \text{IntrasentAnt}(\text{a}) \end{array} \right] \vee \left[\begin{array}{l} \text{m} : \text{LocProp} \\ \text{a} : \text{synsem} \\ \text{c1} : \text{DiscourseAnt}(\text{m}, \text{a}) \end{array} \right] \end{array} \right] \\ \text{cont} : \text{Abandon}(\text{q-params.x}, \text{jemmy-of}(\text{c-params.a.cont})) \end{array} \right]$$

5. Conclusion

Generalized quantifier theory in differing doses is the strategy of choice for analyzing QNPs. Since its inception by Montague, it has been a highly insightful approach but one whose cognitive status is in some doubt. The Reprise Content Hypothesis, which originates in (Purver and Ginzburg 2004), offers a concrete means of establishing this doubt: whereas data from CRification supports the existence of NPs denoting individuals and sets of individuals, of predicate-denoting verbs and common nouns, and even of function denoting NPs, there is no evidence whatever of talk about generalized quantifiers. Although GQ theory provides an elegant solution to the problem of scope ambiguity, once again what evidence dialogue provides for this phenomenon does not support an analysis in terms of scope alternation. In this respect underspecification theories are also unsupported since constructed examples of available CRs concerning scope ambiguities support an approach where ambiguities are resolved and disjoined.

We have sketched an analysis of NP meaning in dialogue using the framework of Type Theory with Records. On this analysis, NPs be they referential or non-referential, denote individuals, but contribute either to the repository of *contextual* or *quantificational* parameters. Scope is handled via dependency. We have shown that this analysis yields a simple picture of grounding and CRification and seems to allow for a theory of intra and intersentential anaphora with minimal additional apparatus, as well as allowing for an account of intensional verbs. We hope to scale up this sketch in future work.

Notes

1. It is quite impertinent on our part to call this a ‘tactic’ given Montague’s brilliant independent motivation for this denotation in terms of intensional verbs like ‘seek’. Nonetheless, our account will be able to provide a simple account of such verbs, building on a proposal in (Cooper 2005b). See section 3.1.
2. For simplicity we identify propositions here with record types, as in (Cooper 2005b) rather than with records that include a record type and a situation, as in (Ginzburg fcmg). The latter *Austinian* strategy will, however, receive some support from the role situations play as the ‘hosts’ of witnesses for anaphora, as discussed in section 3.3.
3. Example (3a,b), and many others following, are taken from the British National Corpus (Aston and Burnard 1998).
4. Ironically, this leaves open the issue of what to do with *referential* arguments of intensional verbs, but we cannot enter into this here.
5. In fact, there *are* reasons for doubt, as we will see shortly, if we take the addressee’s

perspective.

6. (Groenendijk 1998; Asher and Lascarides 2003) abstract away from metacommunication and, for the most part, disagreement.
7. See e.g. (Cooper 2004), p. 26.
8. The data here are quite subtle. Consider the following clearly felicitous anaphor:
 - (i) A: Did a man with a limp pass by here a few minutes ago?
B: Was he squat with a red beard?

This would seem to be a *specific* indefinite, whose existence is not at issue, and would constitute a contextual parameter, as discussed in section 3.2.
Similarly, in (ii), based on examples due to (Dekker 1997), anaphora is possible despite the rejection of the assertion because B has referential access to the fake priest:
 - (ii) A: A priest was looking for you. B: He's not a priest just an actor and I doubt he wanted to see me.

Compare this with the following somewhat similar cases: (iii) seems infelicitous, though (iii') seems acceptable, but involves modal subordination—(iv) is felicitous only to the extent it seems like B has perhaps grudgingly changed his tune after his initial utterance.
 - (iii) A: Mike, we are getting reports of an attempted escape at Wandsworth prison. Did you see anyone wearing a striped jump suit running near the park around 9:30? Mike: # Was he wearing a hat on as well?
 - (iii') Would he have been wearing a hat?
 - (iv) A: A priest was looking for you. B: No way—priests don't come looking for a grubby atheist like me. # What did he want?
9. This ranges over {mascsg,femsg,neutsg }, with potential crosslinguistic differences.
10. Or sums, groups etc, as in the Link-inspired tradition.
11. See, for instance, the possible referential reading given for (10c) above, or examples like:
 - (i) A: Most folks were upset by the decision.
B: Most folks?
A: Yeah well like Bianca, Amanda, Luigi, and me. That's what? About two thirds of the company?
12. Admittedly, there are only two scopings possible here. But there again, it is reasonable to hypothesize that in spoken language at least, there are rarely more possibilities than this.
13. This treatment of 'each' derives from (Link 1983), via (Winter 2006).
14. There being no tolerance for free variables.
15. For a start, it is preferable to remain on the object level in so far as possible. It is not clear why pronouns should give require such a move, as opposed to various other context dependent elements.

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