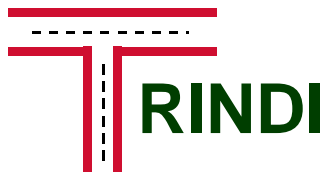

Focus-ground articulation and parallelism in a dynamic model of dialogue

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Chapter 1

Introduction

Human dialogue participants have very good intuitions about how utterances should be realised in order for a dialogue to be coherent. These intuitions cover both how much needs to be said and how what is actually said is realised in terms of intonation and word order. Consider the following example, based on the SRI Autoroute dialogues. S indicates the system and U the user.

- (1) S1: Welcome to the Route Planning Service. How can I help you?
U1: A route please.
S2: Where would you like to start your journey?

We note that the user replies to the systems initial question *How can I help you?* with an elliptical utterance *A route*. The user could have expressed this in various ways (*You can help me by giving me a route, by giving me a route, ...*) but the short answer is sufficient here to prompt the system to carry on the dialogue with the question in S2. How should this question be realised prosodically? There are several options, some of which are shown in (2). Consider the placement of the nuclear accent, marked here with SMALL CAPS.

- (2) a. Where would you like to start your JOURNEY?
b. Where would you like to START your journey?

Most people agree that (b) is the most suitable intonation contour for this question in this context. But what is it that makes this intonation appropriate here or U1's elliptical answer earlier felicitous? More specifically, what determines when elliptical utterances can be used and when a particular intonation is used?¹ The answer, we think, is that human speakers choose a form that (i) fits in with the model they have of the interlocutor's current information state and (ii) achieves the intended effect. In English the informative part of an utterance, i.e. the part that the speaker thinks the hearer should update his/her information state with,

¹We are here disregarding many other issues, such as the inferences that allow the system to go from *route* to *start a journey*.

must contain an accent (often referred to as the *focus* accent), whereas background material is generally deaccented or left out altogether. We will refer to this systematic use of intonation in English as the *focus-ground articulation* of the utterance.²

There has been considerable work on phonological, syntactic and semantic aspects of focus and ground, but not so much work has been done in the context of dialogue systems.³ We believe that the focus-ground articulation is important both for interpretation (knowing how a dialogue participant's information state should be updated) and for generation (choosing the right intonation, deciding what can be left out). In this report we want to look at how we can integrate some focus-ground articulation effects in a dialogue system with dynamic information states as outlined in Cooper et al (1999). We believe that by taking into account focus-ground articulation, we will be able to produce more natural sounding dialogue in task-oriented dialogue systems. The focus-ground articulation is particularly important for generation since utterances with inappropriate intonation often lead to misunderstanding and can actually be off-putting, leading to a breakdown in the communication.

We will begin with an overview of some intonational phenomena that any theory needs to account for. In chapter 3 we review some proposals for the semantic analysis of focus-ground. Chapter 4 reviews various theories relating focus to information states, and in chapter 5, we develop an account of focus-ground articulation in terms of dynamic information states. We propose an analysis of yes/no-questions in chapter 6 and extend this to wh-questions in chapter 7.

²There is a long tradition of research on these matters and different research traditions tend to use different terms. See Vallduví & Engdahl for an overview of different terminologies used.

³But see Nakatani & Chu-Carroll 2000.

Chapter 2

Intonation, accents and focus-ground articulation

We saw in example (2) that the placement of the sentence accent is an important cue to the focus-ground articulation of an utterance in English.¹ However, intonation is not only used to signal focus-ground articulation, as many researchers have pointed out (e.g. Bolinger 1965, Ladd 1980, 1996, Pierrehumbert and Hirschberg 1990). Lambrecht and Michaelis (1998:480) make the point that distinct intonational contours also serve to express other things such as speaker attitude (surprise, politeness, boredom etc), utterance type (e.g. exclamation, query, assertion), propositional attitude (belief, uncertainty, etc.) and other connotations. Although it may be difficult to isolate these intonational functions from the function of signalling the information structure (the focus-ground articulation) of the utterance, we will assume that it is possible to distinguish them. In this report we will only be concerned with the placement of sentence accents that indicate focus-ground articulation.

2.1 Accent placement and parallelism

Sometimes the accent placement constrains the focus-ground articulation so that only one interpretation is possible, as shown for instance in (3) where the main accent falls on the part of the utterance in SMALL CAPS.

- (3) a. John RENTED a car, he didn't BUY one.
b. John flew TO London, not FROM London.

In these examples, it seems plausible to assume that only the accented material is focal, i.e. providing new information. The rest of the utterance is ground, i.e. reflects information that is assumed to be shared. That RENTED in (3a) is focal is confirmed by the fact that

¹Other languages use word order, morphology or a combination of word order and prosody for focus-ground articulation. See Vallduví and Engdahl (1996) for an overview.

it can be contrasted by an appropriate parallel item in the continuation BUY. Note that these continuations must be parallel. If they are not, the discourse is perceived as incoherent (marked with #).

- (4) a. John RENTED a car, #he didn't rent a BOAT.
- b. John flew TO London, #he didn't take the TRAIN.

It's common to refer to the focus-ground articulation in (3) as *narrow focus* on a word or constituent, in this case on the verb in (a) and on the preposition in (b). Narrow focus is often associated with a notion of contrast and sometimes the term *contrastive focus* is used.

2.2 Underdetermined focus-ground articulation and focus projection

In the examples in (3), the only possible construal involves narrow focus. However, the placement of the sentence accent often does not determine the focus-ground articulation of an utterance uniquely. English utterances with the main accent on the final constituent can be used to make two distinct contributions.

- (5) a. John flew to LONDON, not to PARIS.
- b. John flew to LONDON, he didn't stay HOME.
- c. John flew to LONDON, #he didn't SAIL to London.

The follow-on in (5a) suggests that (to) LONDON is a narrow focus. But the accent on LONDON is also compatible with a contrasting VP, as in (5b). This phenomenon is known as *wide* or *broad focus* or *focus projection*.²

²The phenomenon of focus projection also arises inside phrases, e.g. NPs as Chomsky's and Jackendoff's example in (i) shows. This can be interpreted as having focus over any of the phrases (ia)-(id), corresponding to the follow-ups in (iia)-(iid).

- (i) Was it an ex-convict with a red SHIRT that he was warned to look out for?
 - (ii) a. (an) ex-convict with a red shirt
 - b. with a red shirt
 - c. a red shirt
 - d. shirt
- (iii) a. No, it was an AUTOMOBILE salesman
- b. No, it was an ex-convict wearing DUNGAREES
- c. No, it was an ex-convict with a CARNATION
- d. No, it was an ex-convict with a red TIE

There is an extensive literature on focus projection, see Selkirk (1984).

This means that the first part of the utterances in (5) can be understood in two distinct ways. Either it is a narrow object focus utterance or a wide VP focus utterance. It cannot be understood as a narrow V focus utterance, as seen by the infelicitous continuation in (5c). If the utterance thus is ambiguous with respect to focus projection, it is not possible to determine which is the intended focus-ground articulation solely by the form, but this depends on the context, or more precisely on the information states of the dialogue participants at the time the question is asked.

A maximal case of focus projection involves the whole utterance as shown in (6), which can be referred to as an *all-focus* utterance.

- (6) a. What happened?
b. He flew to LONDON.

If there is no object in the verb phrase that can carry the sentence accent, focus projection in English requires the subject to be stressed:

- (7) a. What happened?
b. My SCREEN died.
c. #My screen DIED.

Examples where focus projection is possible thus show that the form of an utterance underdetermines its focus-ground articulation. Or to put it slightly differently, one and the same form may be associated with several distinct focus-ground articulations. In this way utterances with a sentence final accent can be considered *ambiguous* just as utterances containing a polysemous word will be ambiguous.

2.3 Distinguishing accents

So far we have only talked about a single accent, the main sentence accent, which is associated with focal material. However, English also uses another accent which is intonationally distinct from the focus accent. Consider the prosodic realisation of (8b).

- (8) a. Where are these companies located?
b. **DAF** is in BELGIUM, **VW** is in GERMANY, etc.

The focus accent falls on the final word in the utterance. However, the first words, marked in **bold**, are also accented with what may be described as a wavy tune. Jackendoff (1972) refers to the focus accent as the A-accent and to the other accent as the B-accent. In Pierrehumbert's (1980) phonology of intonation, A-accent corresponds to a simplex high pitch accent (H*), generally followed by a falling boundary tone. Jackendoff's B-accent corresponds to a complex

fall-rise pitch accent (L+H*). There is by now quite a rich literature on the contrasting uses of the two accents but it is beyond the scope of this report to pursue the matter here.³

³See e.g. Vallduví 1992, Lambrecht & Michaelis 1998, Hendriks 1998, Roberts 1996, Büring 1997. Not all languages use distinct accents for focus and link function. In German, the link accent is often realised as the normal focus accent (Fery 1993). In Swedish, realisation of the link accent with the characteristic wavy tune is optional, though it tends to be used in so-called contrastive dislocations as in " **Anna** hon sover" ("Anna she is sleeping"). See Beaver (in prep) for an interesting attempt to investigate the different meanings of the accents using prosodically annotated corpora.

Chapter 3

Representing focus-ground

There exist by now a number of proposals for how focus-ground should be represented. The existence of so many proposals follows to a large extent from the fact that different researchers have different purposes. In this chapter, we will give an overview of the way focus has been used in recent linguistic literature, concentrating on semantic analyses of focus.

3.1 Phonetic, phonological and syntactic representations of focus

Phoneticians have mainly been interested in identifying and describing the actual phonetic patterns that are used for focus (e.g. Bruce 1977, Pierrehumbert 1980). The term ‘focus’ is used to classify certain intonation contours. Phonologists have mainly looked at the relation between intonational phrasing and focus-ground (Gussenhoven 1983, Selkirk 1984, Ladd 1983, 1996). For them it is useful to have some feature, e.g. [+FOC] whose presence or absence triggers the appropriate accenting and phrasing.

Syntacticians working within the generative tradition have concentrated on deriving possible surface orders, with appropriate intonation. Chomsky (1971) and Jackendoff (1972) were the first to use [+FOC] as a syntactic feature, i.e. as a categorial feature of the syntactic structure.

Linguists with a more functional orientation such as Bolinger (1989), Halliday (1967, 1985), Sgall and Hajicova (1977-78) and Dik (1989) have concentrated on making the connection between the form used (accented or unaccented) and its pragmatic function such as picking out the topic or comment of an utterance.

3.2 Semantic representations

3.2.1 Jackendoff: structured meanings

Jackendoff (1972) starts from Chomsky's (1970) analysis of focus of a sentence as being determined by the surface structure, as a phrase containing the main stress of the sentence. He formulates a *focus assignment rule* which derives a semantic representation of the focus of a sentence.

Focus assignment derives two objects from the semantic representation SR of sentence S : *Focus*, the semantic material associated with the focussed surface constituent, and a one-place predicate $Presupp_s(x)$, formed by replacing *Focus* with a variable x in SR . From the predicate the presuppositional set $\lambda x Presupp_s(x)$, the set of values which, when substituted for x in $Presupp_s(x)$ yields a true proposition, is constructed.

From these objects, a presupposition is derived, roughly expressed in (9):

$$(9) \quad \lambda x Presupp_s(x) \left\{ \begin{array}{l} \text{is a coherent set} \\ \text{is well-defined} \\ \text{is amenable to discussion} \\ \text{is under discussion} \end{array} \right\} \text{ in the present discourse .}$$

Jackendoff argues that $\lambda x Presupp_s(x)$ is a more appropriate presupposition than the corresponding existentially quantified proposition $\exists x Presupp_s(x)$, since $\lambda x Presupp_s(x)$ can be the empty set, as in "NOBODY likes Bill".

The focus assignment rule is given in (10).

- (10) In a sentence S , with otherwise determined semantic representation SR , the semantic material associated with the surface structure nodes dominated by [the constituent with focal accent] is the *Focus* of S . Substitute an appropriate semantic variable x for *Focus* in SR to form the function $Presupp_s(x)$. The presupposition is then formed as in (9) (...).

For a declarative sentence, the asserted content is $Focus \in \lambda x Presupp_s(x)$. For example, the sentence (11a) corresponds to the presupposition set (11b), and thus presupposes that it is under discussion. The asserted proposition is (11c).

- (11) a. John LIKES Bill
b. λx (the attitude of John toward Bill is x)
c. $like \in \lambda x$ (the attitude of John toward Bill is x)

Rooth (1995) reviews two alternative accounts of the semantic representation of focus. He calls the approach proposed by Jackendoff the *structured meaning* approach, where 'focus has the effect of structuring the propositions denoted by sentences: the focus-influenced semantic value of a clause with single focus is a pair consisting of (i) a property obtained by abstracting the focused position, and (ii) the semantics of the focused phrase'. The original proposition is equivalent to an application of (i) on (ii).

As an example, (12a) has the focus-influenced semantics (13a), while (12b) has the focus-influenced semantics (13b). The “original” (focus-insensitive) semantics is (13c)

(12) a. John introduced [_F Bill] to Sue

b. John introduced Bill to [_F Sue]

(13) a. $\langle [\lambda x \text{introduce}(j, x, s)], \mathbf{b} \rangle$

b. $\langle [\lambda y \text{introduce}(j, \mathbf{b}, y)], \mathbf{s} \rangle$

c. $\text{introduce}(j, \mathbf{b}, \mathbf{s})$

3.2.2 Rooth: alternative semantics

The other approach reviewed by Rooth (1995), and the one he himself advocates, is the *alternative semantics* approach. According to Rooth, the general function of focus is to evoke alternatives. The basic idea comes from the view of the meaning of a question as the set of possible answers. For example, given the question “Does Ede want tea or coffee”, the answer “Ede wants [_F COFFEE]” indicates that propositions of the form “Ede wants x” are alternatives to the actual answer.

Rooth represents the *focus semantic value* of a sentence ϕ as $\llbracket \phi \rrbracket^f$, as in (14).

(14) a. $\llbracket \text{Ede wants [coffee]}_F \rrbracket^f =$ the set of propositions of the form “Ede wants y ”

b. $\llbracket [\text{Ede}]_F \text{ wants coffee} \rrbracket^f =$ the set of propositions of the form “ y wants coffee”

Rooth calls $\llbracket \phi \rrbracket^f$ the *alternative set* of ϕ and notes that focus seems “to evoke the alternative set in a presuppositional way”. To make this more precise, he defines the focus interpretation operator “ \sim ”. ($\llbracket \phi \rrbracket^o$ is the ordinary semantic value of ϕ .)

(15) Where ϕ is a syntactic phrase and C is a syntactically covert semantic variable, $\phi \sim C$ introduces the presupposition that C is a subset of $\llbracket \phi \rrbracket^f$ containing $\llbracket \phi \rrbracket^o$ and at least one other element.

The value of the variable C is contextually determined; for example, the question “Does Ede want tea or coffee” provides the alternative set $C = \{\text{Ede wants coffee, Ede wants tea}\}$. The coupling of C to a contextually available set is, according to Rooth, “simply a matter of anaphora resolution”.

3.2.3 The relation between structured meanings and alternative semantics

On the basis of Rooth’s review of the two basic approaches to the semantic representation of focus, it seems possible to relate the two approaches formally in a way that will make the differences and similarities clearer. One way of doing this is to formulate the semantic objects in the alternative semantics (AS) approach in terms of the background (B) and focus (F) components of the structured meaning (SM) approach.

The first thing to note is that Rooth’s alternative set seems to play the same role as Jackendoff’s presupposition set, i.e. the semantic representation of the non-focussed part of a sentence. We will illustrate this with the example sentence $\phi = \text{“Ede wants [coffee]}_F\text{”}$. For this example, the SM representation is $\langle B, F \rangle$, i.e. (16a).

- (16) a. $\langle \lambda x \text{ want}(\text{ede}, x), \text{coffee} \rangle$
- b. $B = \lambda x \text{ Presupps}_s(x) = \lambda x \text{ want}(\text{ede}, x)$
- c. $F = \text{coffee}$

Now, the AS alternative set is the set of all propositions of the form **want(ede, x)** which can be construed as in (17), where we assume that the “possible answers” in Rooth’s approach are constrained by the rule that the object replacing the focus has the same type as the focus, symbolized as $T(F)$.

$$(17) \quad \llbracket \phi \rrbracket^f = \{B(y) \mid y \in T(F)\}$$

Presumably, $\llbracket \phi \rrbracket^f$ would contain e.g. **want(ede, milk)**, **want(ede, water)** and so on (given that T is something like “drinkable substances”) or even **want(ede, cottage)**, **want(ede, socks)**, **want(ede, happiness)** and so on (given a wider type T).

One difference between the theories regards what objects are the carriers of presuppositions. According to SM, the presupposition of the sentence $\phi = \text{“Ede wants [coffee]}_F\text{”}$ in the example is (18a). According to Rooth’s formulation of AS, however, it is not ϕ but $\phi \sim C$ which introduces the presupposition in (18b) according to the definition of the \sim operator given in (14).

- (18) a. B , i.e. $\lambda x \text{ want}(\text{ede}, x)$, is under discussion
- b. C is a subset of $\llbracket \phi \rrbracket^f$ containing $\llbracket \phi \rrbracket^o$, i.e. $\text{want}(\text{ede}, x)$, and at least one other element.

Possibly, one could say that the presupposition introduced by ϕ in Root’s theory would be something like (19). Note that this formulation leaves open the issue of whether such a C is really available; in Root’s formulation, the presence of C seems to be required, or the “anaphora resolution” strategy would not work.

- (19) C is under consideration, where C is a subset of $\llbracket \phi \rrbracket^f$ containing $\llbracket \phi \rrbracket^o$ and at least one other element.

As it happens, the comparison given above suggests a way to bridge a part of the gap between the approaches by amending the SM approach with a contextually given set A of alternatives to F . In the above example, A would be {coffee, tea} and the relation between A , B and C would be as in (20a) and the semi-Root-style presupposition could be stated as (20b).

- (20) a. $C = \{B(x) \mid x \in A\}$
 b. A is under consideration, where A is a subset of B containing F and at least one other element

3.2.4 Gawron

Gawron (1995) uses Root’s notion of “alternatives under consideration” to analyse the dynamics of domains of quantification. He formulates a variant of Dynamic Logic called Restriction Logic (RL) and provides a formal account of how quantificational phrases incrementally introduce restrictions on variables. In the RL formalism, each noun phrase is split into a restrictor element and an operator. The representation of (21a) is (21b).

- (21) a. A boy walks
 b. $y \mid \text{boy}(y); \exists y[\text{walk}(y)]$

An approximate reading of $x \mid \phi$ is “change the alternatives under consideration to those in which x satisfies ϕ ”. Gawron uses Beaver’s (1992) presupposition operator δ to represent the contribution of focus to the semantics of a sentence. The presupposition operator works as a “test” operator which tests whether the information of its operand is already available in the context, without affecting the information state. For example, The RL representation of (22a) is (22b)

- (22) a. “[Tom]_F loves Jane”
 b. $\delta(x \mid \text{love}(x, j)); \text{love}(t, j)$

The first part of (22b) tests whether the alternatives under consideration in the discourse constrain x to be an entity which loves Jane. If it is, the second part will update the information state to contain the information that Tom loves Jane; if not, the resulting state will be undefined. However, Gawron indicates that it is possible to accommodate restrictions to fulfill the presupposition.

Chapter 4

Relating focus and context

As seen in Chapter 3, both the ‘structured meanings’ and the ‘alternative semantics’ approaches give an account of the presupposition generated by focus, which can be used as a basis for relating focus to the context. That is, the relation between focus and context can be separated into (i) the relation between focus and presupposition and (ii) the relation between presupposition and context. However, the researchers often don’t go much further towards specifying how contextual knowledge is represented. If you are developing a dialogue system you also need a theory of how a particular focus-ground articulation reflects a particular information state and how a particular information state makes a certain prosodic realisation appropriate. In this chapter we will look at some proposals concerning the relation between focus and context in the literature.

4.1 Lambrecht and Michaelis

Lambrecht and Michaelis (1998) deal with the formal and pragmatic principles which govern the placement of sentence accent in English information questions. The analysis is cast within Lambrecht’s (1994) theory of information structure. Some of their central notions are summarised in (23). (cf Lambrecht and Michaelis 1998:493f.)

- (23) a. *Pragmatic presupposition*: The set of propositions lexico-grammatically evoked in a sentence which the speaker assumes the hearer already knows or believes or is ready to take for granted ...

Pragmatic assertion: The proposition expressed by a sentence which the hearer is expected to know or believe or take for granted as the result of hearing the sentence uttered

Focus: The component of a pragmatically structured proposition whereby the assertion differs from the presupposition

Topic: A referent which a proposition is construed to be about in a given discourse situation ...

Lambrecht and Michaelis thus take the focus to be that part of the utterance that isn't already shared. Given this terminology, they define the overall pragmatic function of sentence accents as in (24) (Lambrecht and Michaelis 1998:498).

- (24) *The discourse function of sentence accents*: A sentence accent indicates an instruction from the speaker to the hearer to establish a pragmatic relation between a denotatum and a proposition. An utterance must have at least one sentence accent to be informative.

By pragmatic relation they understand either a focus relation or a topic relation. Although Lambrecht and Michaelis define focus and topic in terms that refer to what they call 'knowledge states', the actual goal of the account seems to be just to identify focus and topic in individual utterances. The authors do not attempt to spell out how the information states of the discourse participants are changed by the utterances. This appears to be taken for granted in this theoretically oriented analysis. But in a dialogue system where you want to keep track of the changes in the information states, it is necessary to go beyond identifying focus and ground and actually look at the effects in the information states.

4.2 Pulman

Pulman (1997) builds on work by Jacobs (1984), von Stechow (1989) and Krifka (1991, 1992) who use the structured meaning approach. Pulman uses higher order unification, an approach developed for ellipsis resolution by Dalrymple, Shieber and Pereira (1991), which allows for a flexible way of abstracting over the focus and applying this to background, without requiring the focus to be a constituent.

Pulman assumes that an utterance with a certain intonation, i.e. a certain focus-ground articulation, is felicitous just in case there is a contextually salient proposition which is structured in a similar way. Following Krifka (1991:339), he assumes that the focus-ground articulation is interpreted by a tacit 'assert' operator.

- (25) $\text{assert}(F,S) \Leftrightarrow S$
 if
 $B(F)=S$
 $\& \text{context}(C)$
 $\& P(A) = C$
 $\& \text{parallel}(B\bullet F, P\bullet A)$

‘asserting S with focus F is equivalent to S if S can be structured into a background B and a focus F ; where some proposition C is salient, and can also be structured into components P and A such that P and B , and A and F , are parallel.’
 (Pulman 1997: 94)

A simple example illustrating the approach is the following:

- (26) Did John kiss Sue?
 John kissed MARY

The contextually salient proposition C is $\text{kiss}(\text{john},\text{sue})$, and focus F of is $S \lambda P.P(\text{mary})$. The equivalence $\text{assert}(F,S) \Leftrightarrow S$ holds if the following higher order equations can be solved:

- (27) $B(\lambda P.P(\text{mary})) = \text{kiss}(\text{john},\text{mary})$
 $P(A) = \text{kiss}(\text{john},\text{sue})$

The desired solution is that $B = P = \lambda O.O(\lambda x.\text{kiss}(\text{john},x))$, with $A = \lambda Q.Q(s)$, and that the relevant parallel condition holds (where the meaning of ‘ $\text{parallel}(B\bullet F, P\bullet A)$ ’ is that B and P are “the same sort of thing”, and that this is also the case for F and A).

One advantage of using higher order unification is that it is independent of order and can be used for generation as well. In the final section, Pulman sketches how the system could be adapted for speech synthesis.

As shown, Pulman gives a formal characterisation of notions like focus and parallelism which relies on a notion of context. However he does not spell out for instance what it means for a proposition to be salient in the context.

4.3 van Kuppevelt

van Kuppevelt (1995) presents a theory which uses *topicality* as the main organising principle of discourse structure, and according to which topic is a context-dependent, question-based and dynamic notion. Topic and comment are characterised in the following way:

- (28) *Topic*: A discourse unit U — a sentence or a larger part of a discourse — has the property of being, in some sense, directed at a selected set of discourse entities (a set of persons, objects, places, times, reasons, consequences, actions, events or some other set). This selected set of entities in focus of attention is what U is about and is called the topic of U

Comment: That which is newly asserted of the topic of U

van Kuppevelt assumes a close relationship between topic and comment, on the one hand, and (explicit and implicit) questions on the other. The topic part of a sentence is related to a question, whereas the comment part contains the answer. This is captured by van Kuppevelt's basic assumption as follows:

- (29) *Basic assumption*: Every contextually induced explicit or implicit (sub)question Q_p that is answered in discourse constitutes a (sub)topic T_p . T_p is that which is being questioned; a set of discourse entities from which one is selected as an answer to Q_p . Comment C_p is provided by this answer and names or specifies the entity asked for

The inclusion of both explicit and implicit questions means that no actual question need be present in the dialogue or text, and that both situations — question present and question not present — can be treated on a par. An implicit question is assumed to be one “which the speaker anticipates will arise in the listeners mind on interpreting preceding utterance”. The term *contextual induction* is used to indicate that a certain unit of discourse brings about a new (sub)question, and hence a new (sub)topic. A unit of discourse having this function is called a *feeder*, and is often topicless. In the following example, A's first utterance, which is the opening sentence of the dialogue, acts as a feeder since it causes, or contextually induces, B's (explicit) question:

- (30) *Feeder*: A: Yesterday evening a bomb exploded near the Houses of Parliament

Question: B: Who claimed the attack?

Answer: A well-known foreign pressure group which changed its tactics claimed the attack

In a discourse, a topic-constituting question is then simply an explicit or implicit question raised as the direct result of a feeder.

A subtopic-constituting subquestion is hierarchically subordinate to some other question, and is essentially seen as the result of an unsatisfactory answer to that question or some other intermediate subquestion. van Kuppevelt formulates two principles which govern the behaviour of subquestions. The first is the *Principle of Recency*, which determines the order of subquestions in a given discourse. If a hierarchy of a discourse topics is seen as a tree

with the initial feeder as the root node, the Principle of Recency seems to imply a depth-first strategy of topic development.

The second principle is the *Dynamic Principle of Topic Termination* which concerns the lifespan of subtopics and topics. van Kuppevelt notes that even if a new (sub)topic is introduced, the old (sub)topic does not necessarily lose its actuality (the notion of topic discussed here is not limited to sentences but extends to discourse level). How to decide when a topic is terminated? The principle is formulated as follows:

- (31) *Dynamic Principle of Topic Termination:* If an explicit or implicit (sub)question Q_p is answered satisfactorily, the questioning process associated with it comes to an end. As a consequence, topic T_p loses its actuality in discourse

This principle implies that as long as one of the conversation participants, or the writer/speaker in the case of a written or spoken monologue, is not satisfied with a certain answer (as indicated by more questions or answers to implicit questions), the topic is still valid.

The termination of a (sub)topic results either in the continuation of a, non-terminated, topic higher up in the topic hierarchy, or in a new feeder. According to van Kuppevelt's theory, then, it is not possible to return to some subtopic after it has been terminated and the participants have engaged in a new, non-subordinated, topic. If such a return to a terminated subtopic, say Q_k , nevertheless does occur, this can only be if the preceding answer, $A_k - 1$, functioned as a new feeder. In principle, then, every answer in a discourse can function as a feeder. Whether a given answer, not immediately followed by an explicit or implicit question, actually is to be seen as a feeder presumably cannot be determined until the end of the entire discourse, since feeder-hood is only determined at the moment an answer/feeder is followed by a question (otherwise the Principle of Recency would be violated). van Kuppevelt also formulates a Subordination Test for determining topic hierarchies. Put simply, Q_q is a subquestion of a preceding question Q_p if it is inappropriate to utter it if Q_p has been closed. Otherwise, if Q_q is appropriately uttered in the same circumstances, Q_q is a topic-constituting question. Question closure is tested by the insertion a sentence like *I now understand Q_p* .

4.4 Roberts

Roberts (1996) follows von Stechow (1989) and uses an alternative semantics approach combined with possible worlds semantics for propositions and questions. A question denotes a set of alternative answers called the *Q-alternative set* which is essentially the same as Root's alternative set.

$$(32) \quad |? \alpha| = \text{Q-alt}(\alpha)$$

Roberts presents a "formal theory of information structure", where an information structure for a dialogue D is a tuple as in (33):

$$(33) \quad \mathbf{InfoStr}_D = \langle M, Q, A, \leq, Acc, CG, QUD \rangle$$

M is the set of setup and payoff moves in the discourse, divided into setup moves (questions; Q) and payoff moves (answers, or equivalently, propositions; A). M is totally ordered according to time of utterance by \leq , and $Acc \subseteq M$ is the set of accepted moves. CG is a function from M to the set of propositions giving the common ground of D just prior to the utterance of any move in M . The common ground is monotonically increasing (i.e. nothing can be removed) and consists of all accepted propositions and a complete history of information structures (for all preceding moves m , a set of propositions describing **InfoStr** $_D$ at the stage when m was made). QUD is a stack of questions-under-discussion realized as a function which for any move $m \in M$ gives the set of all accepted but unanswered questions just prior to m , totally ordered by \leq .

The relation between questions, answers and focus in Roberts' theory is formulated in three definitions. Firstly, the *focus alternative set*, very similar to Root's "focus semantic value", is defined in (34a). The notion of question-answer *congruence* is given in (34b), and the *presupposition of prosodic focus* in (34c).

- (34) a. The **focus alternative set** corresponding to a constituent β , $\|\beta\|$, is the set of all interpretations obtained by replacing all the F-marked (focused) constituents in β with variables, and then interpreting the result relative to each member of the set of all assignment functions which vary at most in the values they assign to those variables.
- b. Move β is **congruent** to a question $?\alpha$ iff its focal alternatives $\|\beta\|$ are the Q-alternatives determined by $?\alpha$, i.e. iff $\|\beta\| = \text{Q-alt}(\alpha)$.
- c. **Presupposition of prosodic focus in an utterance**
 β : β is congruent to the question under discussion at the time of utterance.

Roberts' theory aims mainly at delimiting the set of well-formed dialogues according to a set of game rules, but notes that

...once the rules of a game are set, we often develop strategies for more efficient play. In the case of an assertion, if the prosody presupposes the type of question it addresses, then it might not be necessary to actually ask the question explicitly, especially if the relevance of the question to the ongoing strategy of inquiry is clear. Hence, hearers can use the presuppositions of English prosodic structure to *accommodate* [our emphasis] portions of the information structure assumed by the speaker.

4.5 Vallduví

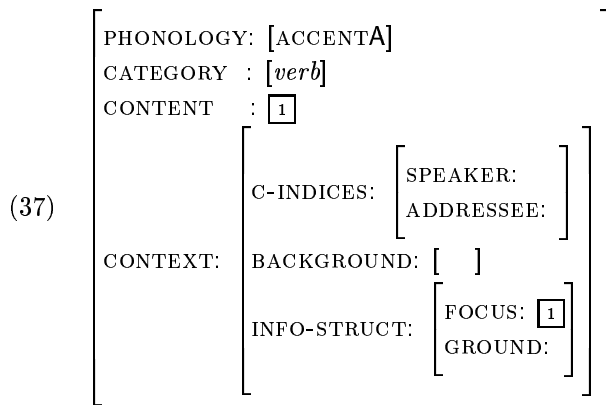
Vallduví (1992, 1994) develops a theory of *information packaging* and provides a semantics for focus-ground in terms of update instructions. Different focus-ground articulations

are viewed as different *instructions* for information update. From a dynamic perspective, these instruction-types can be viewed as transition-types from an input information state to an output information state or as different ways of effecting information update. Vallduví views information states as collections of file cards (cf Heim 1983) and formulates the update instructions with respect to these file cards. Two instruction types are given in (35).

- (35) a. *All focus utterance* instruction to the hearer to add the information in the utterance to his/her information state
- b. *Link-focus*: instruction to go to a particular address and add the focus there

Engdahl and Vallduví (1996) show how this instruction based approach to focus-ground can be expressed in a constraint-based framework such as Head-driven Phrase Structure Grammar (HPSG). They exploit structure sharing in the HPSG sign to express the mutual constraining relation that holds between intonation and information structure in English: If a word is pronounced with focus accent, it must be interpreted as (part of) focus and in order to convey that some part of the utterance is focal, the speaker has to use the appropriate accent. For instance, the sign corresponding to the accented verb used in (36b), would contain the information in (37.)

- (36) a. Do you want to take the TRAIN to Paris?
- b. No, I want to FLY.



A sign in HPSG contains an attribute CONTEXT where relevant information about the speech situation is recorded, such as who the speaker and the addressee are (as values of the attribute C(ONTEXTUAL)-INDICES as well as facts that may be relevant for anaphora resolution etc (represented as sets of states of affairs in BACKGROUND). Engdahl and Vallduví (1996) added the feature INFO-STRUCT to CONTEXT as a convenient hook for the focus-ground articulation of the utterance. The intended role of this feature was that a word whose CONTENT is structure shared with the value of FOCUS can only be used if the speaker intends that the addressee should add this content to his/her information state. However, this intention is not explicit

in (37) as it does not contain any representation of the speakers or hearers information states, nor is INFO-STRUCT connected to SPEAKER.¹

4.6 Ginzburg

Probably the most explicit account of focus-ground articulation in dialogue is being developed in Jonathan Ginzburg’s forthcoming monograph *A Semantics for Interaction in Dialogue* as part of his general theory of dialogue semantics. In this section we will introduce some of Ginzburg’s notions which will play a central role in our analysis in Chapter 5.

4.6.1 The Dialogue Gameboard

As many researchers have noted, an adequate analysis of context needs to account for both the fact that individual dialogue participants (DPs) may have distinct beliefs, including distinct beliefs about matters regarding the conversation, and the fact that ‘DPs presuppose the existence of a common repository, jointly built up and modified by the conversationalists as the conversation proceeds’ (Ginzburg ch 4). It seems hard to account for e.g. the choice of referring expressions and presuppositions without such a notion, called *common ground* by Stalnaker (1974, 1978), and *conversational scoreboard* by Lewis (1979). Ginzburg solves this tension between the individual and the common perspective by assuming that the basic domain of description is the individual DP’s mental state, but that this mental state also contains a *quasi*-shared object corresponding to the DP’s view of what has been established as common ground. Ginzburg introduces the term *dialogue-gameboard* (DGB) for this component of the mental state. He argues that this is necessary in order to account for coherence conditions in dialogue.

Ginzburg’s view of a dialogue participant’s (DP) information state can be schematically represented as a record, where UNPUB-MS stands for “unpublicized mental situation”, i.e. the DP’s private beliefs and DGB stands for “dialogue-gameboard”.

$$(38) \left[\begin{array}{l} \text{UNPUB-MS} : (\text{goals etc}) \\ \text{DGB} : \left[\begin{array}{l} \text{FACTS} : \text{set}(\text{proposition}) \\ \text{QUD} : \text{o-set}(\text{question}) \\ \text{LATEST-MOVE} : \text{move} \end{array} \right] \end{array} \right]$$

The DGB is assumed to contain the following types of information:

- FACTS: set of commonly agreed upon facts.
- QUD (‘questions under discussion’): a set that specifies the currently discussable questions, partially ordered by \prec (‘takes conversational precedence’). If a question q is

¹Engdahl (1998) proposed making this more explicit by specifying attributes for INFO-STATE for SPEAKER and ADDRESSEE and letting these contain the relevant INFO-STRUCT.

maximal in QUD, it is permissible to provide any information specific to q using (optionally) a short answer.²

- **LATEST-MOVE**: content of *latest move* made: it is permissible to make whatever moves are available as reactions to the latest move.

In addition to assuming that a DP's DGB contains a representation of questions, or issues, in QUD, Ginzburg gives an explicit account of how questions are added to QUD and removed from QUD. The most straightforward way that the QUD is updated is when an explicit question is asked and accepted for discussion, in which case the question is made topmost on QUD. We can call this the “QUD update rule”. Questions are removed from the QUD according to the “QUD downdate” rule³:

- (39) **QUD downdate rule**: When an answer a is uttered, remove all questions q answered by a from QUD.

A simple example of QUD updates in dialogue is shown in (40). While Ginzburg uses a situation-theoretical representation of propositions and questions, we indicate questions with a prefixed question mark. Also, we use λ -abstracts over FOL propositions to represent the content of wh-questions. The examples to follow are in the travel agency domain. For representing propositions, we will use unary predicates: **dest** for destination city, **depart** for departure city, and **how** for mode of transport. Additional predicates will be used when necessary.

- (40) a. Are you flying to Paris?
rule: QUD update
 $\Rightarrow \text{QUD} = \langle ?(\text{how}(\text{fly}) \ \& \ \text{dest}(\text{paris})) \rangle$
- b. Yes.
rule: QUD downdate
 $\Rightarrow \text{QUD} = \langle \rangle$

However, the notion of being on QUD is not restricted to questions that have been explicitly uttered in the dialogue. Rather, QUD contains those issues that can be addressed at a given point in the dialogue. For instance, the assertion in (41a) can either be accepted by B, as in (41b), or be discussed, as in (41c).

²Ginzburg's notion ‘currently discussable question’ is similar to the notion of being ‘contextually salient’ in Pulman (1997).

³This is a simplified version of Ginzburg's rule:
QUD DOWNDATING: Assume q is currently maximal in QUD, and that χ is a fact that either (a) resolves q relative to *UNPUB-MS(DP)*, or (b) indicates that no information about q can be provided. Then, adding χ to **FACTS** licenses (1) removing q from QUD, and (2) if (a) applies, adding the fact χ to **FACTS**, where ϕ is the fact that χ **RESOLVES** ϕ relative to *UNPUB-MS(DP)*.

- (41) a. A: It's cold here.
 b. B1: Yes.
 c. B2: Do you think so?

For Ginzburg, an assertion p raises the issue *whether* p for discussion. In terms of the DGB, this means that $?p$ becomes maximal in QUD. An interlocutor then has two options, either to accept p and add it to his/her FACTS, or discuss the issue $?p$. In the former case, $?p$ is removed from QUD, i.e. the issue is *downdated*.

Ginzburg provides some general appropriateness conditions on querying. Simplifying somewhat, A can successfully introduce a question q if either A's QUD is empty or the maximal question in A's QUD is a question q' such that q *influences* q' relative to UNPUB-MS(A). Furthermore, for genuine information seeking questions,⁴ A must not already have some fact that resolves q in FACTS.

4.6.2 QUD and focus-ground

An important assumption in Ginzburg's analysis is that the QUD provides the right locus to account for focus-ground coherence effects. He assumes that an utterance with a particular focus-ground articulation is appropriate in a context where a certain question is QUD maximal, namely the question obtained by abstracting over the focally accented part of the utterance. The result corresponds approximately to the ground of the utterance. Some of Ginzburg's examples are shown in (42).

- (42) a. An utterance with focal accent on the subject as in "JILL likes Bill", i.e. $\text{likes}(\mathbf{j}, \mathbf{b})$ presupposes (QUD-maximality of the question) $? \lambda x \text{likes}(x, \mathbf{b})$, i.e. "Who likes Bill?".
 b. An utterance with focal accent on the object as in "Jill likes BILL" presupposes (QUD-maximality of the question) $? \lambda x \text{likes}(\mathbf{j}, x)$, i.e. "Who does Jill like?"
 c. An utterance with focal accent on the verb as in "Jill LIKES Bill?" presupposes (QUD-maximality of the question) $? \lambda \mathbf{R} \mathbf{R}(\mathbf{j}, \mathbf{b})$.

In (42c) there is no direct English paraphrase of the QUD available, which shows that elements on QUD do not necessarily correspond to overt questions.

Ginzburg states the relation between focus-ground and QUD in the following way:

- (43) An utterance with a given f/g partition requires for its felicity the maximality in QUD of a certain question, one whose defining property is identical with the scope generated by the focus constituent(s)

⁴As opposed to e.g. exam questions or quiz questions.

4.7 Summary

In the TRINDI project we are particularly interested in incorporating aspects of focus-ground articulation in a dialogue system. We would like the system both to extract information from the intonational cues provided by the user's utterances and to generate intonationally appropriate utterances. In order to achieve this capacity, we think it is important to link the focus-ground articulation to the information state update of the dialogue participants as closely as possible.

Chapter 5

Focus-ground articulation and dynamic information states

On Ginzburg's account, focus-ground articulation can be seen as a constraint on information states, namely on what the questions under discussion are. An utterance with a particular intonation provides a way of identifying the questions on QUD. In this chapter, we will expand on and reformulate this theory in terms of rules for updating the dialogue gameboard (dynamic information state). Such rules are process-oriented and thus provide the kind of instruction we need to be able to implement interpretation and generation of focus-ground articulation in a dialogue system. In brief, we are taking Ginzburg's general theory of interaction in dialogue, which is primarily developed for human-human interaction, and adapting it so that it meets the recognition and generation requirements of a dialogue system. In this report we will concentrate on developing the underlying theoretical notions, starting from Ginzburg's Dialogue Game Board and adapting it so that it is compatible with the notion of information state developed in Cooper et al. (1999). In D4.2. we discuss how these notions can be put to work in the GoDiS dialogue system.

5.1 Focal question presupposition

We first reformulate Ginzburg's requirement in (43) as in (44) and give an example in (45.)¹

- (44) An utterance with a given f/g partition requires for its felicity the maximality in QUD of a certain question, obtained by λ -abstracting over the content corresponding to the focused constituent(s)

¹The operation to obtain the required question is actually a bit more complicated than just doing λ -abstraction; in cases where a question has been uttered one should abstract over the propositional content of the question (i.e. the formula obtained by removing the initial question mark) and then prefix the abstracted formula with a question mark. This is to avoid getting e.g. $\lambda x?P(x)$ instead of $? \lambda x.P(x)$.

- (45) “JILL likes Bill”, i.e. $\text{like}(\mathbf{j}, \mathbf{b})$ requires for its felicity QUD-maximality of $?\lambda x \text{likes}(x, \mathbf{b})$, i.e. “Who likes Bill?”

This means that an utterance with narrow focus, as in (45), indicates that the issue *who likes Bill* is an addressable question in the current context. This question is thus assumed to be part of the dialogue participants’ QUD. We can make this explicit by defining the concept of *focal question presupposition*:

- (46) **Focal Question Presupposition (FQP)**: If an utterance u has narrow focus over x , u (focally) presupposes a question q obtained by abstracting x over (the content of) u

Note that this rule allows an utterance to presuppose several questions, for instance when there is more than one focussed constituent.

5.2 Focal question accommodation

We can now interpret (44) as saying that an utterance with a particular focus-ground articulation requires that the focally presupposed questions must be on QUD. By analogy to other kinds of presupposition, we assume that presupposed questions can be accommodated in case the question isn’t already on QUD. This implies a processing rule for how to integrate focused utterances into the information state:

- (47) **Focal Question Accommodation (FQuAcc)**: When an utterance u occurs which focally presupposes a question q not on QUD, add q to QUD.

This explicates our intuition that Ginzburg’s rule (44) should not be interpreted as meaning that utterances are infelicitous in any absolute sense in cases where the required question is not on the QUD prior to the utterance. Rather, it seems reasonable to say that they are *less* felicitous in the sense that they require the hearer to do some extra work: she has to infer the presupposed question and accommodate it. The preferred situation is one where the focally presupposed question is already topmost on QUD. If we choose (with Ginzburg) to interpret all elliptical utterances as short answers to questions, the integration of such an answer requires a matching question and the easier it is to find that question, the more felicitous the answer.

5.3 Presuppositions, propositions and parallelism

In addition to question accommodation, we also consider utterances with narrow focus, which are parallel (in Pulman’s (1977) sense) to other propositions, already established or assumed in the information state.

- (48) **Focal fact presupposition (FFP):** if an utterance u with content s can be structured into a background b and a focus f , u presupposes a proposition c which can be structured into components p and a such that p and b , and a and f , are parallel

Here, we will use this rule to predict felicitousness of utterances with narrow focus. For the generation task, it will turn out to be useful to have a procedure which explicitly looks for parallel propositions amongst the DP's shared facts. While the FFP rule as given above is just a reformulation of Pulman's assertion rule, we will try to extend it to cover not only utterances with propositional content but also questions.

In the following chapters we will show how the rules formulated above apply to the types of utterances we find in dialogues. We begin with yes/no-questions and answers in Chapter 6 and continue with wh-questions and answers in Chapter 7.

Chapter 6

Yes/no-questions and answers

6.1 Some data

We begin this chapter with some relevant data and informal comments on the way the focus-ground articulation of the questions and answers constrain coherent dialogues. In section 6.2 we provide analyses for these examples using the rules introduced in Chapter 5.

6.1.1 Established facts are backgrounded

As we have already seen, the focus-ground articulation distinguishes the part of the utterance which is taken to be known to the dialogue participants from the part which should be used to update the information state. Consequently, if an utterance *U* has focus on some constituent, the rest of *U* is assumed to be mutually established. Consider some different ways the question *Are you flying to London?* could be realised.

- (49) a. Are you flying to LONDON?
b. Are you FLYING to London?
c. Are YOU flying to London?

All the realisations in (49) are possible, but they differ in when they can be used. (49a) makes fewest demands on the context, as it can be interpreted with wide focus, i.e. as a VP question. In (49b) the accented verb is a narrow focus. This means that the rest of the question, i.e. that the addressee is going to London, must be construed as being something that the DPs already have established. Against this background, the speaker can utter a question which is specifically about the mode of travel. Finally (49c) presupposes that the issue of someone flying to London is already known.

6.1.2 Helpful answers to yes/no-questions

If a yes/no-question presupposes another question, as in (49b), both questions need to be resolved.

- (50) a. A: Are you FLYING to London?
- b. B1: No, (I'm) SAILING
- c. B2: No
- d. B3: No, # I'm sailing to LONDON

The question in (50) can of course answered by 'yes' in which case no further reply is needed. But if a yes/no-question is answered negatively, a cooperative speaker often goes on to provide an appropriate alternative, as in B.1. Note that the focus of the answer is parallel (in Pulman's sense) to the focus of the question. If it isn't, the reply is perceived as incoherent, as shown by B.3.

6.1.3 Elliptical answers to yes/no-questions

The focus-ground articulation of the question also determines what kind of elliptical utterance is possible as illustrated in (51).

- (51) a. Should I go OVER the bridge?
- b. No, UNDER (it).
- c. No, # under the BRIDGE

6.1.4 Focus in "check" questions

Many dialogue systems use yes/no-questions as a way of checking that the system had interpreted the previous answer correctly. The focus-ground articulation of such questions is of course important, as illustrated by the two following dialogues.

- (52) a. A1: How do you want to travel?
 b. B1: A flight please
 c. A2: So you're FLYING?
 d. B2: Yes
 e. A3: Where do you want to to go?
 f. B3: London
 g. A4: So you're flying to LONDON ?
 h. A4': # So you're FLYING to London ?

In (52), A4 is felicitous but not A4'; in (53) the situation is the reverse.

- (53) a. A1: Where do you want to to go?
 b. B1: London
 c. A2: So you're going to LONDON?
 d. B2: Yes
 e. A3: How do you want to travel to London?
 f. B3: A flight please
 g. A4: # So you're flying to LONDON ?
 h. A4': So you're FLYING to London ?

6.2 Analysis of yes/no-questions

We can now use the rules put forward in Chapter 5 to explain the data in 6.1. We will interfoliate the dialogues with the rules used and show how the hearers QUD is updated.

6.2.1 Established facts, focus and backgrounding

We start with examples (49b,c)¹. (49a) will be discussed in 6.2.5

¹Here will use a predicate **traveller** to indicate who is travelling.

- (54) a. Are you FLYING to London?
QUD update, Focal Question Accommodation
 $\Rightarrow \text{QUD} = \langle \{ ?(\text{how}(\text{fly}) \ \& \ \text{dest}(\text{london}) \ \& \ \text{traveller}(\text{addr})), \ ?\lambda x(\text{how}(x), \ \text{dest}(\text{london})) \} \rangle$
- b. Are YOU flying to London?
QUD update, Focal Question Accommodation
 $\Rightarrow \text{QUD} = \langle \{ ?(\text{how}(\text{fly}) \ \& \ \text{dest}(\text{london}) \ \& \ \text{traveller}(\text{addr})), \ ?\lambda x(\text{how}(\text{fly}) \ \& \ \text{dest}(\text{london}) \ \& \ \text{traveller}(x)) \} \rangle$

Uttering (54a) with narrow focus on the verb presupposes that everything but the mode of transport is known at this point in the dialogue. Similarly uttering (54b) presupposes that there is a question regarding who is travelling on QUD, or that such a question is accommodated onto QUD. This explains why neither of these questions are plausible at the beginning of a conversation since there might not be any established facts at that point.

6.2.2 Integration of helpful answers to yes/no-questions

If a yes/no-question q which focally presupposes a wh-question q' is answered positively, both q and q' will have been answered and are removed from the QUD. If q is answered negatively, q' will remain on the QUD and needs to be answered separately. The focus-ground articulation of the utterance of q determines q' , and the most felicitous negative answer is thus one which answers q' .

- (55) a. A: Are you FLYING to London?
QUD update, Focal Question Accommodation
 $\Rightarrow \text{B's QUD} = \langle \{ ?(\text{how}(\text{fly}) \ \& \ \text{dest}(\text{london}), \ ?\lambda x(\text{how}(x) \ \& \ \text{dest}(\text{london}))) \} \rangle$
- b. B1: No, (I'm) SAILING
QUD downdate
 $\Rightarrow \text{A's QUD} = \langle \ \rangle$
- c. B2: No
QUD downdate
 $\Rightarrow \text{A's QUD} = \langle \ ?\lambda x(\text{how}(x) \ \& \ \text{dest}(\text{london})) \ \rangle$

The answers are given in order of decreasing felicitousness. Answer B1 answers both questions on QUD, but B2 leaves the question about the mode of transport unanswered (apart from the fact that it's not flying). Thus we can account for the fact that B2 is less felicitous -

it leaves unanswered a question which was not explicitly raised, but rather inferred by Bob. The inference is explained by the rule for Focal Question Accommodation (FQA).

6.2.3 Elliptical answers to yes/no-questions

- (56) a. A: Should I go OVER the bridge?
 b. B1: No, UNDER.
 c. B2: No, # under the BRIDGE.

A's utterance presupposes the question "Should I go over or under the bridge" (assuming that these are the only alternatives), which should thus be accommodated by B and put on B's QUD. When B says "No", the explicit question is answered, leaving the accommodated question on QUD. In B1, Bob continues by giving a helpful answer which presupposes the topmost question on QUD, and it is therefore felicitous. However, in B2 Bob goes on to provide an answer to the question "What should A go under?", which is not on QUD (indeed, it is hard to make any sense of this question in the given context), and it is therefore infelicitous.

6.2.4 "Check" questions

We next show how the concept of focal question presupposition explains the dialogues in (57) and (58). In these dialogues, A (which could be a dialogue system) uses a cautious grounding strategy where questions are not popped off the QUD until they have been confirmed.

- (57) a. A1: How do you want to travel?
 b. B1: A flight please
QUD update
 \Rightarrow A's QUD= $\{\lambda x.\mathbf{how}(x)\}$
 c. A2: So you're FLYING?
 d. B2: Yes
 e. A3: Where do you want to to go?
 f. B3: London
QUD update
 \Rightarrow A's QUD= $\{\lambda x.\mathbf{dest}(x)\}$
 g. A4: So you're flying to LONDON ?
 h. A4': # So you're FLYING to London ?

In (57), A4 is felicitous since it presupposes the question "Where is Bob flying" which is still under discussion. A4', on the other hand, presupposes the question "How are you travelling to London?" which is not on QUD. By contrast, in (58) A4' is felicitous while A4 is not.

- (58) a. A1: Where do you want to go?
 b. B1: London
QUD update
 \Rightarrow A's QUD= $\{\lambda x.\mathbf{dest}(x)\}$
 c. A2: So you're going to LONDON?
 d. B2: Yes
 e. A3: How do you want to travel to London?
 f. B3: A flight please
QUD update
 \Rightarrow A's QUD= $\{\lambda x.\mathbf{how}(x)\}$
 g. A4: # So you're flying to LONDON ?
 h. A4': So you're FLYING to London ?

6.2.5 “Ambiguous” questions

We saw in Chapter 2 that utterances with the sentence accent on the final constituent in English are ambiguous between having narrow focus on the object only and wide focus on the VP. The same ambiguity shows up in yes/no-questions. Let us look at what may happen in a dialogue between Anna and Bob².

- (59) a. Anna: Are you flying to LONDON?
QUD update, Focal Question Accommodation
 \Rightarrow Bob's QUD= $\{\lambda x.(\mathbf{how}(\mathbf{fly}) \ \& \ \mathbf{dest}(\mathbf{london}) \ \& \ \mathbf{traveller}(\mathbf{addr})), \ ?\lambda x.(\mathbf{how}(\mathbf{fly}) \ \& \ \mathbf{dest}(x) \ \& \ \mathbf{traveller}(\mathbf{addr})) \}$
 b. Bob: No, to LYON.
- (60) a. Anna: Are you flying to LONDON?
QUD update, Focal Question Accommodation
 \Rightarrow Bob's QUD= $\{\lambda x.(\mathbf{how}(\mathbf{fly}) \ \& \ \mathbf{dest}(\mathbf{london}) \ \& \ \mathbf{traveller}(\mathbf{addr})) \ ?\lambda P.P(\mathbf{bob})\}$
 b. Bob: No, I'm staying HOME.

These examples show that Bob has two options for updating his QUD when he hears Anna's question. If he chooses the narrow focus interpretation in (59,) he will answer with just an

²This example requires a slightly different semantic representation from that used in the other examples.

alternative destination. But if he updates his QUD matching a wide focus construal of Anna's question as in (60), he should provide an alternative activity if he wants to be helpful. There is of course also the issue whether Bob's QUD matches Anna's QUD. In case they don't, Anna most likely will use Bob's answer as a prompt to accommodate to his QUD.

Chapter 7

Wh-questions and answers

In this section we will start by looking at the focus-ground articulation of answers to wh-questions, including elliptical answers. Having established what the focus-ground articulation of such answers is, we will consider possible focus-ground articulations of the corresponding questions. The reason for looking at answers first is that wh-questions often constrain the focus-ground articulation of their answers in a rather precise way: The minimal answer to a wh-question carries focal accent and often provides the answer to the maximal question on QUD. In case it doesn't, focus question accommodation normally takes place. The focus-ground articulation of the questions themselves depends on several factors, some of them syntactic and some having to do with the dialogue participants' overall plans and immediate concerns.

7.1 Some data

7.1.1 Parallelism between wh-questions and answers

Consider the way the answers are realised in the following dialogues.

- (61) a. Where are you going?
b. I'm going to PARIS
c. to PARIS
d. #I'm GOING to Paris
- (62) a. How are you travelling to Paris?
b. I'm FLYING to Paris
c. #I'm flying to PARIS

- (63) a. Who is going to Paris?
 b. My BOSS is (going to Paris)
 c. #My boss is going to PARIS

In these examples we see that the type of answer is largely determined by the question. The *where*-question in (61a) can be given a full answer as in (b), with the focal accent on the new information. It can also be answered elliptically as in (c), provided that the short answer does provide the new information. (61d) is not a coherent answer to this question, since the informative part does not contain an accent whereas part of the ground is accented. In other contexts, this focus-ground articulation would be appropriate. If the dialogue continues with the question in (62a), an answer with focal accent on the verb would fit in very well, as shown in (b). Accenting the destination as in (c) is not appropriate since this is already assumed to be part of shared knowledge

The generalisation seems to be that the focus of an answer to a wh-question must match the wh-phrase. In some sense, this follows from the interpretation and function of wh-questions. By using an information seeking wh-question, the speaker indicates that she requires information concerning the nature or identity of the wh-phrase referent. Uttering a wh-question then involves updating QUD with that question, and possibly doing focal question accommodation in case the focus-ground articulation of the utterance indicates that some other questions must be on QUD (see below).

7.1.2 Bare wh-words

We have seen that the wh-phrase establishes what the question is about and that it must be matched by a focally accented phrase in the answer. However, one interesting aspect of wh-questions is that an initial wh-phrase need not be accented. Instead the main sentence stress often falls on some constituent in the VP, as in the preceding examples. We repeat these questions here, indicating plausible locations for the main accent.

- (64) a. Where are you GOING?
 b. How are you TRAVELLING (to Paris)?
 c. Who is going to PARIS?

If the wh-phrase establishes the focus of the answer, it is somewhat surprising that it is not accented.¹ Below in section 7.1.4 and 7.1.5 we mention some cases where initial wh-phrases are accented, but frequently they are not. The unmarked way of asking this question is as in (65a) whereas (65b) can only be used in special contexts .

¹This is the main issue discussed in Lambrecht and Michaelis (1998) who maintain that the wh-phrase is still the focus. The reason that it isn't accented is, they suggest, that bare wh-phrases belong to the same category of expressions as indefinite pronouns (*something, somewhere ...*) which are also not normally stressed.

- (65) a. Where are you GOING?
 b. #WHERE are you going?

7.1.3 Lexical wh-phrases and parallelism

Contrary to the case with unaccented bare wh-words, the stress normally falls on the noun if the interrogative phrase consists of a wh-word followed by a common noun, as illustrated in (66).²

- (66) a. What CITY are you going to ?
 b. #What city are you GOING to?

However, the accenting of wh-phrases is highly context sensitive. The preference for accenting the common noun in examples like (66) can be offset if the wh-phrase has already occurred in a previous question. Consider the continuation of the dialogue in (67).

- (67) a. A1: What CITY are you going to ?
 b. B1: London
 c. A2: What city do you want to go FROM?
 d. A2': #What CITY do you want to go from?

Whereas A1, with accent on CITY, is appropriate at this point in the dialogue, the same pattern is inappropriate in A2', which gives the impression that A didn't understand the reply in B1. Instead A2 with focus accent on the preposition *from*, is appropriate in case A1a has already been asked and answered

7.1.4 Multiple questions

In multiple wh-questions, all wh-phrases are normally accented, including the first one as in (68)

- (68) WHO wants to go WHERE?

- (69) The question isn't WHETHER to strike, but WHEN.

Multiple questions raise a number of interesting problems concerning presuppositions of questions and are potentially quite revealing for a theory of information state update. We have nothing to contribute at this point but refer the reader to the detailed discussion in Ginzburg & Sag (forthc.) who also analyse various forms of *in situ* wh-questions, commonly referred to as *echo*-questions.

²See Bresnan (1971) and Selkirk(1984:241ff).

7.1.5 “Reminding questions”

There are also interesting cases where an initial bare wh-word is accented, as discussed in Ginzburg (forthc.). Consider the following examples.

- (70) a. (So) WHEN are we going to Edinburgh?
b. (So) WHERE are you going?

It seems to us that such questions, often preceded by the connective *so*, are used in a particular context, namely one where the timing of a particular trip to Edinburgh or the destination of a trip has already been raised but not completely resolved. This issue is thus still on QUD in some sense. An utterance with an initial accented wh-word seems to presuppose that the question expressed by it is already on QUD, though not topmost. Uttering such a question thus has the effect of making it maximal on QUD.³

7.2 Analysis of wh-questions

In this section we will outline how our theory of QUD updating and downdating can account for some of the data in section 7.1. We concentrate on some core cases.

7.2.1 Parallelism between wh-questions and answers

On our analysis, the parallelism that obtains between the question and the answer in (61)-(63) is explained by the fact that the felicitous answers presuppose exactly the questions which are in fact on QUD, and thus require no accommodation. Let us look at the dialogue in (71.) We assume that the accent on the final word here is not a narrow focus accent but the default sentence final accent in English.

- (71) a. A: Where are you GOING?
rules: QUD update
 $\Rightarrow \text{QUD} = \langle ?\lambda x.\text{dest}(x) \rangle$
- b. B1: I'm going to PARIS
rule: QUD downdate
 $\Rightarrow \text{QUD} = \langle \rangle$
- c. B2: #I'm GOING to Paris

According to the F-QuAcc rule, B1 presupposes the question posed in A. The infelicitous answer in B2 on the other hand doesn't match what is on QUD, as the narrow focus on the verb presupposes that the question was about what the addressee was doing to some location.

³See Cooper et al. 2000 for a proposal to distinguish a global QUD in the analysis.

7.2.2 Parallelism and contrastive focus

In this section, we will use the FFP rule introduced in 5.3 to explain the dialogues in 7.1.3.

- (72) **Focal fact presupposition (FFP):** if an utterance u with content s has focus on (the realisation of) content f and content b is backgrounded, u presupposes a proposition c which can be structured into components p and a such that p and b , and a and f , are parallel

For two structured propositions to be parallel, Pulman requires that the backgrounded material is “the same sort of thing” for both propositions, and likewise for the focused material.

- (73) a. A1: What CITY are you going to ?
b. B: London
 QUD downdate
 \Rightarrow Anna’s FACTS = { **dest(london)** }
c. A2: What city are you going FROM?
 QUD update
 \Rightarrow Anna’s and Bob’s QUD = { $? \lambda x.$ **depart**(x) }
d. A2’: #What CITY do you want to go from?
e. A2’’: #What city do you want to GO from?

To show that A2 is felicitous, we divide the semantic representation into focus and ground using the equation $b(f) = ? \lambda x.$ **depart**(x), with the result $b = \lambda R(? \lambda x.R(x))$, $f =$ **depart**. There is also a mutually established proposition **dest(london)** which can be divided into background $p = \lambda R.R(\mathbf{london})$ and focus $a =$ **depart**. Now what is required is (in Pulman’s notation) $b \bullet f$ and $p \bullet a$ are parallel. Since p is a question and c a proposition, the present case is slightly more complicated than Pulman’s; however, if we accept (without going into detail) that b and p are at some level “the same sort of thing”, we can note that f and a (destination city and departure city, respectively) are definitely the same sort of thing, and also that they are contrasting.

On this account, the proposition c satisfies the FFP rule for A2. However, no such proposition can be found for A2’ or A2’’. Accenting *city* as in (73)d gives the impression that Anna didn’t catch Bob’s reply. Finally, accenting the main verb as in (73)e gives a very incoherent impression.

At this point in the conversation, the fact that Bob is going somewhere should certainly be shared, i.e. ground, information. Any deviation can be perceived as a sign that the system is not properly aware of the speakers information state. For a discussion of these issues in the context of generating appropriate intonation in an experimental system see D4.2.

Chapter 8

Conclusion

In this report we have reviewed a number of recent approaches to focus-ground articulation from the point of view of developing dialogue systems that can interact with human users. As human users have certain expectations concerning the way prosodic cues are used, it is important that the system conforms with these expectations as far as possible. For instance, material that resolves an issue that is under discussion should be accented whereas already known material should be deaccented. A system that places the main sentence accent on material that is already known to the hearer will probably give rise to misunderstandings.

We have adapted Ginzburg's dialogue game board proposal to suit the needs of developing a dialogue system. Ginzburg's approach is very close to the idea of information states developed in Cooper et al (1999) which permeates a lot of the work in this project. In particular we have made use of Ginzburg's notion *question under discussion* as a way of predicting what part of an utterance should be stressed and hence interpreted as focal. In D4.2. we give some illustrations of the way these ideas can be exploited for generating appropriate intonation contours in the GoDiS system. Furthermore we believe that a good command of the range of realisations of particular dialogue moves will also improve speech recognition of natural dialogue and contribute to move identification.

8.1 Future research

It would be possible to formulate an accommodation rule in line with FQuAcc for FFP, but we have not had reason to do so here. Also, we have not explored the exact relation between FPQ, FQuAcc and FFP and how they interact. A result of such an investigation would ideally be algorithms combining FQP, FQuAcc and FFP for assigning and interpreting focus and for deciding when an utterance is infelicitous and should not be accepted (perhaps due to recognition errors).

Types of questions that remain to be accounted for include multiple questions and reminding questions.

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