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Diderichsen, Philip

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PO Box 117
221 00 Lund
+46 46-222 00 00

ONE OF A KIND

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The processing of indefinite *one*-anaphora
in spoken Danish

Philip Diderichsen



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Lund University Cognitive Studies 138

One of a kind. The processing of indefinite one-anaphora in spoken Danish

Philip Diderichsen

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To all my loved ones

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Foreword

What you presently hold in your hands, dear reader, is not a book. I have had fun trying to make it look like one, but it is not. It is a Ph.D. thesis, and as such it has been completed over the last few weeks under the slogan of “an anonymous, but very experienced supervisor” at Lund University Cognitive Science: “Ph.D. theses should not be perfect, they should be done.” It appears I have succeeded in achieving both desiderata.

Many people have been generous to me with their help, support, and encouragement while I have been working on the thesis, and I am very grateful for it. I have generally found the people I have met in Skåne to be so extraordinarily kind and considerate that I almost wish I had been born a Swede. Well, Skåne is more Danish than Swedish anyway, so it figures.¹ I would especially like to thank the following long list of people.

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¹ *Kungshuset* (‘The King’s House’) containing Lund University Cognitive Science as a part of the Department of Philosophy, as well as Lund’s magnificent cathedral just across from it, were built by Danish kings.

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And last but not least, my beautiful girlfriend Katinka, who in no small part helped me get on the right track for finishing this thesis. You rock!

Copenhagen, January 2008

Ph. D.

List of publications

The work for this thesis has been presented in various public fora. Most of the publications on the following list are available online at the web page www.lu.se/people/philip.diderichsen/.

- Diderichsen, P. (2007). *Givenness revisited. Indefinite one-anaphora in unscripted Danish dialogue*. Acta Linguistica Hafniensia, vol. 39, pp. 179-208.
- Diderichsen, P. (2007). *Investigating referential givenness in unscripted danish dialogue: The case of indefinite one-anaphora*. In Toivanen, J. and P.J. Henrichsen (eds.): Current trends in research on spoken language in the Nordic countries. Oulu University Press.
- Diderichsen, P. (2007). *Givenness marking and eye movements*. Poster at the 13th Annual Conference on Architectures and Mechanisms for Language Processing, Turku, Finland.
- Diderichsen, P. (2007). *Investigating unscripted spoken dialogue processing using eye-tracking*. Poster at the 14th European Conference on Eye Movements, Potsdam, Germany.
- Diderichsen, P. (2006). *Augmented Communication: The communicative potential of the internet*. Lund University Cognitive Studies, vol. 132. Lund, Sweden.
- Diderichsen, P. (2006). *Cross Recurrence Quantification Analysis of indefinite anaphora in Swedish dialogue. An eye-tracking pilot experiment*. In Proceedings of BranDial 2006 - the 10th workshop on the semantics and pragmatic of dialogue. Potsdam, Germany.
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Chapter 1

Introduction

Language use is a social as well as a cognitive endeavor. Linguistic communication is social in that it requires pairs or groups of interlocutors to perform joint actions: they need to cooperate in much the same way that two dancing partners or the performers of a piano duet coordinate with each other. It is cognitive in that it requires the planning and execution of participatory actions of the individuals involved. Just like both dancers perform their own moves and both pianists play their individual part, each interlocutor utters his or her contributions to the conversation. This is the central idea of Herbert Clark's book *Using language* (1996), and this basic view can be regarded as the overall theoretical vantage point of this thesis. Clark's view on language use takes conversation to be the basic setting of linguistic communication, and sees speakers, listeners, times, places, and other concrete circumstances of conversations—all of them aspects of what is routinely called "context" in the literature—as central to its understanding. This sets the approach apart from more structurally oriented traditions of linguistic inquiry, and arguably makes it better suited to accommodate the description and explanation of linguistic devices that hinge on contextual factors like these.

One such device is reference. Reference is language users' principal means of communicatively singling out entities in the world, or rather, in interlocutors' mental models of the world, the term *reference* being used

here in accordance with the terminology of linguistic pragmatics rather than the philosophical tradition (Garnham, 1999). A referent is an entity that may be construed as existing in the world (without necessarily actually existing in the world), and is pointed to as such by a speaker, writer, or signer using a referring expression.

In each of the sentences in (1) below, a certain sailboat is either introduced into or accessed in the interlocutors' mental model of the world by means of different referring expressions.

- (1) a. I finally bought **a sailboat** last week.
 b. I finally bought **the sailboat** last week.
 c. I finally bought **it** last week.
 d. I finally bought **one** last week.

The expressions shown here are an indefinite noun phrase,¹ a definite noun phrase, an indefinite *one*-anaphor, and a definite pronoun. The way the sailboat is mentioned signals certain assumptions on the part of the producer of the sentence: that the comprehender is or is not able to identify the entity the producer has in mind, and that the comprehender is or is not attending to this entity (or an entity of this type).

By designating things in the minds of language comprehenders, referring expressions are inherently context-dependent. Many linguistic studies of referring expressions have established that pragmatic categories such as assumed accessibility and identifiability in the comprehender are the primary determinants of the grammatical form of expressions, e.g. the choice of a pronoun over a full noun phrase (Ariel 1990, Gundel et al. 1993, Lambrecht 1994, Prince 1981). A common term for the multiple aspects of referential status underlying referential form is *givenness*, as in Gundel et al.'s *Givenness Hierarchy*. Given information is traditionally the information in an utterance which can be taken for granted, whereas new information is the information that is added by the utterance. However, the given-new distinction is by no means exhaustive with respect to refer-

¹ A noun phrase is sometimes abbreviated *NP*.

ential status, and the term *givenness* will therefore be used more broadly here, in accordance with its common use in the literature, to cover such things as the identifiability and accessibility of referents in the minds of interlocutors.

Referential form varies systematically with givenness in natural discourse. Anaphoric expressions (i.e. expressions used to refer to entities that have been mentioned already) are typically definite rather than indefinite, and they are often pronominal rather than fully explicit noun phrases. Expressions used to introduce new entities into the discourse are usually indefinite. The systematic progression in givenness associated with going from indefinite to definite form, and from full noun phrase to pronominal form, has been dealt with in various ways in the literature, but has typically been treated as a unitary or one-dimensional progression through stages of increasing cognitive prominence. As we shall see, this type of account of referential form works well for capturing the systematic changes in the givenness of entities referred to using expressions such as *a sailboat* (indefinite full noun phrase), *the sailboat* (definite full noun phrase), and *it* (definite pronoun). But it does not elegantly capture the last of the four expressions used above, *one* (indefinite *one*-anaphor).

The goal of the present thesis is to investigate the coupling of referring expressions and the givenness of referents in unscripted spoken Danish. On the basis of indefinite *one*-anaphors, a case can be made for a new way of viewing givenness and its reflection in referring expressions. It will be argued in this thesis that givenness should be seen as an at least two-dimensional property of referents instead of a property varying along some one-dimensional scale of cognitive prominence, and that these dimensions of givenness are reflected in grammatical features such as definiteness marking (the feature $[\pm\text{def}]$) and pronominalization (the feature $[\pm\text{pron}]$).

A second goal of the thesis is to explore the use of a more fine-grained and at the same time more ecologically valid method of investigating referential status than what has been possible before. Givenness has so far mainly been measured in terms of, for instance, referential distance

and/or topic persistence (Ariel, 1990; Givón, 1983a). One aspect of givenness is investigated in this thesis on the basis of referential distance and other corpus-based measures: the accessibility of indefinite compared to definite pronominal referring expressions. The corpus study is used to discover some basic differences and similarities between referring expressions sharing the [+pron] feature and differing in the [\pm def] feature—promising results that support the feature-based view of givenness proposed here. It might be argued, however, that these measures are not fine-grained enough to capture the cognitive status of referents as it dynamically changes in the flux of the minds of speakers and listeners. The rest of the thesis is therefore devoted to the exploration of potentially more accurate methodologies.

One possible way of accurately measuring correlates of the status of referents in the minds of spoken language comprehenders is through eye movement analysis. It is a central goal of this thesis to explore this method. Eye movement analysis should be ideally suited to investigate referential status, since eye movements to visual referents are initiated unconsciously and closely time-locked to referring expressions in linguistic input (see e.g. Tanenhaus et al. (1995)). The eye-tracking methods from the so-called *visual world* paradigm in psycholinguistics can thus reveal the moment-by-moment attentional status of referents at a temporal grain that is impossible to achieve using corpus-based measures.

Visual world studies are usually conducted in the presence of arrays of line drawings or real-world props to be inspected or manipulated by the experimental participant in response to well-controlled, often pre-recorded, verbal utterances. Their eye movements are then measured in order to study which pictorial stimuli attract visual attention in association with which verbal stimuli. This thesis reports one such well-controlled eye-tracking study. It used drawings presented on a computer screen for the participants to interact with with the mouse, in order to facilitate the subsequent automatic data analysis. This study demonstrates how eye movement patterns can be used as indicators of referential processing of the finest grain, albeit in response to stimuli that can only be characterized

as artificial, and as such, a poor substitute for natural conversation.

There is at present a movement in psycholinguistics to bridge the ‘language-as-product’ and ‘language-as-action’ approaches to the study of language use (Clark, 1996) by means of visual world eye-tracking techniques (Trueswell & Tanenhaus, 2005). Recent studies suggest that participants in experimental studies are highly sensitive to the non-spontaneous nature of the replies of confederate interlocutors in scripted ‘conversations’ in the lab, regardless of efforts made to make the interaction appear natural and unrehearsed (Schober & Brennan, 2003). This stresses the importance of finding ways to study language use that are as close to everyday conversation as possible. At the same time, it is desirable to retain the accuracy of the experimental measures normally used in the laboratory studies. New eye-tracking techniques make it possible to bridge the gap and accurately investigate spoken language collected in relatively natural, spontaneous dialogue. In the final experiment in this thesis the stimuli comprise a virtual work space with Lego bricks and the spontaneous utterances from two interlocutors in a task-oriented dialogue. Both wear eye-trackers, and it is thus possible to record the eye movements of both speaker and listener in association with the same referring expression. This dyadic eye-tracking technique constitutes a true methodological innovation and a step in the direction of bridging the product and action traditions.

The rest of the thesis is organized as follows. The next chapter provides background on the existing theories of referring expressions and the cognitive status of referents, and this is followed by a traditional corpus-based study of the cognitive status of indefinite *one*-anaphors in unscripted spoken Danish. Chapter four gives a selective overview of the visual world paradigm, and will also touch upon the special challenges that the eye-tracking methodology presents with respect to statistical analysis. Chapter five and six report on two eye-tracking studies of the association between referring expressions and the cognitive status of their referents: one in a controlled experimental setting, and the other in the less restricted context of a task-oriented dialogue. In chapter seven the theoretical and method-

ological perspectives of the thesis will be discussed before the conclusion in chapter eight.

Chapter 2

Givenness and referring expressions in Danish

There are various different types of referring expression at our disposal whenever we want to refer to a simple, singular object, as when we refer to, say, a painting using utterance (a), (b), (c), or (d) in the following example.

- (1)
- a. Would you like to have a look at **a painting**?
 - b. Would you like to have a look at **the painting**?
 - c. Would you like to have a look at **it**?
 - d. Would you like to have a look at **one**?

Do the expressions in (1) mean different things, since their form is different? In a way, they do not, since they refer to the same thing, or at least the same *kind* of thing. But the expressions will typically be used under different circumstances. We choose among these and other forms according to pragmatic principles that have to do with the cognitive status of the referent in our own mind and in the mind of our conversation partner, and thus the meaning of the different expressions depends on such things as our mutual memory representations and attentional state.

There is a large literature within linguistics on the subject of referring expressions and their discourse function (Ariel, 1990; Gundel, Hedberg

& Zacharski, 1993; Lambrecht, 1994; Prince, 1981; Walker & Prince, 1993, etc.). Many have written about different noun phrase types and the discourse conditions that motivate their use. Among these conditions is the pragmatic variable of *givenness*, i.e. the distinction between ‘familiar,’ ‘known,’ ‘active,’ etc. information and new information in linguistic utterances. The consensus is that the more given a referent is, the less explicitly it needs to be coded. However, there is also a wide consensus in the literature that givenness is not a simple dichotomy. Givenness is rather more multifaceted. There have been various cognitive approaches to givenness combining attention- and memory-based views in different ways. Some linguists separate the category into several subcategories, typically in terms of a knowledge sharing or memory aspect and a consciousness or attention aspect, and settle for an account of one such subcategory (Ariel, 1990; Prince, 1981). Others roll several different aspects into one, and present conflated, ‘one-dimensional’ models (Gundel, Hedberg & Zacharski, 1993). Others still try to keep several aspects distinct as multiple dimensions in their overall accounts (Chafe, 1987; Chafe, 1994; Chafe, 1996; Lambrecht, 1994).

The present chapter has as its main purpose to present some existing views of givenness and then integrate and generalize them in order to be able to account for an anaphor type which has not received much attention in the literature: indefinite *one*-anaphors.

2.1 Givenness and referring expressions

The present section will introduce the notion of givenness marking as seen through a number of accounts of reference and referring expressions. In the following, four different views will be presented as exemplars: Prince’s shared knowledge approach, Ariel’s *Accessibility Marking Scale*, Gundel et al.’s *Givenness Hierarchy*, and Lambrecht’s two-dimensional approach to referential status. First, however, we will take a look at some of the assumptions about reference that are shared by all the accounts.

Reference

The consensus theory of reference can be formulated as follows. The portrayal offered here owes a lot to Clark (1996), and will form part of the background of the rest of the thesis.

The consensus theory contains the notion of *common ground* between the speaker and the listener(s) in a discourse, an overarching representation of their mutual knowledge of the world. This representation contains assumptions such as that clean water is good to drink, that the Earth revolves around the Sun, and, depending on the cultural community memberships of the interlocutors, the name of the current president of the United States, the assumption that Ludwig van Beethoven's hearing gradually deteriorated beginning in his twenties, etc.

A special subpart of this total common ground is the interlocutors' *discourse model*, also known as their *discourse representation* or *universe of discourse*. The discourse model comprises two parts: the *situational* and the *textual* representations. The situational representation contains the entities talked about, their properties, and the relations among them. It also includes the speaker and listener and their 'here and now' physical setting. The textual representation is a record of the linguistic devices used in the discourse to invoke the representations in the situational representation. Entities present in the physical surroundings of the interlocutors may be in the situational representation, but not necessarily in the textual part of the discourse model. For instance, if Joel pulls up to Mike in a brand-new sports car, it will probably feature prominently in the situational part of their discourse model even before it is mentioned. On the other hand, when entities do get mentioned explicitly, the situational discourse model is immediately updated accordingly. As an illustration of this view of the discourse model, consider example (2) and figure 2.1.

(2) Here comes a cab now. I'll hail it.

These utterances can be imagined in the context of two travel companions

standing at the curb and with a taxi approaching. Two entities are explicitly mentioned: the taxi (*a cab, it*) and the speaker (*I*). Other entities are also part of the situation, but are not mentioned explicitly (the listener and the taxi driver, possibly among other things).

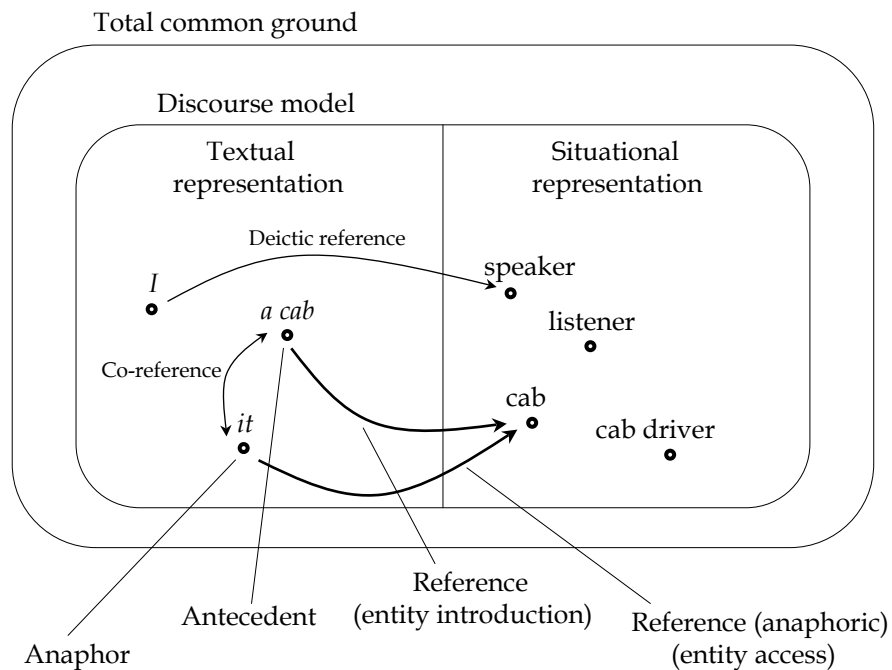


Figure 2.1: A graphical representation of the discourse model. Inspired by Clark (1996), pp. 53-54.

When entities become represented in the discourse model through linguistic reference, they become *discourse referents*. Discourse referents are thus introduced into the discourse model by being mentioned a first time, and may then be referred to using subsequent *referring expressions*. When a referring expression points to an entity that is already in the discourse model, it is *anaphoric*. The previous referring expression designating the entity is called the *antecedent*. Anaphors and antecedents are said to *co-refer*. Expressions that refer to entities that are already in the situational

model without having been introduced explicitly are not anaphoric. They are *deictic* expressions. Deictic expressions are not specifically of interest in this thesis.

While the term *referring expression* is sometimes reserved for expressions pointing to entities that are already in the discourse model, it is common to use the term for expression types that *introduce* discourse referents as well, and this practice will be followed in this text. Furthermore, *referent* is often used as a convenient substitute for *discourse referent* about representations in mental discourse models rather than entities actually existing out in ‘the real world,’ and this will also be the prevalent use in this text.

Finally, the accounts presented below also more or less explicitly subscribe to the following distinction. Referring expressions have properties, and so do (discourse) referents—and they are not to be confused. It may be useful to point out already now, for instance, that definiteness is not the same thing as identifiability. The former is a feature of linguistic expressions, whereas the latter is a feature of referents. This distinction is quite important, and we will return to this point later in the chapter.

From this sketch of the consensus on reference of various accounts of givenness and referring expressions, we will now turn to a review of four such accounts.

Prince (1981): The Assumed Familiarity Scale

Among many other writings on information structure and reference, Ellen Prince is the author of the seminal article *Toward a taxonomy of given-new information* (Prince, 1981). Here, she introduces the analogy of a recipe as a way of thinking about discourse: different entities in the discourse model are compared to the staples that are needed to cook some dish. Depending on which staples the cook has on his shelves, the tools he possesses, and the techniques he masters, the recipe may be more or less explicit in mentioning these. Analogously, the more knowledge that can be assumed by the speaker/writer to be familiar to the listener/reader, the less specific the relevant references need to be.

Prince introduces a set of terms that befit different degrees of such *assumed familiarity*, and thus focuses on a shared knowledge aspect of givenness after briefly considering two other approaches: a predictability/recoverability approach, and a consciousness/salience approach. In Prince's account, referents can have the assumed familiarity statuses in the following list.

- Situationally Evoked (E^S), e.g. referents of personal pronouns as in *I bought a Toyota*.
- Textually Evoked (E), e.g. referents of anaphoric pronouns such as *it* and *she*.
- Unused (U), e.g. referents of proper names of persons that both interlocutors know, as in *Ellen bought a Toyota*.
- Inferrable (I), e.g. entities that are associated with evoked entities, as in *I got on a bus yesterday and the driver was drunk*.¹
- Containing Inferrable (I^C), i.e. referents that are inferrable from evoked entities inside noun phrases, as in *One of the people that work at Penn bought a Toyota*.
- Brand-New anchored (BN^A), e.g. referents of indefinite NPs linked to a non-brand new entity, as in *A person that works at Penn bought a Toyota*.
- Brand-New unanchored (BN), i.e. unanchored entities that the interlocutor is not assumed to have any familiarity with, as in *a person bought a Toyota*.

The assumed familiarity categories are arranged in an implicational scale in the order shown above, as in (3) [Prince's (32)]:

(3) Familiarity scale: $E/E^S > U > I > I^C > BN^A > BN$

¹ At the point where the driver is mentioned, the bus is Textually Evoked. Before the noun phrase *a bus*, the bus was Brand-New.

The scale is ranked such that if one were to use a form signalling one category while being in a position to use a form signalling a category further to the left, one would be under-informative and therefore non-cooperative in the Gricean sense. For instance, if one—suspiciously—uttered (4) to a friend, well aware that the woman was in fact his wife, one would be using a form signalling an assumption of low familiarity even though the referent was in fact very familiar to the listener. One would apparently be mentioning a Brand-New entity, well aware that the entity in fact had the status Unused for the listener.

(4) I was talking to **a beautiful woman** yesterday.

Likewise, if one knew that the listener was acquainted with the bus driver in question, one would be withholding information in a similar fashion by uttering (5).

(5) I went on the bus yesterday and **the driver** was drunk.

One would be using a form signalling that the referent was merely Inferred to the listener, well aware that the referent was again Unused.

The central assumption is that the choice of a form corresponding to one of the assumed familiarity statuses follows the Gricean maxim of quantity, and that a cooperative speaker will therefore always seek to use the highest possible, or leftmost, form on the scale.

A problem with Prince's article is that it associates specific types of noun phrase with the categories on the assumed familiarity scale without empirical support.

Prince states that the purpose of the article is to provide a taxonomy of referential statuses, that is, which degree of assumed familiarity the entities in a discourse have, and sets aside the issue of the correlation between different linguistic forms and the degrees of assumed familiarity arrived at for future research. She uses examples such as the ones shown above to justify the ordering of the scale of assumed familiarity, thus providing an intuitive mapping between familiarity statuses and specific types of noun

phrase.

The assumed familiarity scale can usefully be applied to provide a finer categorization of referential status than the traditional dichotomy of Given and New, as long as the cognitive statuses of referents can be established independently of the linguistic data one wants to investigate. This is not easily done, however. One way would be to rely on speakers' introspections by simply asking them directly, but this is often impossible in practice, especially if one is investigating written language.

In the following, we turn to some alternative accounts of givenness, first Mira Ariel's concept of accessibility, which is a more consciousness/salience-driven approach, and later some accounts that combine these two aspects.

Ariel (1990): The Accessibility Marking Scale

Mira Ariel's widely cited theory of referent accessibility is presented in (Ariel, 1990). She focuses on the consciousness/mental accessibility aspect of givenness, and arrives at a continuum which she terms the Accessibility Marking Scale.

The scale arranges numerous types of definite noun phrase according to their degree of accessibility. Thus, lighter noun phrase types such as pronouns and null forms are the most accessible ones, while modified full noun phrases are the least accessible ones. She generally considers expressions that refer to entities in long term or encyclopedic memory (*Low Accessibility Markers*, i.e. proper names and definite full noun phrases) to be less accessible than those that refer to entities in the physical environment (*Intermediate Accessibility Markers*, i.e. deictics and demonstrative noun phrases), which are in turn less accessible than those that corefer with other expressions in the discourse (*High Accessibility Markers*, i.e. various types of anaphors). Ariel's Accessibility Marking Scale is reproduced as (6) below.

(6) Accessibility Marking Scale

Low accessibility

- a. Full name + modifier, e.g. *Joan Smith the president*
- b. Full ('namy') name, e.g. *Joan Smith*
- c. Long definite description, e.g. *the newly elected president*
- d. Short definite description, e.g. *the president*
- e. Last name, e.g. *Smith*
- f. First name, e.g. *Joan*
- g. Distal demonstrative + modifier, e.g. *that hat we bought last year*
- h. Proximal demonstrative + modifier *this hat we bought last year*
- i. Distal demonstrative (+ NP), e.g. *that (hat)*
- j. Proximal demonstrative (+ NP), e.g. *this (hat)*
- k. Stressed pronoun + gesture, e.g. *SHE*
- l. Stressed pronoun, e.g. *SHE*
- m. Unstressed pronoun, e.g. *she*
- n. Cliticized pronoun
- o. Extremely High Accessibility Markers (gaps, including pro, PRO, and *wh* traces, reflexives, and Agreement).

High accessibility

The retrieval context (i.e. encyclopedic memory, physical environment, or discourse) and the average antecedent-anaphor distance are the most important sources of evidence for the scale. Generally, the more accessible a form, the shorter the distance. Ariel considers it a consequence of the accessibility differences that the more accessible forms in the scale tend to be lighter: the more accessible a referent, the less lexical material is generally needed to activate it.

Gundel et al. (1993): The Givenness Hierarchy

Jeanette Gundel and colleagues are the authors of a widely cited article on referential status (Gundel, Hedberg & Zacharski, 1993). In it, they propose their Givenness Hierarchy, which is a one-dimensional account of the

choice of referential form. The following cognitive statuses are proposed as conditions for the use of different noun phrase types.

Type identifiable

When the type of thing referred to can be assumed to be identifiable to the listener, and when he or she can be assumed to know the word for it, it is possible to use an indefinite expression, such as *a dog (next door)* in Gundel et al.'s (2), shown as (7) below:

(7) I couldn't sleep last night. **A dog (next door)** kept me awake.

The only possible words with referents that are not type-identifiable would be nonsense words. Either because the listener does not know the word, or because he or she does not know the type of thing in question.

Referential

This status is the minimum requirement for using a form that signals that the speaker has a certain referent in mind, but does not assume that it is identifiable to the listener. This category is exemplified with the 'indefinite this' construction:

(8) I couldn't sleep last night. **This dog (next door)** kept me awake.

Uniquely identifiable

Next, to use any definite full noun phrase, it is not enough that the referent can be assumed to be type identifiable and referential for the listener. It must also be uniquely identifiable. This does not mean that it has to be previously familiar to the listener, as long as the intended referent can be identified on the basis of the noun phrase itself:

(9) I couldn't sleep last night. **The dog (next door)** kept me awake.

In the case of simple, singular objects in a display, this requirement is fulfilled if there is just one entity of the described type.

If a referent is uniquely identifiable, but not type identifiable, it is once again infelicitous to use a definite expression. If you do not know which of the two grey objects in figure 2.2 is called, say, a 'lape,' then there is no way of knowing which object is meant by the referring expression *the grey lape*.

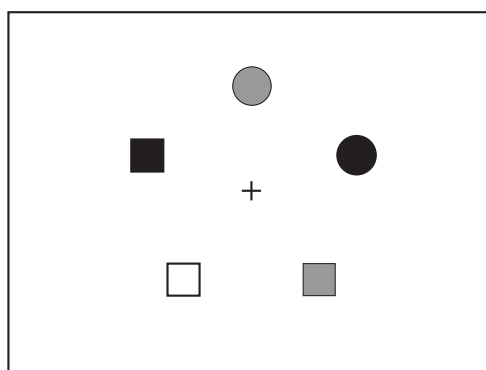


Figure 2.2: Simple, singular objects in a display.

Only when the referent is type identifiable AND you can assume your listener to be able to identify which referent you mean, it is possible to use a definite expression.

Familiar

This category contains referents which the listener can be assumed to already be familiar or personally acquainted with. Not only are such referents type- as well as uniquely identifiable, they also already exist as a representation in long term memory. The forms supported by this status are demonstrative noun phrases, as in (10), which signals that the listener is assumed to already know about the dog of the neighbor.

(10) I couldn't sleep last night. **That dog (next door)** kept me awake.

Activated

If a referent is currently represented in short term memory, it is said to be

activated. This cognitive category corresponds to linguistic forms such as demonstrative pronouns and accented personal pronouns, retrieving the referent from the immediate linguistic or the extralinguistic context.

- (11) I couldn't sleep last night. **That** kept me awake.

In focus

Finally, to use a 'regular,' unaccented definite pronoun, it is not enough that the referent is type identifiable, referential, uniquely identifiable, familiar, and activated, it also has to be in the listener's current focus of attention.

Uttered out of the blue, a referring expression such as *it* is not felicitous. But as soon as a compatible object is in focus, there is no problem. A referent can be assumed to be in focus immediately after it has been mentioned. Importantly, though, it is not enough for the use of a definite pronoun that the referent is in focus. It has to be both uniquely identifiable and type identifiable as well.

If a category type is in focus without any singular referent being in focus, a pronoun is not appropriate. This could be in the case of a generic expression. In (12), the concept of a tiger is in focus, but a singular definite pronoun is nevertheless infelicitous with the intended referential reading:

- (12) a. The tiger is an endangered species.
b. ?**It** was born in captivity on July 14.

If something is uniquely identifiable but not type identifiable, then referring to it using a definite pronoun is also infelicitous even if whether it is in focus:

- (13) The black lape is reserved.
?You cannot have **it**.

Only when a referent satisfies *all* the statuses is it fully acceptable to use a definite pronoun.

The cognitive statuses required for the use of different referring expressions seem to be organized in a hierarchy. Apparently, for something to be *uniquely identifiable*, it must necessarily also be *referential* and *type identifiable*. For something to be *in focus*, it must necessarily also be *activated*, *familiar*, and so on.

This observation led Gundel et al. (1993) to propose their *Givenness Hierarchy*, see figure 2.3.

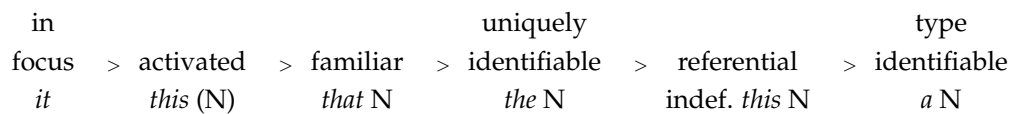


Figure 2.3: Gundel et al.'s *Givenness Hierarchy*.

The Givenness Hierarchy specifies that it is not felicitous to use noun phrase types that are higher on the hierarchy than the current cognitive status of the referent. If some referent is 'only' uniquely identifiable, then one cannot use a pronoun.

However, the hierarchy does not explicitly forbid the use of a noun phrase type that is lower on the hierarchy.

Consider the following example.

- (14) Take **a soda_i**.
 You can put **it_i** in the fridge when we get home.
- a. ?Then you can have **a soda_i** when **it_i** has gotten a little colder.
 - b. Then you can have **it_i** when **it_i** has gotten a little colder.

The utterance in (14-a) sounds strange, and the underlined noun phrase might be interpreted as meaning a different soda as the one in the first sentence. But the Givenness Hierarchy itself does not forbid the use of an indefinite full noun phrase in a situation like this: as long as something is type identifiable, even when it is also uniquely identifiable AND in focus, as is the case here, the condition for using an indefinite noun phrase is obeyed.

Gundel et al. argue that examples like (14-a) are ruled out by the general communicative constraint of the Gricean maxim of quantity, which states that one should not be redundant: “Do not make your contribution more informative than is required” (Grice, 1975). The reason why (14-a) sounds odd is that the referent is overspecified. The indefinite expression provides too much information in the context and thus violates the maxim of quantity.

In general, the Gricean cooperative principle motivates people to use referring expressions of the highest possible rank on the Givenness Hierarchy. In this way, Gundel et al. attempt to account for all types of simple singular referring expressions on one conflated dimension of givenness. In the following we shall see how other linguists have tackled the various dimensions of this cognitive category.

Lambrecht (1994): Activation and identifiability

Knud Lambrecht (1994) follows Chafe (1976) in his two-dimensional approach to referential status. Like Chafe, Lambrecht considers referential status to be associated with the two cognitive dimensions of *activation* and *identifiability*, having to do with consciousness and memory, respectively. The dimension of activation comprises the three categories *active*, *semi-active*, and *inactive*. Identifiability comprises the two statuses *identifiable* and *unidentifiable*.

How these categories are interrelated is illustrated in his example (3.25), reproduced as figure 2.4 below. The figure shows that something has to be identifiable in order to have mental activation—that activation depends on identifiability.

As for the formal expression of these categories, Lambrecht considers the most important grammatical contrasts to be (i) presence vs. absence of accent; (ii) pronominal vs. lexical coding; and (iii) in some languages definite vs. indefinite marking (Lambrecht, 1994, p. 107). Pronominalization and definiteness marking are the ones that will be investigated in this thesis.

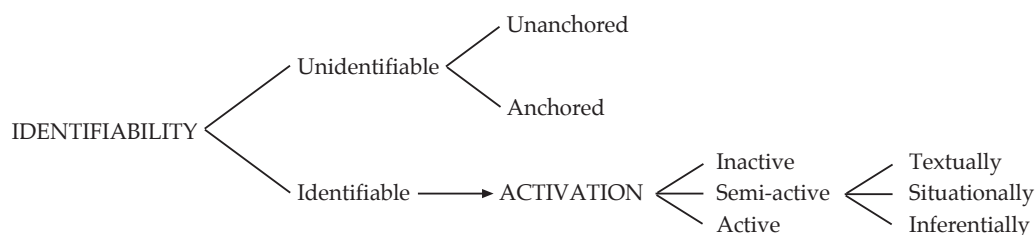


Figure 2.4: Lambrecht's information status terms (Lambrecht, 1994, 109).

Lambrecht describes the asymmetrical interaction of these categories both from the perspective of the cognitive states expressed, and from that of the grammatical categories expressing the cognitive states. Thus, an active referent may be expressed using any grammatical category: it may be unaccented or accented, pronominal or lexical, definite or indefinite, under different circumstances. On the other hand, according to Lambrecht, inactive referents are necessarily expressed as accented, lexical noun phrases, which may be definite or indefinite. If I have a certain thing in mind, but you do not, I cannot say *It was too expensive, don't you think?*, and expect to be understood. I would have to use a more explicit expression. Unidentifiable referents must be expressed as indefinite noun phrases. If I were dismantling a bomb and you told me to cut "the blue wire," where in fact it did not matter which of several blue wires I cut, you would probably have me working up a bit of a sweat.

From the perspective of grammatical features, pronouns and unaccented forms can be assumed to be active and identifiable for the listener. Neither definite nor indefinite coding are strictly necessary or sufficient conditions for any cognitive state. However, if one leaves out of the analysis certain 'less referential' noun phrase types such as generics, for instance (as in *the rhinoceros is almost extinct*), and also excludes the 'indefinite this' construction (as in *I saw this wonderful dress yesterday, and almost bought it*), a very strong correlation emerges after all. Thus, by and large, definite expressions signal identifiability. At least, this pattern generally holds

for simple, singular references to concrete objects, which is the mode of reference investigated in this thesis. If a referent is coded as an accented, lexical expression, it may be, but does not have to be, inactive. Indefinite expressions may or may not be unidentifiable. These are necessary, but not sufficient, conditions for inactiveness. These form-function correlations are summarized in figure 2.5. The tables summarize Lambrecht's description of the correlations between referential form and cognitive status. Lambrecht does not explicitly mention that Unidentifiability entails lexical coding, but it can be assumed that this is consistent with his overall view.

Cognitive status		Formal feature
Inactive	→	Lexical NP
	→	Accented NP
Unidentifiable	→	Lexical NP
	→	Indefinite NP
Formal feature		Cognitive status
Pronoun	→	Active
	→	Identifiable
Unaccented NP	→	Active
	→	Identifiable
Definite NP	→	Identifiable

Figure 2.5: Lambrecht's form-function correlations.

In this section we have seen a number of accounts of the correlation between the cognitive statuses of referents and their grammatical coding. I will return in a later section to referential status and present my synthesis of the ideas reviewed here in terms of the two cognitive dimensions of *identifiability* and *accessibility*, which will be seen as independently underlying the grammatical features of definiteness and pronominalization, henceforth $[\pm\text{def}]$ and $[\pm\text{pron}]$. It is these two grammatical features to which we now turn, in the context of a description of indefinite *one*-anaphors.

2.2 Indefinite *one*-anaphors in Danish

In this section I will define the grammatical categories of definiteness and pronominalization and specify how these terms will be used in this thesis. I consider both to be *grammatical surface features* rather than semantic/pragmatic features. Simplifying matters for the sake of expository convenience, I will treat them as if they were binary features. I will thus pretend for the moment that there are two values of pronominalization: full noun phrase form and pronominal form, and likewise, perhaps more reasonably, two values of definiteness: indefinite and definite. These two features, $[\pm\text{def}]$ and $[\pm\text{pron}]$, combine freely in Danish referring expressions, the rare combination of indefiniteness and pronominal form yielding indefinite *one*-anaphors.

Definiteness

What is definiteness? The Danish grammarian Aage Hansen writes : “The determination system regards the speech situation, the relation between the one speaking and his listener(s) or between the one writing and the one reading the written. Comprehension is greatly facilitated thereby that, thanks to this system, it can be stated whether the instance, occurrence etc. which is mentioned, and which attention should be paid to, is something already known or mentioned or something that follows from the speech situation, or whether it is something new, as yet unknown.” (Hansen, 1967, p. 91f).² This is one formulation of the *familiarity hypothesis*, according to which definite forms, informally speaking, express the statement ‘you know which one I mean,’ a view that probably also inspired Prince’s assumed familiarity scale. Example (15) illustrates why familiarity is not an adequate characterization of the feature $[\text{+def}]$ (Lyons, 1999, p. 3):

² Translated from Danish: “Determinasjonssystemet har henblik på talesituationen, forholdet mellem den talende og hans tilhører(e) eller mellem den skrivende og den der læser det skrevne. Forståelsen lettes i høj grad ved at der takket være dette system kan angives om det eksemplar, tilfælde osv. der omtales og som opmærksomheden skal rettes imod, er noget allerede kendt eller omtalt eller noget der fremgår af talesituationen, henholdsvis er noget nyt, endnu ukendt.”

- (15) They've just come in from New York. **The plane** was five hours late.

In this example, the listener is unlikely to have a personal memory representation of the particular plane 'they' just arrived with, and it would seem forced to say that the first sentence has introduced the idea of a specific plane, thus making it familiar in some sense by the time the second sentence is uttered.

In this thesis, definiteness will not be regarded as expressing familiarity. The definiteness distinction will be seen as a grammatical category expressing a meaning element, indeed a *grammaticalization* of a meaning element (Lyons, 1999)—and the meaning element is identifiability rather than familiarity. In the words of Christopher Lyons (1999): "In languages where identifiability is represented grammatically, this representation is definiteness; and definiteness is likely to express identifiability prototypically." The noun phrase *the plane* in (15) is thus characterized by definiteness. But its referent is characterized by identifiability, which informally speaking amounts to the statement 'you know *or can work out* which one I mean.' The definiteness of the noun phrase signals this statement, and it can indeed be worked out which plane is meant: the one 'they' came on from New York, without it ever becoming familiar to the listener.

Another main approach to definiteness involves uniqueness. Examples can be produced that are not handled well by the identifiability approach (Lyons, 1999, p. 9):

- (16) **The winner of this competition** will get a week in the Bahamas for two.

Clearly, in this example the winner of the competition has not been found yet, and it is therefore neither known nor possible to work out who the noun phrase will eventually refer to. But it is implied that there will be a unique winner.³

³ Strictly speaking, what is involved is *inclusiveness* rather than uniqueness: the noun phrase signals that its referent exhausts the set of entities that satisfy the description—

Most identifiable referents are at the same time unique in the relevant context, but in fact not always, as the following example shows (Lyons, 1999, p. 14):

- (18) [In a room with three doors, one of which is open]
Close **the door**, please.

The door is not unique, but identifiable nonetheless. There are thus examples of definite expressions used about identifiable but not unique entities and vice versa. But most referents of definites are actually both unique and identifiable. Especially in situations where there is a concrete entity to be found in a physical context, the referent of a definite expression will usually be both identifiable and unique. This thesis will be concerned with such concrete referents, and definite expressions will therefore be understood as signalling the conflated referential status of *unique identifiability*, adopting the term from Gundel et al. (1993).

Pronouns

What is a pronoun? Aage Hansen writes that “In establishing lexical categories according to the function of the words as part of speech, there is no basis for positing numerals and pronouns as special classes [...] The four big lexical categories contain a number of words without consistent lexical content which are able to represent another word or another part of the speech and become the bearer of this content, e.g. in the class of nouns: *I, he*, in that of adjectives: *my, his, it/this, so*, in that of adverbs: *there, here*,

in the case of singular definite expressions, a set of one. Thus inclusiveness subsumes uniqueness as a special case. That the more general category of inclusiveness is called for is illustrated by the following variant of (16), where the noun phrase is plural:

- (17) **The winners of this competition** will get a week in the Bahamas.

Here, no unique winner is implied, but it is certainly implied that *all* the winners will get to go to the Bahamas. This important theoretical detail will be ignored here for expository reasons.

where, thus, in that of verbs a single word *do* [...].” (Hansen, 1967, p. 17)⁴ Note that when he is classifying the words corresponding to ‘it’ and ‘this’ with the adjectives, this is because he considers articles a form of adjectives (qua their juxtaposition to nouns)—and the articles in Danish are homonymous with pronominal forms that can function independently. Hansen’s rejection of pronouns as a distinct lexical category reflects the difficulty of finding a unified definition of such a category.

	<i>Subject pronouns</i>		<i>Object pronouns</i>		<i>Reflexive pronouns</i>	
<i>Singular</i>						
1	jeg	I	mig	me	mig	me, myself
2	du	you	dig	you	dig	you(rself)
	De	you	Dem	you	Dem	you(rself) [polite]
3	han	he	ham	him	sig	him(self)
	hun	she	hende	her	sig	her(self)
	den	it	den	it	sig	it(self)
	det	it	det	it	sig	it(self)
<i>Plural</i>						
1	vi	we	os	us	os	us, ourselves
2	I	you	jer	you	jer	you(rselves)
	De	you	Dem	you	Dem	you(rselves)
3	de	they	dem	them	sig	them(selves)

Table 2.1: Personal and reflexive pronouns in Danish according to Allan et al. (2000).

⁴ From Danish: “Ved fastlæggelse af ordklasser efter ordenes funktion som del af talen bliver der ikke noget grundlag for opstilling af numeralier og pronominer som særlige klasser [...] De fire store ordklasser rummer et antal ord uden fast leksikalsk indhold som er i stand til at repræsentere et andet ord eller et andet parti af talen og bliver bærere af dettes indhold, fx. i substantivernes klasse: *jeg, han*, i adjektivernes: *min, sin, den(ne), sådan*, i adverbierne: *der, her, hvor, således*, i verberne et enkelt ord *gøre* [...]”

Reference grammars such as (Allan, Holmes & Lundskær-Nielsen, 2000) do treat pronouns as a distinct category. They list the Danish personal and reflexive pronouns as shown in table 2.1. They thus consider 3rd person pronouns a type of personal pronoun. Bhat (2004) would classify them among the non-personal pro-forms, i.e. forms that are used to refer to entities other than those present in the speech situation (the speaker and listener), and would do the same with the following forms in table 2.2 which Allan et al. list as indefinite pronouns.

<i>Common gender</i>	<i>Neuter</i>	<i>Plural</i>	
al	alt, alting	alle	all, everything, everyone
		begge	both
(en)hver	hvert		each, every(one)
ingen	ingen, ingenting	ingen	no, none, no one, nothing
	lidt	få	little, few
man			one, you, they
megen, meget	meget	mange	much, very, many
nogen	noget	nogle (nogen)	some/any, something/anything, someone/anyone

Table 2.2: Indefinite pronouns in Danish according to Allan et al. (2000).

There is much to be said about the difficulty of defining a unified concept of pronominality, but this thesis will skirt the many issues involved and adopt a consensus definition as expressed in (Fillmore, 1992):

When we speak of pronouns as making up a special ‘part of speech’ in a language, we generally have in mind words meeting most of the following conditions:

- (a) They make up a closed class of forms [...]
- (b) They serve the grammatical roles of nominals where they occur, while differing from lexical nominals in their distribution. [...]

- (c) They participate in, and are limited to, a fixed set of abstract semantic and grammatical paradigmatic oppositions. [...]
- (d) They serve particular pragmatic functions. In the case of personal pronouns, they link linguistic expressions with participants in the communication act, or provide ‘abbreviated’ reference to entities (him, she) or concepts (one) introduced elsewhere in the discourse.

Three aspects of this definition that can be emphasized are, first, that pronouns are considered *nominal* forms and second, that they provide ‘abbreviated’ reference, and third, that this reference is to entities or concepts *introduced elsewhere*. Thus they are characterized by a specific lexical category, by formal reduction, and by anaphoricity.

It can be further noted that the definition explicitly speaks of ‘abbreviated’ reference to entities *or concepts*,⁵ thus placing forms such as *one* (referring to a concept) among other pronouns. Allan et al., for instance, do not list this form among the indefinite pronouns where one might have expected it (the form translated as ‘one’ that they do list (*man*) is not the form used to refer to a concept, but rather to a generic person, usually translated as ‘you’ in English) or among any other type of pronouns for that matter.

The next subsection will be concerned with how forms such as *one* can be characterized in terms of definiteness and pronominalization as defined in this subsection—and it will take a closer look at what it means for such forms to “provide reference to a concept.”

Indefinite *one*-anaphors: indefinite and pronominal

Indefinite *one*-anaphors are expressions like *one* in the following example.

- (19) I saw the Sony laptops that were doing a similar thing, and immediately wanted **one**.

⁵ — presumably intended to mean a concept *type* rather than a concept *token*.

Are indefinite *one*-anaphors a type of pronoun? As we saw above, one of the four criteria of Fillmore's definition of pronouns is that they are anaphoric. It can be easily demonstrated that indefinite *one*-anaphors are just as anaphoric as definite pronouns. They both need an antecedent, which makes both utterances in (20) unacceptable when uttered 'out of the blue,' i.e. without an antecedent.

- (20) a. ?I saw **it** yesterday.
 b. ?I saw **one** yesterday.

By this criterion, then, indefinite *one*-anaphors are pronouns. How about the criterion of nominalness? Discourse anaphors can be classified according to various characteristics, i.e. syntactic categories, truth-conditions, contexts, and type of discourse reference tracking system (Huang, 2000). In terms of generative syntax, for instance, *one*-anaphors belong to the class of N'-anaphors ('N-bar'-anaphors) or NP-anaphors. As N'-anaphors, they serve the grammatical function of nominal head of a noun phrase, whereas as NP-anaphors they serve the grammatical function of a whole noun phrase. Thus both variants are nominal. An example of a modified indefinite *one*-anaphor where *one* replaces the nominal head is shown below (Dahl, 1985).

- (21) I like cakes.
 I would like **a three layer chocolate one**. [one = cake]

Definite pronouns cannot function as N'-anaphors, as the following example shows (the 'it' variant might conceivably have meant that the speaker would like a different version of the cake he or she doesn't like, namely a three layer chocolate version—in a sense, the same cake, but with some features changed).

- (22) I don't like this cake.
 I would like **a three layer chocolate one/*it**.

Definite pronouns are strictly NP-anaphors. Since N'-anaphors are both nominal and anaphoric, these two criteria are not enough to exclude modified *one*-anaphors, but there is of course the aspect of formal reduction. N'-anaphors can be argued not to be formally reduced to such a degree that they fulfill this criterion. N'-*one*-anaphors, or modified *one*-anaphors (Dahl, 1985), are thus not pronouns. Unmodified *one*-anaphors on the other hand, as Dahl's (4) shown as (23), can be regarded as a pronoun by Fillmore's definition.

(23) Phil gave Bob a doughnut because he asked for **one**.

Despite the fact that unmodified *one*-anaphors comply with a definition of pronouns like Fillmore's, not everyone agrees that they are pronouns. *One* is regarded by some as a numeral. For instance, Martin Haspelmath characterizes indefinite pronouns in general as a traditional "waste-basket category" which comprises all the pronoun types that do not readily fit into one of the four coherent main categories of personal, demonstrative, relative, or interrogative pronouns (Haspelmath, 1997, p. 11). The waste-basket contains several subcategories, none of which actually include unmodified *one*-anaphors. But the category of *mid-scalar quantifiers* comes close. Mid-scalar quantifiers are expressions such as *few*, *several*, and *many*, which occupy the middle of a scale from maximal to minimal quantity. The pronoun *one* seems to lie at one extreme of such a scale. But according to Haspelmath, mid-scalar quantifiers are not indefinite pronouns, since they "express quantity and have nothing to do with indefiniteness." A similar argument can be made for all numerals, and it is therefore likely that Haspelmath considers *one* a numeral rather than a type of indefinite pronoun. There are arguments against this, however. For instance, native speakers of Danish perceive a subtle meaning difference between the numeral *én* and the pronoun *én*. Thus, (24-a) implies that there is no more than one cookie for each child, whereas if (24-b) were uttered, it would not be bad behavior to take two. Example (24-c) is ambiguous, and can be synonymous with either (24-b) or (24-a).

- (24) Hej med jer, børn. Sæt jer ned, der er **småkager** til alle.
 Hey there, kids. Sit down, there are cookies for everybody.
- a. Tag **én småkage** og send dåsen videre.
 Have one cookie and pass the jar on.
- b. Tag **en småkage** og send dåsen videre.
 Have a cookie and pass the jar on.
- c. Tag **én** og send dåsen videre.
 Have one and pass the jar on.

The (24-a) reading of (24-c) gives the numeral sense of *én*, the (24-b) reading the pronominal sense. Note that accenting obligatorily signals the numeral sense by accenting when *én* functions as a determiner. This is not the case when it functions as a pronominal noun phrase.

This difference can also be shown using the following attested example⁶ ((25-a) is the original):

- (25) a. Selv om de populære billetter har været i forsalg længe, så er der dog stadig mulighed for at få **én** her på dagen, siger DSBs underdirektør.
- b. ?Selv om de populære billetter har været i forsalg længe, så er der dog stadig mulighed for at få **én billet** her på dagen, siger DSBs underdirektør.
- c. Selv om de populære billetter har været i forsalg længe, så er der dog stadig mulighed for at få **en billet** her på dagen, siger DSBs underdirektør.
- Eng. Even though the popular tickets have been on offer for a long time, it is still possible to get **one/one ticket/a ticket** today, says DSB's [Danish Railroads] vice president.

The original utterance (25-a) and the adapted (25-c) are perfectly fine under a non-numeral reading, whereas (25-b) sounds odd because of the numeral reading imposed by the accent on *én* (i.e., there is one and *only* one

⁶ The news on national Danish radio, May 26, 2006. From a story about a cheap one-day holiday special offer of train tickets valid for all of Denmark.

ticket available!). The utterance is pragmatically strange because it is implausible that there should indeed be exactly one ticket left (although ‘one’ might also be interpreted here as “one per person,” which would be less odd).

The subtle difference between numeral and non-numeral readings of indefinite *one*-anaphors is pointed out here to substantiate that there indeed exists a distinct *pronominal* category of indefinite nominals. However, I will consistently be speaking about indefinite *one*-anaphors, not indefinite pronouns, partly to avoid confusion between the forms studied here and indefinite pronouns of the *something, anything, nothing*, etc. type (Haspelmath, 1997), and partly to follow the terminological tradition promoted by Dahl (1985).

The other main characteristic of *one*-anaphors besides being pronominal forms is of course their indefiniteness. Indefiniteness usually suggests newness/non-sharedness/mere type identifiability (although, technically speaking, they are neutral or unmarked with respect to unique identifiability (Lyons, 1999)). This can be demonstrated with the following example. It is not fully acceptable to use an indefinite expression with identical intended reference. Therefore, the intended ‘same bird’ readings (indicated by the subscripts) of utterance (26-a) and (26-b) below are odd.

- (26) There is a **bird**_i at the bird feeder right now.
 a. ?Now a **bird**_i entered the bird house.
 b. ?Now **one**_i entered the bird house.

According to Yan Huang (2000), *one*-anaphors “correspond roughly to the semantically defined type of ‘identity of sense’ anaphors, that is, anaphors in which the anaphor and its antecedent are related in terms of sense” (Huang, 2000, p. 2f). The identity of sense relation is illustrated in the following example. The expressions in boldface refer to an entity of the same type as the underlined noun phrase, and thus instantiate the identity of sense relation. The difference between the two lies in their definiteness marking, creating a ‘same instance’ reading in the (a) sentence and a ‘dif-

ferent instance' reading in the (b) sentence. Here, uppercase subscripts are used to indicate identity of sense, while identity of reference is indicated by traditional index-style lowercase subscripts.

- (27) I heard that Ahmed's uncle bought a **Ferrari**_{A,i} last week.
- a. That's right! I saw **it**_{A,i} yesterday at the stadium!
 - b. Really? I saw **one**_{A,j} yesterday at the stadium!

Thus, pronouns signal identity of sense as well as identity of reference, whereas indefinite *one*-anaphors signal identity of sense, but non-identity of reference. The identity of sense relation is what is implied in Fillmore's definition of pronouns where he says that pronouns can refer to "concepts." It should be emphasized here, however, that although indefinite *one*-anaphors may refer to non-referential entities and thus mere concepts as shown in example (28), they are perfectly suitable for referring to an entity which is specific and individuated in the mind of the speaker (as shown by the possibility of referring back to it using a pronoun), but which is just not identifiable to the listener yet, as demonstrated by (29). In this respect, too, they behave like indefinite full noun phrases.

- (28) a. I am very attracted to public figures, but I would never marry **a politician**.
- b. I am very attracted to public figures, but I would never marry **one**.
- (29) a. Oh, this machine only takes quarters. I know I have **a quarter** in here somewhere, I just need to find **it**.
- b. Oh, this machine only takes quarters. I know I have **one** in here somewhere, I just need to find **it**.

2.3 A new view of givenness marking

The two grammatical features [\pm def] and [\pm pron] are normally not found in the same referring expression. Referring expressions are usually ei-

ther definite pronouns or definite or indefinite full noun phrases—seldom indefinite pronouns. The combination of pronominalization and indefiniteness makes indefinite *one*-anaphors fit badly into existing accounts of givenness and referring expressions. In this section, the cognitive categories underlying the grammatical oppositions of givenness marking will be reconsidered. A new view of givenness will be outlined in terms of the independent cognitive dimensions of *accessibility* and *identifiability*.

Indefinite and pronominal: A problematic combination

The various theories of givenness and referential form do not have an obvious place for indefinite *one*-anaphors. Memory approaches like Prince's could place them with other indefinite forms such as *a woman I know* (BN^A) or *a woman* (BN), since the intended referent when using such a form is usually not assumed to be shared by the interlocutor. The problem is that the concept or *type* of the thing referred to depends on an antecedent for its interpretation, and is thus not Brand-new. On the other hand, treating the form as Evoked misses the fact that the *referent* is most likely Brand-New. The problem here is that indefinite *one*-anaphors simultaneously belong in two different places on the scale. Prince's account thus has pronouns at one extreme of her 'shared knowledge'-type givenness scale, and indefinite noun phrases at the other, but no obvious place for expressions that are both pronominal and indefinite.

Ariel in her consciousness approach does not deal with indefinite forms, including indefinite *one*-anaphors—although she does mention *one*-anaphors as an instance of "pronouns belonging to the category of High Accessibility Markers" (Ariel, 1990, p. 63). Her example [10a] is shown as (30) below:

(30) This is a fine hall you have here. I've never lectured in a finer **one**.⁷

⁷ This is not a 'pure,' unmodified indefinite *one*-anaphor—but an unmodified version would have been acceptable, too: "This is a fine amphitheatre you have here. I've never lectured in **one** before."

For this reason it is likely that she would place indefinite *one*-anaphors at one extreme with the highly accessible items. But consciousness/mental accessibility approaches completely miss the fact that the referent of an indefinite *one*-anaphor is not shared by the conversation partners.

Ariel does not engage in a discussion of such forms, and it is therefore not possible to say whether she would attribute the choice of such a form to sheer variations in accessibility. But if so, why choose an indefinite form? Her account offers no straightforward answer.

Gundel et al. have definite pronouns at one extreme of their conflated one-dimensional hierarchy, and indefinite full noun phrases at the other extreme. Again, something seemingly cannot be at both extremes at the same time. The Givenness Hierarchy states that if something is in focus, then it is necessarily also uniquely identifiable. But this is not necessarily the case. It is possible for a category type (concept) to be identifiable and in focus without any category token (referent) being uniquely identifiable.

A simple example of this is when several objects have been referred to in a plural noun phrase like *the red sodas*. When a type is in focus, what kind of (singular) noun phrase is licensed? A definite pronoun is not appropriate, since the referent is not uniquely identifiable. On the other hand, it may sound slightly odd to use an indefinite full noun phrase when the type has just been activated—depending on the situation, this may amount to an overspecification which sounds a bit too repetitive, perhaps suggesting that the speaker thinks the addressee did not hear him the first time:

- (31) The **red sodas**_A are for you.
 a. ?You can have a **red soda**_A if you like.
 b. You can have **one**_A if you like.

As this example shows, the identity of sense relation between the antecedent and the anaphor is better expressed using an indefinite *one*-anaphor.

The Givenness Hierarchy includes both definite and indefinite noun

phrases and attempts to place identifiability and accessibility on the same cognitive continuum. Focus of attention is associated with pronominalization, while identifiability is associated with definiteness. And crucially, in-focus referents are assumed to be automatically uniquely identifiable.

Indefinite *one*-anaphors are at the same time pronominal noun phrases and indefinite noun phrases, signalling at the same time focusedness and mere type identifiability. It is not obvious where indefinite *one*-anaphors belong in the Givenness Hierarchy. Are they more like indefinite full noun phrases, or more like definite pronouns? They have features of both.

Finally, Lambrecht, building on Chafe, comes close to defining a model where the two dimensions are independent of each other. Lambrecht is on the right track in treating the consciousness and memory aspects of referent givenness as two partially independent (but interacting) functional dimensions. Lambrecht also comes close to formulating a coherent account of indefinite *one*-anaphora. He mentions indefinite *one*-anaphors as “an apparent exception to the one-to-one relationship between lack of accentuation and/or pronominal coding on the one hand, and activeness of the coded referent on the other,” in that the referent of such an anaphor is treated as accessible even though it is unidentifiable (Lambrecht, 1994, p. 106). He gives the following explanation of this apparent exception:

In uttering a lexical noun phrase, whether definite or indefinite, a speaker necessarily activates the CATEGORY denoted by the lexical head in addition to activating an individual in that category. The active status of this category may then be reflected in an anaphoric expression, independently of whether the addressee can identify the particular referent the speaker has in mind or not. Expressed in different terms, while the TYPE has become active, the TOKEN may not be. In the competition for formal marking, the type wins out over the token. (Lambrecht, 1994, p. 107. Original emphasis.)

The question is if this account fits elegantly into his overall account of givenness. He makes the seemingly reasonable claim that referents have

to be identifiable in order to have an activation status. According to Lambrecht, a referent cannot be both active and unidentifiable, so he posits a competition between a concept category and a concept instance with respect to givenness marking, forcing forms such as indefinite *one*-anaphors to choose sides, as it were.

This does not seem satisfactory. An account of singular referring expressions should be able to more elegantly handle indefinite *one*-anaphors, and I believe that a two-dimensional model is the way to proceed. I would argue that referring expressions indeed *can* be simultaneously active (or *accessible*) and unidentifiable. The solution to the problem is to take seriously the distinction between concept and referent, type and token, category and instance. The next subsection will establish the terms *identifiability* and *accessibility* as they will be used in the rest of this thesis, and after these definitions follows the outline of a givenness model combining the two in a novel way.

Identifiability and accessibility

Identifiability, as we have already seen, is the referential feature underlying definiteness marking. Unique identifiability is a property of a referent: the property of an addressee being able to work out which entity (possibly among many others) it is, on the basis of the referring expression alone. Unique entities in a referential domain generally have this property. Identifiability is strictly speaking an all-or-nothing category: either an entity is uniquely identifiable or it is not. However, it can be argued that non-uniquely identifiable entities can retain different degrees of identifiability. Consider the following noun phrase in the context of a scenario like the one depicted in figure 2.6:

(32) The small striped box on the table.

The referent of this noun phrase gradually becomes more and more identifiable: the words in the noun phrase one by one constrain the set of boxes that could be intended. If the noun phrase had not been completed,

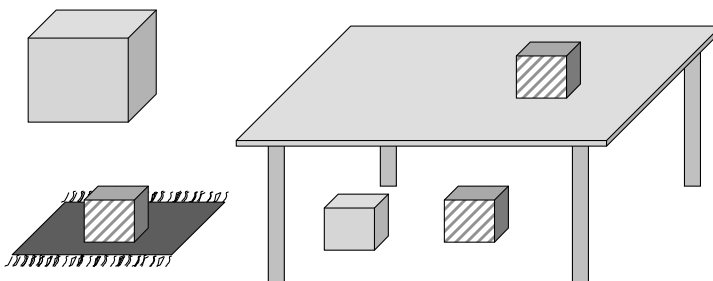


Figure 2.6: More or less identifiable boxes.

no box would be uniquely identifiable: *the small striped box on ...* could be either the one on the mat or the one on the table. *The small striped box* could be any of the three small striped boxes, *the small box* any of the four small ones, and *the box* any of the boxes. (And indeed, *the ...* could be any of the seven objects in the picture, including the mat and the table.) It could be argued that the more constrained the set of referents is, the more identifiable an entity in that set is. Thus, in the context of figure 2.6, a small striped box, while not uniquely identifiable, would nevertheless be more identifiable than just a box or even a small box. Such graded identifiability is reflected in grammatical devices for constraining reference such as adjectives (e.g. *small, striped*), prepositional phrases (e.g. *on the table*), restrictive relative clauses, etc., which thus constitute very important supplements to mere definiteness marking. In this thesis, however, identifiability will be treated simply as a matter of uniquely identifiable or not, corresponding to the binary terminology used about definiteness marking ([+def] vs. [-def]).

Accessibility marking is likewise reduced here to the binary distinction between [+pron] (pronominal forms) and [-pron] (full noun phrases) for simplicity. These two grammatical features map onto values somewhere near the extremes of a scale of mental accessibility which can most intuitively be thought of as continuous. Referents are more or less salient in the

discourse model, and are hence more or less accessible for the addressee. Accessibility, like identifiability, is a property of referents: the more accessible the referent, the easier it is to (re)activate in the discourse model. Accessibility is thus seen as a kind of activation potential. This formulation demonstrates how I will use two related and sometimes confused terms: *activation* (Lambrecht's term) will henceforth denote the degree to which a referent is 'lit up' in the mind of the addressee, whereas *accessibility* (Ariel's term) will denote the ease with which it can be activated. This distinction is made because activation is evidently a much more dynamic property than accessibility. Psycholinguistic results that we shall return to in chapter 4 thus show that entities referred to repeatedly in discourse are immediately activated when first mentioned, then quickly 'fade out' to become quickly reactivated when mentioned again, e.g. using a pronominal anaphor shortly after (Nicol & Swinney, 2003). While activation has thus fluctuated considerably over a short stretch of discourse, the accessibility of the entity will have remained high in order for a pronoun to be felicitously used as a subsequent referring expression. Accessibility can be assumed to linger while activation fades. The relation between activation and accessibility is asymmetric, one of unidirectional implication. When an entity becomes activated, it necessarily becomes more accessible. The reverse is not necessarily the case.

Since higher activation leads to higher accessibility, activation can be used as a new way of assessing the accessibility of referents. It is one of the major goals of this thesis to use activation to this end: as an online measure of accessibility.

With the two cognitive dimensions of identifiability and accessibility defined as they will be used in the rest of the thesis, we can now turn to an account of how they are seen to form a coherent functional space underlying givenness marking.

Givenness: A multidimensional feature space?

The two dimensions of identifiability and accessibility map out part of the meaning space of referring expressions, and presumably a large part of that. They are rather clearly mapped to the linguistic surface features of definiteness and pronominalization which together with accenting are identified by e.g. Lambrecht (1994) as the most important ones with respect to marking the differences in referential status, or givenness.

Indefinite *one*-anaphors seem to pattern with definite pronouns with respect to accessibility, but with indefinite full noun phrases with respect to identifiability. This leads to a notion of givenness where accessibility and identifiability have separate consequences for the use of different referring expressions. I will call this the *feature-based* view of givenness. The prevalent view of givenness is one where accessibility and identifiability are combined into a one-dimensional scale, as exemplified by Gundel et al.'s Givenness Hierarchy. I will call this the *conflated* view of givenness.

What I would suggest is that accessibility and identifiability form two orthogonal dimensions of cognitive status. The model I propose looks as sketched in figure 2.7.

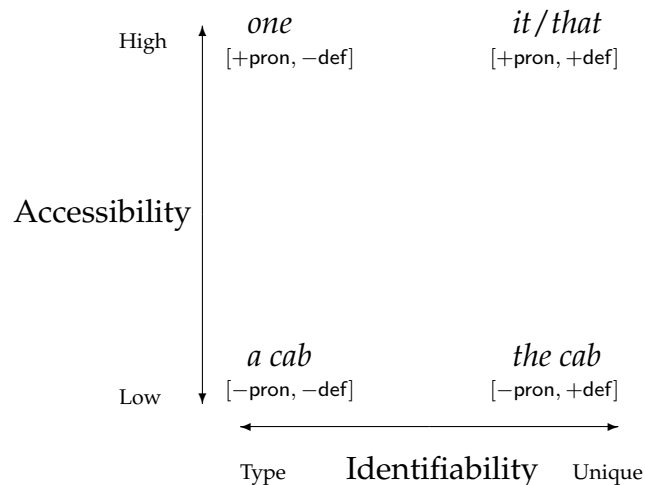


Figure 2.7: Two-dimensional model of cognitive statuses licensing referential form.

In this approach, accessibility motivates pronominalization, independently of identifiability, and identifiability motivates definiteness, independently of accessibility. If something can be assumed to be highly accessible in the mind of the listener (i.e. *in focus*), then it is appropriate to use a pronominal form, no matter whether this something is a uniquely identifiable referent or not. And correspondingly, if something can be assumed to be uniquely identifiable for the listener, then it is suitable to use a definite expression, no matter whether the referent is in focus or not.

I will assume that the two dimensions are essentially independent of each other—although there are likely to be complex interactions between them after all. This model incorporates various aspects of all the accounts presented above. Most notably, the basic idea from Chafe and Lambrecht is that the two dimensions both play a role. The dimension of identifiability may be seen as scalar in the way discussed in connection with example (32) above. The accessibility dimension is probably more continuous. It has to do with the prominence of a referent or type in the mind of the listener, which presumably varies in a graded manner. Conceivably, the categories on the Accessibility Marking Scale might be mapped directly onto the accessibility axis of the two-dimensional model. The primary motivation for this model is that it elegantly accommodates indefinite *one*-anaphors as highly accessible, but merely type identifiable referring expressions.

While the model highlights important functional differences between four major types of singular referring expression, I am not claiming that it represents an exhaustive functional map of referential meaning. It is a fragment showing the aspects under discussion in this thesis, along the lines of the functional maps shown in typological studies such as (Croft, 2001). A further dimension that could be added, but will be completely ignored in this thesis, is semantic number, which might become a third axis in the diagram, since each of the combinations of accessibility and identifiability in singular entities has a corresponding set with the same combination. The approach is generalizable in terms of features, an approach which is well-known from traditional structuralist linguistics (see Lyons

(1999) for a modern example). Thus, an indefinite *one*-anaphor could be described as a $[-\text{def}, +\text{pron}]$ referring expression if one were only interested in distinguishing the four expression types shown in the plot (which I will be in the rest of the thesis). Refining the characterization, it could be described as $[-\text{def}, +\text{pron}, +\text{sing}]$, thus accounting for number. Even more refined, it could be described as $[-\text{def}, +\text{pron}, +\text{sing}, +\text{stress}]$, now specifying that indefinite *one*-anaphors are obligatorily accented in Danish,⁸ etc. As I already noted above, the $[\pm\text{def}]$ and especially $[\pm\text{pron}]$ features are not necessarily binary, and it should be underscored here that the binary ‘plus/minus’ notation is mainly used for expository convenience.

If ever more axes were added to the plot above, it would no longer be straightforwardly representable in 3D space. While the ability to be graphically represented is not a theoretical merit of a model, it is nevertheless a hard-learned insight of this author that it is well worth keeping things simple, especially if one wants to study them empirically. Therefore this two-dimension model will serve as the theoretical background for the empirical studies reported in the following chapters.

⁸ Although this particular feature would therefore be redundant.

Chapter 3

Identifiability and anaphoric *én* in spoken dialogue

Indefinite *one*-anaphors are relatively rare, compared to the ubiquitous definite pronouns. As we shall see in this chapter,¹ they tend to occur under highly specialized circumstances, namely when a category is given in the discourse but no specific instance of that category has been individuated. This special nature of indefinite *one*-anaphors makes it difficult to study them through corpus linguistics. The intention in the present study is to gather some initial information about attested examples of this type of referring expression, which play an important role in this thesis as the prime example of an expression type which is both indefinite and pronominal—an expression type which in turn motivates a new view, sketched in the last chapter, of the interaction of identifiability and activation and their associated grammatical markers: the features [\pm def] and [\pm pron].

Indefinite *one*-anaphors are interesting because they possess two features that rarely co-occur: pronominal coding and indefiniteness. In my opinion, none of the existing models of givenness in the literature account well for this combination of features.

The feature-based view of givenness (cf. figure 2.7, p. 40) predicts that

¹ This chapter is based on an article published as (Diderichsen, 2007).

accessibility and identifiability will have separate consequences for the use of different referring expressions, whereas the conflated view sees these two parameters as lying on a one-dimensional continuum from less to more given.

The question in this chapter is whether indefinite *one*-anaphors will pattern with either definite pronouns or indefinite full noun phrases with respect to both accessibility and identifiability, as would be expected from the conflated view, or whether accessibility and identifiability will have separate consequences for the distributional pattern, which would support the dissociated view.

If the dissociated view is correct, there should be no difference in accessibility between the antecedents of indefinite *one*-anaphors and the antecedents of definite pronouns. Indefinite *one*-anaphors would simply be the indefinite counterparts of definite pronouns. On the other hand, something has to motivate the choice of an indefinite over a definite form, and differences would be expected relating to the degree of identifiability of indefinite *one*-anaphors and definite pronouns.

These considerations can be formulated as two hypotheses, which will be tested in the small corpus study reported below:

- (1) **Accessibility hypothesis:** There are no significant differences between relevant indicators of the accessibility of referents of definite pronouns and indefinite *one*-anaphors.
- (2) **Identifiability hypothesis:** There are significant differences between relevant indicators of the identifiability of referents of definite pronouns and indefinite *one*-anaphors.

These hypotheses will be further refined and operationalized on the basis of the theoretical considerations in the following sections.

The rarity of indefinite *one*-anaphors motivates the investigation of a quite intricate sort of negotiations, and must therefore necessarily make the corpus investigated rather small. The corpus used in the study

was the dialogue part of the DanPass unscripted spoken Danish corpus² (Grønnum, 2006). This part of the corpus consists of approximately 48,000 words.

The corpus was created in a laboratory setting with 11 dyads of participants (acquainted with each other) completing Edinburg University's Human Communication Research Centre's map tasks (Anderson et al., 1991). Each participant had a map (figure 3.1 and figure 3.2 below show an example of a set of maps). One, the instructor, had a route on his or her map. The other, the matcher, did not. Their goal was to collaborate so as to reproduce the instructor's route on the matcher's map. The maps were not exactly identical: landmarks were missing on one or the other map, a landmark might appear in two different locations on one map but not the other, and the same landmark might have slightly different labels on the two maps. This gave rise to true negotiations, with questions and answers, backtracks, etc. Participants were explicitly informed about the irregularities in the maps in written instructions prior to the recording. It was left to them, however, to discover how and where the maps or the labels differed, and to supply the missing items and correct labels on their respective maps. Each pair of speakers completed four different sets of maps.³

The orthographic transcription of the map task corpus was searched semi-automatically for occurrences of anaphoric *én/ét*. Indefinite *one*-anaphors are accented by default in Danish, but at the time of data collection, the corpus had not yet been annotated with stress, so this feature could not be used. Instead, a part-of-speech tagger was employed in order to find all occurrences of *en/et* followed by anything that was not a noun, an adjective, or a participial. These occurrences were then manually searched for indefinite *one*-anaphors. The corpus was later perused once more, and a few more indefinite *one*-anaphors turned up. These instances were included. A total of 30 instances were found: 26 of the common gender (*én*), 4 of the neuter gender (*ét*).

² Used with kind permission of prof. Nina Grønnum, Copenhagen University.

³ See www.danpass.dk and www.hrcr.ed.ac.uk/maptask for more information.

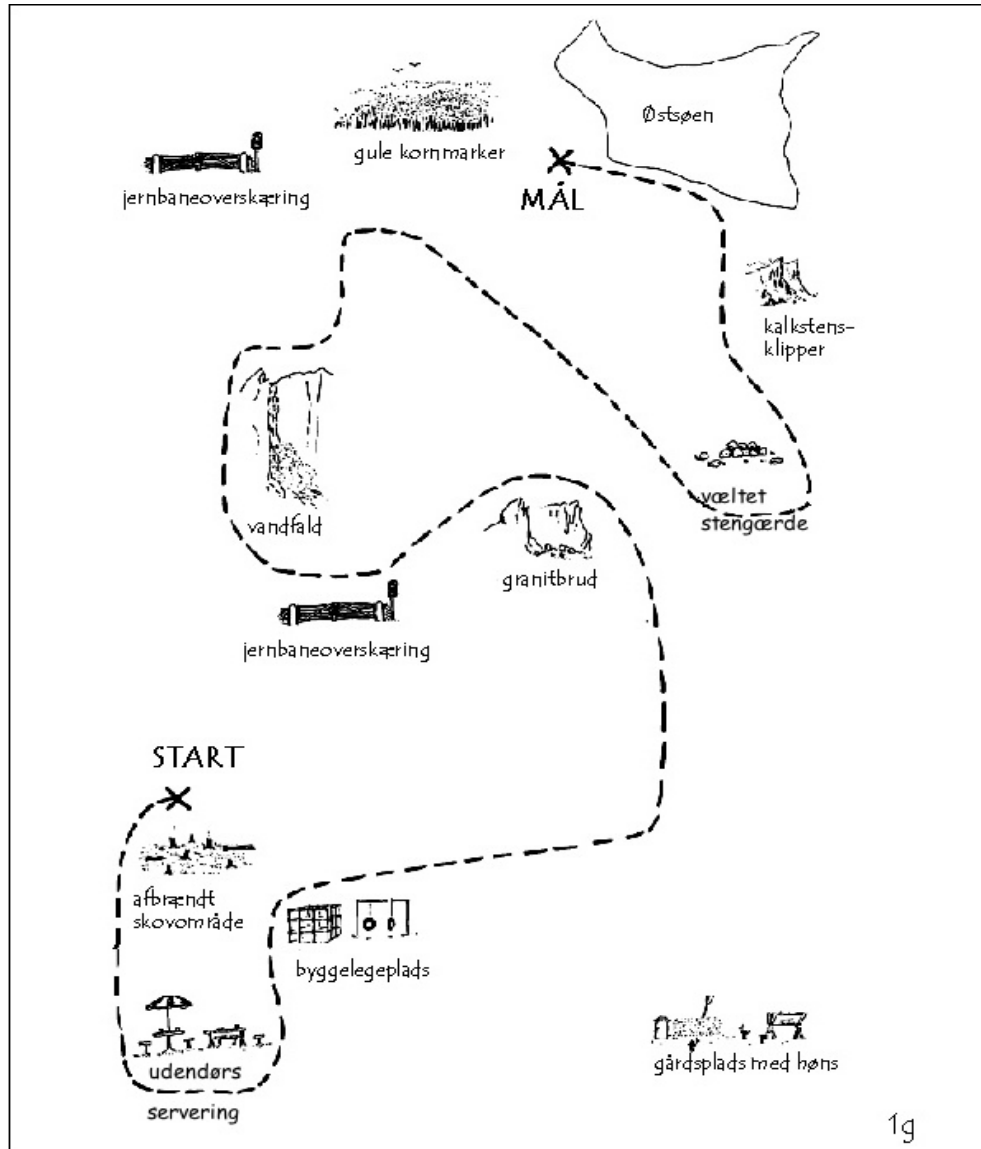


Figure 3.1: One of the maps used. Instructor version.

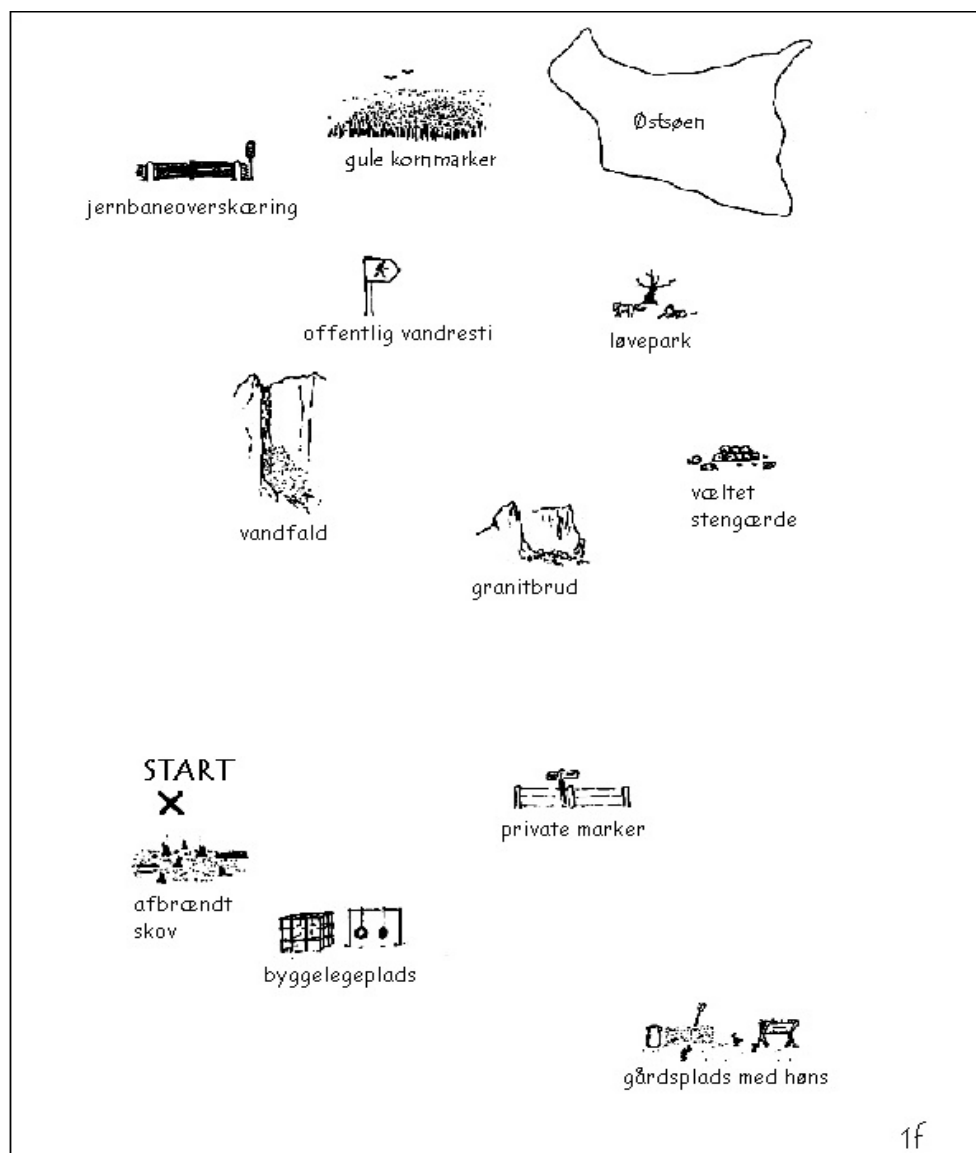


Figure 3.2: One of the maps used. Matcher version.

For comparison, the corpus was also searched for definite pronouns of the common gender (*den*). This search yielded some 350 instances. Given that there are about as many instances of the neuter gender,⁴ there should be in the order of 700 definite pronouns in the corpus, corresponding to a frequency of 146 tokens per 10,000 words as opposed to a frequency for indefinite *one*-anaphors of 6 tokens per 10,000 words.

A sample of 60 definite pronouns was extracted. Of these, 30 were chosen from the subset of pronouns judged by the author to be accented, and 30 from the unaccented subset. This categorization is relevant because of the well-known effect of accenting on the referential properties of referring expressions (Kristiansen, 1996; Venditti, Stone, Nanda & Tepper, 2001). The judgments of the author with respect to accenting were corroborated by 7 other linguists in a small experiment. At least 7 of the 8 coders agreed on 79% of the items. In terms of Cohen's kappa intercoder agreement (Bakeman & Gottman, 1997; Rietveld & van Hout, 1993; Carletta, 1996), this corresponds to $\kappa = 0.68$, which indicates that the categorization is reasonably reliable.

3.1 Accessibility and pronominal expressions

How accessible are indefinite *one*-anaphors compared to definite pronouns? Several measurements were performed in order to estimate and compare the accessibility of the referent and/or concept referred to with the three types of pronoun extracted from the corpus (indefinite *one*-anaphors, accented definite pronouns, and unaccented definite pronouns). Referential distance to the nearest compatible antecedent is the most common linguistic measure of accessibility in the literature (Givón, 1983a; Ariel, 1990; Grüning & Kibrik, 2005). The more recent the antecedent, the more accessible it can be assumed to be at the time when the pronoun is uttered. Here, referential distance is measured in terms

⁴ An assumption that has not been verified, and should only be taken as a rough estimate.

of number of utterances to the left, as opposed to e.g. Givón's (1983a) number of *clauses* to the left. The operational definition of an utterance employed here is inspired by Chafe's *intonation unit* (Chafe, 1994). As a practical heuristic, a portion of speech was considered an utterance if it could be perceived as completed in isolation. Both interlocutors' utterances were counted, and if the antecedent occurred in the same utterance, the antecedent-anaphor distance was scored as 0. First position reduplications as in example (3) below, a common occurrence in spoken Danish (Nedergaard Thomsen, 1992), were treated as anaphors immediately preceded by their antecedent, and consequently had an antecedent-anaphor distance of 0.

- (3) B₁: *den der jernbaneoverskæring den den har jeg helt oppe*
 'that railway crossing, that that I have all the way up'
 B₂: *i det nordvestlige hjørne af min tegning*
 'in the north-west corner of my drawing'

A variant of the distance measure is the distance to the nearest lexical antecedent, i.e. an antecedent with an explicit nominal head. Again, the closer the nearest lexical antecedent, the more accessible the concept can be assumed to be.

Also, repeated mention gives an indication of the accessibility of an antecedent (Lappin & Leass, 1994; Mitkov, 1997; Cristea & Postolache, 2005; Nicol & Swinney, 2003). The more frequently a referent or concept has been evoked prior to the occurrence of the anaphor, the more accessible it can be assumed to be, an assumption that is often made in computational approaches to pronoun resolution.

Furthermore, the syntactic and morphological nature of the immediate antecedent is an indication of the salience, and thereby accessibility, of an entity. For instance, an antecedent that is itself an anaphor can be assumed to be more accessible than one that is a full noun phrase (Kaiser, 2005). Most notably, many studies, for instance within the Centering framework, suggest that there is a preference for the grammatical subject to be inter-

preted as the antecedent in case of ambiguity (Grosz, Joshi & Weinstein, 1995; Kehler, 1997; Kehler, 2002).

Finally, the definiteness and lexical explicitness of the antecedent may give a hint about the accessibility of the referent. The assumptions here would be that a definite antecedent renders an entity more accessible than an indefinite antecedent, and that a pronominal antecedent renders an entity more accessible than a full noun phrase antecedent.

In the following subsections, I report the results of these measures as applied to the three types of [+pron] expressions investigated: indefinite *one*-anaphors, accented definite pronouns, and unaccented definite pronouns.

Referential distance to the antecedent

The mean distance measured in number of utterances between indefinite *one*-anaphors and their antecedent was 1.4 (sd = 0.9). This measure reflects that the antecedent was typically in the immediately preceding utterance. The mean pronoun-antecedent distance of the accented definite pronouns was exactly the same, although with a higher variance ($t(30) = 0$, n.s.). There was a larger difference between indefinite *one*-anaphors and unaccented definite pronouns ($t(30) = -1.76$, $p = 0.09$, two-tailed), as well as between accented definite pronouns and unaccented definite pronouns ($t(30) = -1.64$, $p = 0.11$, two-tailed).

Anaphor type	Avg. referential distance
Indefinite <i>one</i> -anaphors	1.4 (sd = 0.9)
Accented definite pronouns	1.4 (sd = 1.3)
Unaccented definite pronouns	2.1 (sd = 2.1)

Table 3.1: Average referential distance in number of utterances of different types of anaphoric expression.

There are no significant differences in the data, possibly for lack of statistical power, but there is a tendency for accented forms to have shorter

referential distances. This result suggests that the differences in referential distance among the three anaphor types is due to accenting rather than definiteness, and is thus consistent with the hypothesis that there is no difference in accessibility between indefinite and definite pronominal forms.

What is a bit puzzling is that the tendency is in the opposite direction of what would be expected. Givón's (1983a) topic activation scale and Ariel's (1990) Accessibility Marking Scale both predict that the antecedent of an unaccented pronoun would be closer than that of an accented pronoun, since, according to them, unaccented pronouns code higher accessibility. The opposite tendency can be observed in the present data. This may be due to the fact that accented pronouns tend to shift attention away from the referent that would otherwise be the most likely antecedent and instead pick out some contrasting entity. For instance, a grammatical object antecedent will typically be preferred to a grammatical subject in parallel clause sequences such as 'John hit Bill and then HE hit George,' where native speakers interpret the accented HE as Bill rather than John (Venditti et al., 2001). The same *switch reference* or topic continuity/discontinuity pattern has been documented for spoken Danish (Kristiansen, 1996). The canonical Danish word order is SVO (i.e. subject - verb - object), and therefore grammatical object antecedents will tend to be closer than subject antecedents. Since sentences in spoken language are often divided into several utterances, grammatical object antecedents may well be closer to the anaphor than subjects in the utterance-by-utterance metric employed here.

When one looks at the data, it is obvious that topic continuity/discontinuity also plays a role, especially in situations of potential interference. Several of the definite pronouns from the unaccented sample 'bypass' the nearest possible antecedent in favor of the current topic expressed as a noun phrase in a more distant utterance, whereas the accented definite pronouns tend to prefer the most recent possible antecedent (which may, however, be located several utterances back). Another prominent factor is the fact that accented definite pronouns relatively frequently figure in first position reduplications, which yields an antecedent-anaphor distance of 0, and thus contributes to the difference.

It should be noted, by the way, that Givón himself finds a shorter average referential distance of demonstrative pronouns than of unaccented pronouns in spoken English (Givón, 1983b). This is consistent with the above explanations. Indefinite one-anaphors never appear in first position reduplications, yet they usually occur promptly after the antecedent is first mentioned, and almost never occur in situations of potential interference. Thus, although indefinite one-anaphors never have extremely short anaphor-antecedent distances, the mean distance is still relatively short.

Linear distance to the nearest lexical antecedent

While the immediate antecedent is typically very close to a pronoun, the necessary type description in the form of a lexical nominal head is usually a bit farther away.

Each definite pronoun and indefinite *one*-anaphor extracted from the corpus had at least one such lexical antecedent. The average distance from an indefinite *one*-anaphor to the most recent lexical antecedent was 3.6 utterances back. Accented definite pronouns had a lexical antecedent 2.3 utterances back on average. The difference is non-significant ($t(30) = 1.70$, $p = 0.09$). The difference between indefinite *one*-anaphors and unaccented definite pronouns is significant ($t(30) = -2.05$, $p < 0.05$), and so is the difference between accented and unaccented definite pronouns ($t(30) = -2.9$, $p < 0.01$).

Anaphor type	Avg. referential distance
indefinite <i>one</i> -anaphors	3.6 (sd = 3.5)
Accented definite pronouns	2.3 (sd = 2.2)
Unaccented definite pronouns	7.1 (sd = 8.8)

Table 3.2: Distance to the lexical antecedent of different types of anaphoric expression.

This result repeats the pattern from above: accented forms tend to have lower distances than unaccented forms. When accenting is controlled for,

there is thus no evidence of an accessibility difference between indefinite and definite pronominal forms, as predicted in the accessibility hypothesis.

The relative closeness of lexical antecedents to accented forms suggests that entities referred to using accented forms are introduced relatively late. This is consistent with the observation that accented pronouns are typically not used to maintain reference to the main topic of a discourse, but rather to shift attention to contrasting other entities introduced along the way (Venditti et al., 2001). If this is in fact the case, this would predict lower values of repeated mention for referents of accented pronouns. We turn to measures of repeated mention in the following subsection.

Repeated mention

The anaphors in the corpus often have more than one prior reference. The number of prior references is indicative of the accessibility of the referent and/or concept being reactivated by the anaphor. The higher the count, the more accessible the referent/concept. It follows from the accessibility hypothesis that there should be no statistically significant difference in this respect between indefinite and definite pronouns. This was in fact the case (cf. table 3.3).

Anaphor type	Avg. number of prior references
Indefinite <i>one</i> -anaphors	3.2 (sd = 2.3)
Accented definite pronouns	3.9 (sd = 5.3)
Unaccented definite pronouns	6.1 (sd = 4.2)

Table 3.3: Number of prior references of the different types of pronoun.

The average number of prior references of indefinite *one*-anaphors was 3.2. For accented definite pronouns it was 3.9. This difference is not significant ($t(30) = -0.72$, $p = 0.47$, two-tailed). The difference between indefinite *one*-anaphors and unaccented definite pronouns is significant ($t(30) = -3.31$, $p < 0.01$, two-tailed), whereas the difference between accented and

unaccented definite pronouns is not ($t(30) = -1.72, p = 0.09$, two-tailed).

This result once again groups the two accented forms together, and the most significant differences among the three anaphor types thus seems to be due to accenting. This means that again there is no evidence of higher accessibility of indefinite or definite anaphors.

Note that the observed pattern is in accordance with Givón's and Ariel's theories of accessibility. The finding that unaccented pronouns tend to have more prior references suggests that this type of pronoun is used to a higher extent to maintain reference to the main topic over longer stretches of discourse, which is also consistent with the referential distance results reported above. Furthermore, the result supports the idea that referents of accented pronouns are often introduced relatively late, and function to shift attention away from the main topic.

The syntactic role of immediate antecedents

Many studies suggest that syntactic salience plays a role in the interpretation of anaphors: the antecedent should be high on a grammatical role hierarchy such as (4) (Givón, 1983a; Kehler, 2002; Gundel, Hedberg & Zacharski, 1993, p. 280: ex. (9) and (10)).

(4) Subject > Object > Indirect object > Oblique role

The assumption is that grammatical subjects tend to code higher topic continuity, and will therefore be more natural, or accessible, antecedent candidates for continued anaphoric reference. The Centering framework in some of its formulations (Grosz et al., 1995) makes the explicit assumption that syntactic role is an important factor in the ordering of the so-called forward-looking center list, which is a theoretical construct corresponding to a list of potential topics. The highest-ranking entity in the forward-looking center list is the most likely entity to be talked about in the ensuing utterance, and grammatical subjects generally rank higher than other syntactic roles.

The importance of syntactic roles is partially confirmed by the immediate antecedents in all three anaphor types (cf. table 3.4). The majority of antecedents are subjects or direct objects, while few are in oblique syntactic positions. But there is a clear difference between indefinite *one*-anaphors and definite pronouns. The accented definite pronouns more frequently have subjects as antecedents, and less frequently have objects (Fisher's exact test: $p < 0.01$). The same holds for unaccented definite pronouns (Fisher's exact test: $p < 0.01$). The frequency distributions of accented and unaccented definite pronouns do not differ significantly (Fisher's exact test: $p = 0.66$). Indefinite *one*-anaphors, on the other hand, have objects as their most frequent antecedent.

Anaphor type	Grammatical role of antecedent		
	Subject	Object	Oblique
Indefinite <i>one</i> -anaphors	1	23	6
Accented definite pronouns	11	12	7
Unaccented definite pronouns	15	10	5

Table 3.4: Grammatical roles of the immediate antecedents of the three anaphor types.

Why is this? Note that subjects of presentational *der* ('there') constructions were coded as objects. In the midst of the general confusion in the next example, a series of presentative *der* constructions can be observed (underlined). Both participants come to realize that there are two banana palms on the map, and the matcher finally tries to sum up by introducing each of them in their own presentative construction in turn.

- (5) A₁: *ligger bananpalmen hos dig efter feltstationen*
 'is the banana palm in your map after the field station?'
 B₁: *ja* 'yes'
 A₂: *okay nå men min ligger før*
 'okay, well but mine is before'
 B₂: *jamen jeg fattede at der var to*
 'but I gathered there were two'

- B₃: *det er der så også kan jeg se*
 ‘well so there are, I can see’
- A₃: *ja det er der også*
 ‘yes, so there are’
- B: *så der er en bananpalme altså syd for feltstationen*
og så er der én sydvest for
 ‘so, **there is a banana palm** south of the field station,
 and then **there is one** to the south-west’

Presentative constructions like these account for a substantial part of the difference. Seven of the indefinite *one*-anaphors follow presentative constructions, and are consequently coded as having objects as their immediate antecedents. None of the definite accented pronouns do, and only one of the definite unaccented pronouns does. This suggests that the antecedents of indefinite *one*-anaphors tend to be more newly introduced than those of the two types of definite pronoun. Presentative *der* constructions by definition introduce a new referent, normally using an indefinite form (although exceptions, like “there were the usual people at the party,” have been noted in the literature).

It is not self-evident why antecedents of indefinite *one*-anaphors would be newer than antecedents of definite pronouns. Indefinite *one*-anaphors themselves usually introduce a new referent—after all, they are indefinite. The explanation may be somewhat task specific. The most likely scenario is that unique landmarks are routinely introduced using definite forms, which will work fine if the landmark in question is indeed unique in both maps. But if it turns out, like in example (5) above, that the landmark is in fact not unique in one or both of the maps, communication will break down and only continue once it has been clarified how many instances of the landmark actually exist, and where they are located. The function of indefinite *one*-anaphors is to introduce a *different (i.e. contrasting) referent of the same type* as one just mentioned. This is the ideal context for one or more presentative *der* constructions.

This partial explanation has more to do with identifiability than accessibility. The motivation for using indefinite forms in cases like this is precisely that the referent turns out not to be uniquely identifiable—not that the concept is inaccessible. Therefore, it may be unwise to take the result above as evidence that concepts referred to using indefinite *one*-anaphors are less accessible than those referred to using definite pronouns.

Definiteness and lexical explicitness of immediate antecedents

Are there any differences in definiteness and phonological size in the antecedents of the three anaphor types? The assumptions here are that definite forms will render an entity more accessible than indefinite forms, and that pronominal forms will render an entity more accessible than lexical forms.

Although an antecedent with an overt nominal head can usually be found somewhere in the referential chain, this is not the only type of noun phrase that can function as the immediate antecedent. As the following examples illustrate, the antecedent of an indefinite *one*-anaphor can be in the form of full noun phrases or pronouns, definite as well as indefinite—singular as well as plural.

- (6) A: *når du er kommet godt syd om- eller godt forbi girafferne så svinger du til v- en runding til venstre ned rundt om **en lille sø***
 ‘when you have passed well south of- or well past the giraffes then you turn l- in an arc left down around **a little lake**’
 B: *sådan en har jeg ikke*
 ‘**such a one** I don’t have’
- (7) A: *skal jeg ovenover eller nedenunder **det forladte pakhus***
 ‘should I go above or below **the abandoned warehouse**’
 B: *se sådan et har jeg ikke men jeg tror du skal oven over det*
 ‘see, **such a one** I don’t have but I think you should go above it’

- (8) A: *sådan en har jeg ikke*
 'such a one I don't have'
 B: *har du ikke sådan en*
 'don't you have such a one'
- (9) A₁: *den har jeg helt oppe*
 'that one I have all the way up'
 A₂: *i det nordvestlige hjørne af min tegning*
 'in the north-west corner of my drawing'
 B: *nå der har jeg også en*
 'right, there I also have one'
- (10) A₁: *de- det kan være der er flere*
 'it- it may be that there are more'
 B: *å-åh 'uh-oh'*
 A₂: *men der ligger et hvad skal vi sige vest for den.. telefonboks*
 'but there is one, what shall we say, to the west of that.. tele-
 phone booth'

These examples show that the type description needed to interpret an indefinite *one*-anaphor can be maintained without necessarily using a referring expression that includes an explicit nominal head. Furthermore, the use of singular antecedents shows that it is not necessary for entities of the relevant type to be evoked in the plural in order to use indefinite *one*-anaphors. Referents of indefinite *one*-anaphors must not necessarily be non-unique, as long as they are type identifiable. By contrast, referents of singular definite pronouns must necessarily be uniquely identifiable.

The definiteness and lexical explicitness of the immediate antecedents of the three anaphor types are shown in the tables below. First, consider the definiteness data presented in table 3.5. The differences among the frequencies in the "total" column are marginally significant (Fisher's exact test: $p = 0.054$, two-tailed) . The difference between *én* and *den* is significant (Fisher's exact test: $p = 0.04$, two-tailed), whereas the accented definite pronouns do not differ statistically significantly from either the

indefinite one-anaphors or the unaccented definite pronouns (*én* vs *dén*: Fisher's exact test: $p = 0.61$, two-tailed; *dén* vs *den*: Fisher's exact test: $p = 0.18$, two-tailed). However, the values of *én* and *dén* are closer than those of *dén* and *den*, and thus there is a tendency for the two accented forms to pattern together.

		Singular	Plural	Total
<i>én</i>	Indefinite	14	3	17
	Definite	11	2	13
<i>dén</i>	Indefinite	14	0	14
	Definite	16	0	16
<i>den</i>	Indefinite	8	0	8
	Definite	22	0	22

Table 3.5: Definiteness of immediate/nearest antecedents of the three anaphor types.

Apparently, speakers to a certain extent avoid using accented forms to refer back to referents of definite expressions. This may be because accenting on pronouns tends to switch reference away from the main topic—that is, in many cases to a referent that has been newly introduced with an indefinite form. In any case, the data once again group the three anaphor types according to accenting, and there is no evidence of a difference in definiteness between antecedents of indefinite one-anaphors and definite pronouns.

		Singular	Plural	Total
<i>én</i>	Lexical	10	2	12
	Pronominal	15	3	18
<i>dén</i>	Lexical	18	0	18
	Pronominal	12	0	12
<i>den</i>	Lexical	11	0	11
	Pronominal	19	0	19

Table 3.6: Lexical explicitness of immediate/nearest antecedents of the three anaphor types.

Now consider the lexical explicitness results in table 3.6. Fisher's exact test indicates that there are no significant differences among the three anaphor types with respect to the lexical explicitness of their antecedents

($p = 0.17$, two-tailed). However, there is a quite clear tendency for the indefinite one-anaphors and the unaccented definite pronouns to have more pronominal than full noun phrase antecedents, whereas the accented definite pronouns have more full noun phrase antecedents than pronominal antecedents. I investigated the data more closely, and found that a prominent difference between *én* and *dén* is that *én* has more indefinite one-anaphors as antecedents, and *dén* has more indefinite full noun phrases. Thus, the difference between the two accented forms mainly stems from differences in lexical explicitness within the indefinite antecedents. It is a possibility that the type description which is sufficient for the use of one-anaphoric expressions tends to be more prominent when the speaker chooses a one-anaphor than when he or she chooses an accented definite pronoun, where the focus may to a higher degree be on the individual newly introduced referent. The accessibility of referents of these two types of referring expression is distributed slightly differently on type and token, so to speak.

A further reason for the many one-anaphoric antecedents of indefinite one-anaphors may be structural priming, or 'alignment.' A growing body of psycholinguistic evidence shows that structures on all levels of language tend to become 'aligned' during dialogue (Pickering & Garrod, 2004; Hadelich, Branigan, Pickering & Crocker, 2004; Kreysa, Arai, Haywood & Pickering, 2006). For instance, if one interlocutor uses a certain syntactic construction like the passive, the other interlocutor will be more likely to do so as well. The same may well hold for indefinite one-anaphors.

Since the difference between accented definite pronouns and indefinite one-anaphors is not statistically reliable, this finding should not be regarded as conclusive evidence against the accessibility hypothesis.

Accessibility: Summary of results

The accessibility of three types of anaphoric expression (indefinite *one*-anaphors, accented and unaccented definite pronouns) was assessed. A

number of different measures were used to this end.

The two measures that were used yielded qualitatively similar results: the patterning of accented, indefinite *one*-anaphors with accented, definite pronouns, which had a shorter distance to the immediate antecedent and the nearest lexical antecedent than unaccented, definite pronouns—contrary to what would be expected from Givón's (1983a) and Ariel's (1990) accessibility scales. With respect to the repeated mention measure, accented indefinite *one*-anaphors also patterned with accented definite pronouns, which both had fewer prior references than the unaccented, definite pronouns. With respect to the syntactic role of the antecedent, the two types of definite pronoun patterned together with a large number of subjects relative to the indefinite *one*-anaphors. However, the difference seemed to be due mainly to identifiability differences, not accessibility differences. As for the definiteness of the antecedent, the two accented forms again seemed to pattern together, in that they both had substantially fewer definite antecedents than the unaccented definite pronouns did. The lexical explicitness of the antecedent yielded no significant difference among the three anaphor types. However, there was a surprising tendency for the accented definite pronouns to have more full noun phrase antecedents than both indefinite *one*-anaphors and unaccented definite pronouns. The difference between the indefinite *one*-anaphors and accented definite pronouns turned out to exist mainly in the indefinite antecedents, and it was speculated that the tendency might have to do with a difference in type accessibility, and possibly also with alignment.

Thus, in sum, none of the differences found convincingly indicated any accessibility difference between indefinite and definite anaphors—when accenting is accounted for, that is. The majority of differences were due to accenting, and thus the results also suggest that accented forms differ from unaccented forms with respect to accessibility. One result seemed to mainly indicate a difference due to identifiability. Identifiability is exactly what we will turn to in the following.

3.2 Identifiability and pronominal expressions

We now turn to the identifiability hypothesis. If the choice between indefinite and definite pronominal forms is determined by identifiability, then one should be able to observe differences in this feature among the referents of the three types of pronouns.

In the following, a number of illustrative examples will be used to clarify what kinds of expressions can be expected to be used to refer to entities of different sharedness status in the visual common ground. In order to do this, a quite elaborate notation scheme for visual sharedness must be applied. This notation scheme will be explained before we proceed to the examples.

The map task maps were designed to include a number of landmarks that vary in sharedness in the following ways:⁵

1. *Sharedness*: Certain landmarks (the majority) were represented on both maps.
2. *2:1 landmarks*: Certain landmarks appeared twice on the instructor's map (once in a position close to the route and once in a more distant location), whereas the matcher had only the distant one.
3. *Absence/presence of landmarks*: Certain landmarks were found on one map but not the other.
4. *Name change of landmarks*: Certain landmarks were identical in form and location but had different labels on the two maps.

In the following, the term 'speaker' will be used to designate the person producing the utterance containing a particular referring expression. Conversely, 'listener' designates the interlocutor, i.e. the person who is not the speaker at that moment.

Either the instructor or the matcher can be the speaker when shared landmarks are described, whereas only the instructor has duplicate landmarks, which means that if the speaker has duplicate landmarks, the

⁵ See www.hcrc.ed.ac.uk/dialogue/maptask.html

speaker is the instructor, and if the speaker is the one with the solitary landmark, the listener is the instructor. This asymmetry does not exist in the remaining categories, where either instructor or matcher can be the speaker.

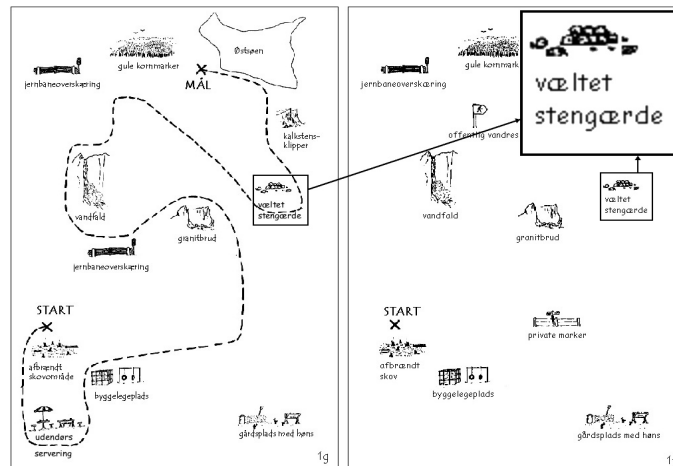
This yields the logical possibilities for the visual sharedness status of referents on the list below.

1. Speaker: unique; Listener: unique (designated *1:1 landmarks*).
2. (a) Speaker (instructor): non-unique; Listener (matcher): unique (*2:1 landmarks*).
(b) Speaker (matcher): unique; Listener (instructor): non-unique (*1:2 landmarks*).
3. (a) Speaker: absent; Listener: unique (*0:1 landmarks*).
(b) Speaker: unique; Listener: absent (*1:0 landmarks*).
4. Speaker: (name: A) unique; Listener: (name: B) unique (*1(A):1(B) landmarks*).

First mention

Let us examine what kind of referential choices would be expected for these different situations or sharedness statuses of the landmarks. As a starting point, consider first the simpler case of choosing a referring expression on first mention, i.e. when an item is first referred to.

It is reasonable to assume that by default, the speaker's mental representation of the speech situation includes the belief that the listener has perceptual access to the same objects as the speaker (Keysar & Barr, 2005). Thus, if an object is unique in the speaker's visual field, he or she will probably assume, if there is no evidence to the contrary, that the object is unique to the listener as well. In this default 1:1 situation, the speaker will typically use a definite expression in accordance with the assumption that the referent is uniquely identifiable to the listener (too), as shown in figure 3.3 below. And when this is in fact the case, all is well.



- I₁ *så skal du dreje.. skråt mod.. øhh mod syd skal du gå*
 'then you turn diagonally to- err to the south you should walk'
 [...]
- M₂ *ja 'yes'*
 [...]
- I₄ *æh imod **det væltede stengærde***
 'err toward **the turned-over stone wall'**

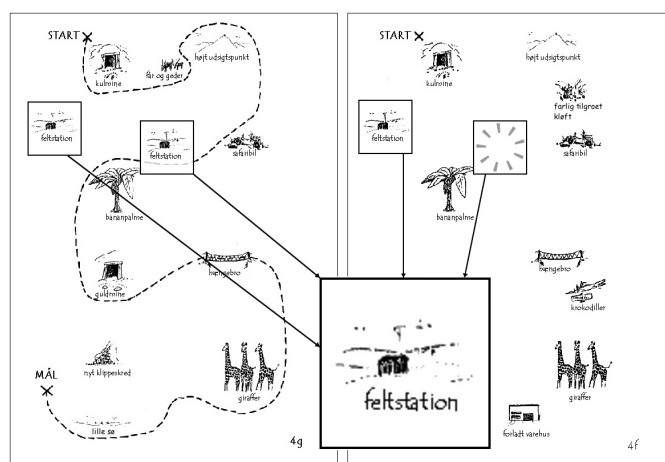
Figure 3.3: First reference to a uniquely identifiable landmark using a definite noun phrase in the 1:1 situation.

Conversely, an indefinite expression will typically be used when the speaker assumes that the referent is not uniquely identifiable to the listener (i.e. in a '2:2' situation). When this assumption holds, the choice of referring expression is again perfectly felicitous.⁶

Sometimes, however, this default reciprocity does not obtain. A landmark can be non-unique in the visual field of the speaker, but not in that of the listener (2:1), or vice versa (1:2), and it can be absent for the speaker while unique for the listener (0:1), or vice versa (1:0).

When the speaker has two instances of a certain landmark, and the listener has only one, the speaker can choose to use an indefinite form to refer to one of the two landmarks, as shown in figure 3.4.

⁶ Note that this situation, where a referent has a speaker-non-unique/listener-non-unique sharedness status, happens to be absent in the map task.



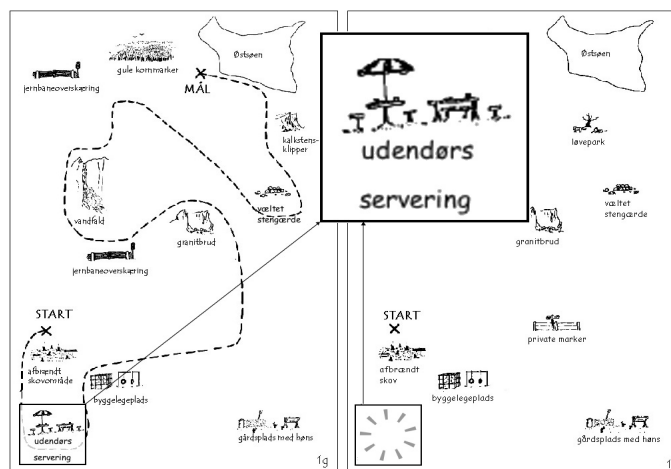
- I₁ *så k- ææhm, kommer du ned syd om en feltstation*
 'then err, you pass to the south of a **field station**'
- M₁ *øh. ja så ja jeg går stadigvæk vestpå*
 'er. yes so yes I still go west'
- I₂ *du går SYDvestpå*
 'you go SOUTH-west'
 [...]
- M₄ *så synes jeg nemlig at jeg skal gå s-
 lige stik vest for at komme hen til feltstationen*
 'then it seems like I should go
 directly west in order to arrive at the field station'
- I₇ *hmmm ...*

Figure 3.4: First reference to a 2:1 landmark using an indefinite noun phrase.

The discrepancy between the speaker's and the listener's visual representations may go unnoticed in the 2:1 situation, since an indefinite expression does not rule out a unique referent, as predicted by Gundel et al.'s (1993) Givenness Hierarchy. (An indefinite expression is unmarked for unique identifiability.) Note, however, that the matchers' singular instances of the 2:1 landmarks are always located at some distance from the path he or she is supposed to follow, and as a consequence, the landmark is usually outside the current referential focus domain of the matcher. The example in figure 3.4 shows the map where the matcher's landmark is

closest to the one first encountered by the instructor as compared to 2:1 landmarks in the three other sets of maps, and thus the one most likely to be accepted as the intended referent, but even at this relatively close distance, the matchers typically sense that something is not quite how it should be, as the example in figure 3.4 illustrates.

In general, whether the instructor uses an indefinite form depends to a large extent on whether the two identical referents are close enough in space to likely be confused by the listener. Recent psycholinguistic research suggests that this distance can be quite small without affecting the use of definite expressions (Chambers, Tanenhaus, Eberhard, Filip & Carlson, 2002), and since the instructor's two instances of a 2:1 landmark are always placed at a distance, he or she in fact often treats the first 2:1 landmark encountered as uniquely identifiable.



- [...]
 I₁ *og direkte nedad*
 'and directly downward'
 I₂ *nedenunder udendørsserveringen*
 'below **the outdoor restaurant**'
sådan en har jeg ikke
 M₁ 'such a one I don't have'

Figure 3.5: First reference to a 1:0 landmark using a definite noun phrase.

When the landmark is absent from the speaker's map, as in figure 3.5, he or she will obviously be unlikely to be the first to mention it. Depending on the utterances of the interlocutor, he or she may mention it in subsequent turns. Only when a landmark is unique for the speaker and non-unique or absent for the listener will the use of a definite expression (which may seem perfectly appropriate from the speaker's perspective) result in a highly noticeable violation of communicative cooperativeness from the listener's perspective. This is likely to happen in the 1:0 and 1:2 situations.

The final possible sharedness status of a landmark is shown as point number 4 in the list shown earlier: 1(A):1(B). In this situation, the visual aspects of the landmarks on the two maps are identical, but they have different labels. For instance, one of the maps depicts a 'green lake' in the upper right corner. The same lake is called 'blue lake' on the other map. In this situation, the speaker will be inclined to use a definite expression to the extent that they believe the referent in question is also unique to the listener, which they in fact always are. The interlocutor may use an indefinite or a definite form on subsequent mention.

Thus, the likely choice of referring expression in connection with different sharedness statuses of landmarks, and the likely consequences thereof, are relatively straightforward in the case of first mention. The more complex referential context of subsequent mentions is less straightforward, and this is what we turn to in the following subsection.

Subsequent mention

To make matters slightly more complicated, let us now consider what can be expected with respect to definiteness when it comes to anaphoric expressions such as the definite pronouns and indefinite *one*-anaphors that are of interest in this study. Anaphors are by definition subsequent rather than first mentions, since they require an antecedent for their interpretation. It follows that concepts referred to using anaphors cannot be expected to be 'Brand-New' (Prince, 1981).

On the feature-based view of givenness, referents of indefinite *one*-

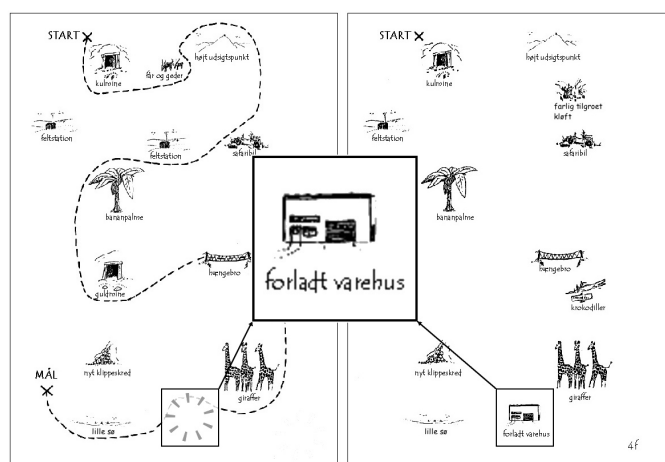
anaphors can be assumed to be non-uniquely identifiable (i.e. merely 'type identifiable' in Gundel et al.'s (1993) terms) and at the same time highly accessible. In the map task, any visually non-shared entity will be non-uniquely identifiable for one of the interlocutors, at least until its existence has been verbally established in the discourse model. In the dialogues analyzed here, a referent cannot be talked about for very long before visual sharedness ceases to play a role for the choice of referring expression used. Differences with respect to sharedness will soon be verbally negotiated by the interlocutors, thus individuating the referent in question and establishing unique identifiability in the discourse model. This quickly makes definite expressions a felicitous option regardless of visual sharedness. Thus, what we are looking for in this section are transient 'niches' of asymmetrical givenness caused by discrepancies in visual sharedness, which may give rise to the use of indefinite *one*-anaphors.

What complicates matters with subsequent mentions is that prior mentioning affects the identifiability status of anaphors so that it can never be determined by visual sharedness alone, as opposed to first-mention expressions.

In the following example of subsequent 0:1 reference by the instructor (figure 3.6), the matcher first introduces the landmark "abandoned warehouse" using a definite noun phrase. The landmark is absent from the instructor's map, so he responds by referring to a new—or rather, hypothetical—landmark of the same type, namely the one which should be, but in fact is not, on his map. In doing so, he appropriately uses an indefinite *one*-anaphor.

But even though the instructor cannot see the landmark, he might as well have used an accented definite pronoun (as indicated with square brackets), since the referent is uniquely identifiable after being introduced by the matcher.

After the exchange shown, one would normally expect the matcher to specify where the landmark should be. She might do so by referring to another hypothetical entity: one which she expects the instructor to draw on his map. If so, she may use an indefinite *one*-anaphor or a definite



- M₁ *skal jeg ovenover eller nedenunder **det forladte pakhus**?*
 ‘should I go above or below **the abandoned warehouse**?’
- I₂ *se **sådan et/[dét]** har jeg ikke*
men jeg tror du skal ovenover det
 ‘see, **such a one/[that]** I don’t have
 but I think you should go above it’
- M₂ *nå ‘oh’*

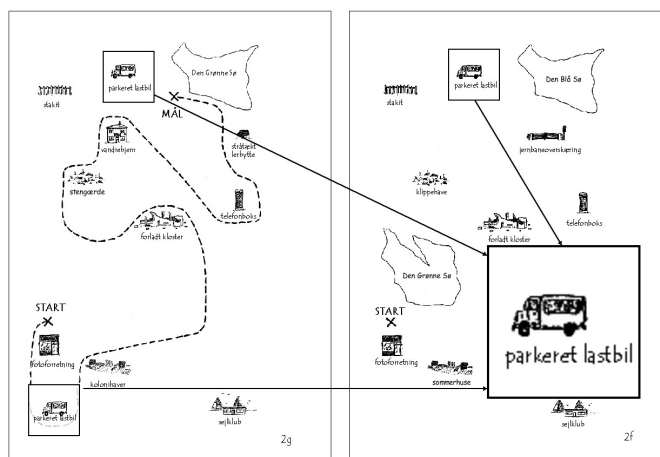
Figure 3.6: Subsequent reference to a 0:1 landmark by the instructor (the landmark is absent from the instructor’s map, and the instructor is the speaker of the utterance containing the subsequent mention—hence 0:1) using an indefinite *one*-anaphor.

pronoun. If she chooses to tell the instructor where her own instance is located, she may likewise use an indefinite *one*-anaphor or a definite pronoun.

Thus, in subsequent 0:1 or 1:0 reference, a given referent may elicit either indefinite *one*-anaphors or definite pronouns. All this applies whether the landmark exists on the instructor’s or the matcher’s map. Therefore, no specific predictions about the frequency of indefinite vs. definite forms can be made for subsequent 0:1 and 1:0 reference.

In the case of subsequent 1:2 (speaker-unique, listener-non-unique) mentions, some landmark appears twice (incidentally, always on the instructor’s map). In such situations, it will thus always be the matcher who refers to an already-introduced landmark. Consider the example in fig-

ure 3.7 below, where the landmark is introduced by the instructor, and is subsequently mentioned by the matcher.



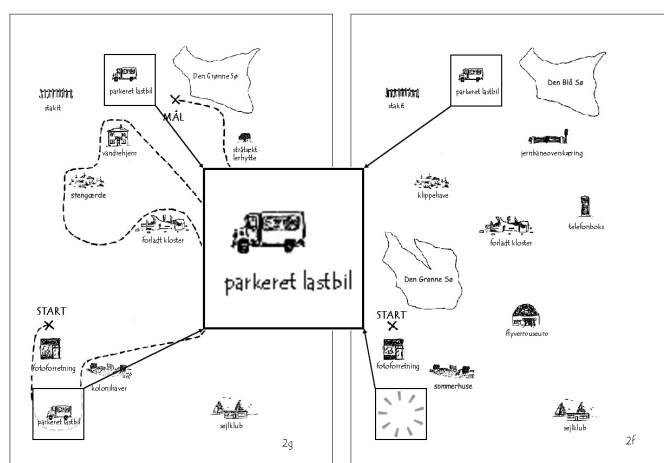
- I₁ *og ud fra målet skulle der være en parkeret lastbil*
 ‘and in line with the target there should be a **parked truck**’
 M₁ *ja men **dén** er helt aller øverst*
 ‘yes but **that** is all the way at the top’
 I₂ *ja ‘yes’*
 M₂ *er den det? ‘is it?’*
 I₃ *ja ‘yes’*

Figure 3.7: Subsequent reference to a 1:2 landmark by the matcher (the landmark is unique in the matcher’s map, and the matcher is the speaker of the utterance containing the subsequent mention—hence 1:2) using an accented definite pronoun.

The instructor could have chosen to introduce the parked truck using either an indefinite or a definite full noun phrase (since the two instances of a 1:2 landmark are always placed at a distance, cf. the discussion earlier). The landmark being unique in the matcher’s map, and apparently being singled out by the instructor, is then treated by the matcher as uniquely identifiable. She refers to it using an accented definite pronoun, but in this context, an utterance containing an indefinite *one*-anaphor would have been acceptable as well. In this case, the reference went well, since the interlocutors were in fact speaking about the same landmark.

But in many cases, the landmark introduced by the instructor will be

the first instance on the route, as in the following figure. In such cases, the landmark is likely to be treated as absent from the matcher's map, since the singular instance on the matcher's map will be placed far away from the current location on the route.



- I₁ *og der fortsætter du.. øhh et godt stik- stykke sydpå*
 'and there you continue.. err some distance to the south'
 I₂ *indtil der kommer en parkeret lastbil*
 'until you reach a **parked truck**'
 M₁ *sådan en/[dén] har jeg ikke*
 '**such a one**/[that one] I don't have'
 [...]
 I₄ *nej, okay 'oh, ok'*

Figure 3.8: Subsequent reference to a 1:2 landmark using an indefinite *one*-anaphor.

In figure 3.8, the parked truck is introduced by the instructor using an indefinite noun phrase. In this case, since the landmark mentioned is the one missing from the matcher's map, the matcher appropriately reacts by treating the parked truck as absent. She refers to the kind of landmark mentioned by the instructor by using the indefinite *one*-anaphor *sådan én*, lit. 'such one.' However, she might acceptably have used *dén* 'that one' instead, as indicated with square brackets.

Further considering the 1:2 situation, if the referent is introduced by the matcher, for whom the landmark looks unique, the instructor is likely to fail to notice that he or she actually has another instance of the mentioned landmark somewhere on the map, because it is outside the current referential domain. The turn comes back to the matcher, who will now as subsequent speaker be in a position to refer to a given, seemingly unique landmark. Under these circumstances, the occurrence of indefinite *one*-anaphors seems highly unlikely.

Let us sum up at this point. Because of the narrow scope of referential domains (i.e. the interlocutors literally focus on a narrow area within the map, with respect to which referring expressions are interpreted, cf. the discussion above), subsequent 1:2 situations will often resemble either 1:1 or 0:1 situations. The likelihood of encountering indefinite *one*-anaphors would be expected to be highest when the subsequent 1:2 situation resembles the subsequent 0:1 situation, that is, when the solitary landmark of the matcher is outside the current referential domain (i.e. located in a different area of the map than the area currently talked about), and the landmark therefore appears to be absent from the matcher's map.

Let us now turn to the 2:1 situation. A subsequent mention 2:1 situation resembles the subsequent 1:2 situation. The main difference is that the turn has come back to the instructor. A 2:1 situation is one where the instructor mentions an already-introduced 2:1 landmark. If the landmark was introduced by the matcher (to whom it is unique), using a definite form, the situation is similar to the one discussed above: because of the narrow scope of the referential domain, the instructor is unlikely to notice that there are multiple instances of the landmark in question, and it is thus likely to be treated as a 1:1 landmark, yielding few indefinite *one*-anaphors.

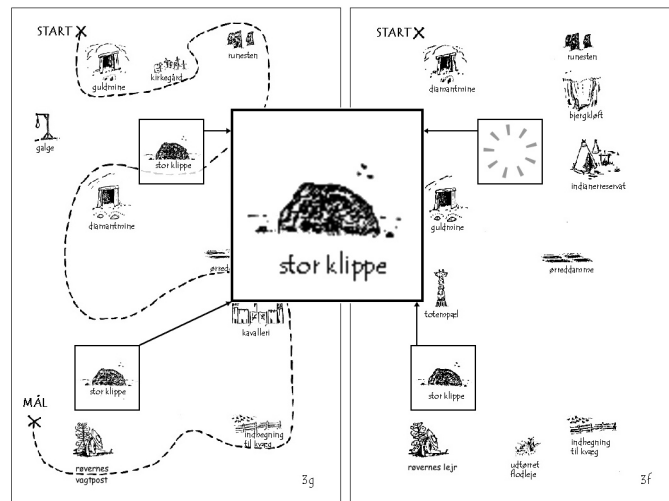
In the other conceivable case of a 2:1 situation, where the instructor introduces a non-unique landmark, the matcher says something, and the turn then comes back to the instructor, the course of the exchange will depend to a large degree on which instance of the 2:1 landmark the instructor originally introduced. If it is the one that is present on the matcher's map, the matcher will have no reason to question anything, and the instructor

will be likely to use definite forms for subsequent mentions, since the landmark will now have been established as uniquely identifiable within the referential domain. Again, this situation will resemble the 1:1 situation. But if the landmark originally introduced by the instructor is the instance that the matcher does not have on his/her map, the matcher is likely to protest. The matcher can be expected to do one of two things: either state that he or she does not have the instance in question on his/her map, or ask whether the instructor means the other instance located farther away. Either way, either a definite form or an indefinite form may be used.

In the example in figure 3.9 below, the matcher is about to say that he cannot see the large rock mentioned by the instructor, but then implicitly asks whether she in fact means the one located “all the way down there.” When the matcher mentions the landmark that does exist on his map, the instructor is almost forced to refer to the other instance, i.e. a different landmark of the same type. This is the perfect context for an indefinite *one*-anaphor, and she indeed chooses this type of referring expression.

Turning now to the 1(A):1(B) situation, where the instructor or the matcher has introduced a 1(A):1(B) landmark, whether the interlocutor subsequently uses a definite or an indefinite form about his/her version of the landmark will depend in part on whether he or she interprets it as the *same* landmark, in which case the speaker-mentioned landmark will be unique in the discourse model (prompting a definite form), or as a *different* landmark, in which case the speaker’s landmark will be absent or located in a different position on his/her map, and the listener’s version of the landmark must be treated as a new entity (prompting an indefinite form).

The example in figure 3.10 illustrates both possibilities. The matcher introduces a 1(A):1(B) landmark using an indefinite noun phrase. The instructor refers to the matcher’s landmark, which is by now uniquely identifiable, using an accented definite pronoun. As indicated with square brackets, he might as well have used an indefinite *one*-anaphor in this context. He then refers to his own version of the landmark, which has a different label, using an indefinite noun phrase, which signals that he considers the landmark ‘Brand-New,’ i.e. a *different* item.

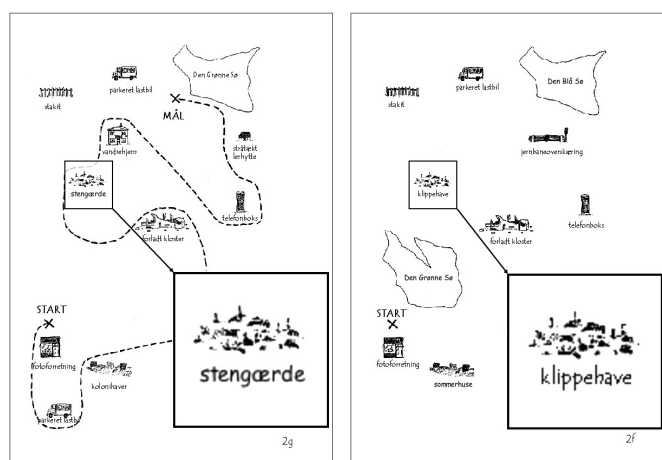


- I₁ *du skal nemlig ned omkring syd for en stor klippe*
 'you see, you should go south around a **large rock**'
- M₁ *dén kan jeg ikke- nå helt der nede*
 '**that one** I can't- oh all the way down there'
- M₂ *jeg har en stor klippe sådan altså*
 'I have a **large rock** like about'
- I₂ *du har den meget langt nede*
 'you have **it** very far south'
- F *ja 'yes'*
- G *ja 'yes'*
- I₃ *nej jeg har en til*
 'no, I have **another one**'
- I₄ *og dén har jeg lige vest for indianerlejren*
 'and **that one** I have just west of the indian camp'

Figure 3.9: Subsequent reference to a 1:2 landmark using an indefinite *one*-anaphor.

In cases where two versions of the same landmark are seen as different landmarks altogether, one would generally expect fewer anaphoric expressions and more full noun phrases.

Finally, in the 1:1 situation, the only situation involving a truly 'doubly unique' landmark, one would normally expect mainly definite pronouns on subsequent mention. However, indefinite *one*-anaphors are not precluded from this context, since both instructor and matcher may choose to



- M₁ *ja så- be- [...] går jeg mod noget der hedder en klippehave*
 'yes then [...] I go toward something called **a rock garden**'
- I₁ *ja.. dén/[sådan én] har jeg heller ikke*
 'yes.. **that one/[such a one]** I don't have either'
- I₂ *har du noget der hedder et stengærde i nærheden*
 'do you have something called a stone wall nearby?'
- M₂ *b- nej det har jeg ikke*
 'no, I don't'

Figure 3.10: Subsequent reference to a 1(A):1(B) landmark using an accented definite pronoun. the instructor is under the impression that the landmark is absent from his map, but this is not correct. The landmark just has a different name.

treat the landmark on his or her own map as a new entity, for instance if the location of the landmark is not clear from the interlocutor's description.

Predictions

We can now finally ask what predictions the above analyses give rise to. Is it possible to predict which pronominal forms will be used on the basis of the visual sharedness status of landmarks? Under some circumstances, yes. Given the above considerations, and the Gricean cooperative principle, the following should hold.

To sum up the analyses from the previous sections, most of the contexts

for subsequent mention allow both definite pronouns and indefinite *one*-anaphors to be used. The only case in which there is good reason to expect a higher frequency of indefinite *one*-anaphors expressions is the particular version of the 2:1 situation where a landmark is introduced by the instructor, the matcher asks whether he or she means the 'other' instance, i.e. the solitary instance present somewhere else on the matcher's map. In this context, it will be difficult for the instructor to use a definite form without referring to the non-intended, other instance just mentioned by the matcher.

The identifiability hypothesis, presented as (2) earlier, is repeated as (11) below:

- (11) **Identifiability hypothesis:** There are significant differences between relevant indicators of the identifiability of referents of definite pronouns and indefinite *one*-anaphors.

This can now be refined to the following testable hypothesis:

- (12) **Asymmetric uniqueness hypothesis:** There are significantly more 2:1 landmarks among referents of indefinite *one*-anaphors than among referents of accented or unaccented definite pronouns.

This difference would support the idea that identifiability plays a role in the choice of referring expressions, and constitutes a sort of minimum requirement for concluding that the identifiability hypothesis is correct. Should there be no such difference, this would be quite strong evidence against the identifiability hypothesis.

Identifiability: Results and discussion

The results pertaining to identifiability and definiteness are shown in table 3.7 below. The predicted difference shows up in the 2:1 column: there are indeed more speaker-non-unique landmarks referred to by indefinite *one*-anaphors than by accented definite pronouns. The data are collapsed for statistical analysis in table 3.8.

Pronoun type	Visual sharedness status						Sum
	1:1	2:1	1:2	0:1	1:0	1(A):1(B)	
Indefinite <i>one</i> -anaphors (<i>én</i>)	8	9	4	3	2	0	26
Accented def. prons (<i>dén</i>)	10	5	4	4	6	1	30
Unaccented def. prons (<i>den</i>)	10	2	3	2	9	4	30
Sum	28	16	11	9	17	5	86

Table 3.7: The visual sharedness of referents of different types of anaphoric expressions. In the indefinite *one*-anaphors row, two instances have been left out because the referents were not on the maps and thus did not have a visual sharedness status. Two further instances of indefinite *one*-anaphors are disregarded since they seem to be production error-like repetitions.

Pronoun type	2:1	not 2:1	Sum
Indefinite <i>one</i> -anaphors (<i>én</i>)	9	17	26
Accented def. prons (<i>dén</i>)	5	25	30
Unaccented def. prons (<i>den</i>)	2	28	30
Sum	16	70	86

Table 3.8: Collapsed visual sharedness categorization.

A Fisher's exact test shows that the pronoun type used is not independent of whether the landmark referred to is a 2:1 landmark or not (Fisher's exact test: $p = 0.025$), and that there are thus statistically reliable differences in the amount of 2:1 landmarks associated with the three types of pronoun. The difference between *én* and *dén* is non-significant (Fisher's exact test: $p = 0.108$, one-tailed), and so is the difference between *dén* and *den* (Fisher's exact test: $p = 0.212$, one-tailed). But the difference between *én* and *den* is reliable (Fisher's exact test: $p = 0.01$, one-tailed). This result partially supports the asymmetric uniqueness hypothesis, but it is unclear whether the difference found between *én* and *dén* is associated with definiteness or with accenting.

A curiosity in the data is the fact that so many referents of indefinite *one*-anaphors are doubly unique (1:1). This sharedness status would normally be expected mainly of referents of definite forms. On closer scrutiny, it turns out that many of these referents were assumed to be non-unique

or absent at the time of utterance. Three of the 8 indefinite *one*-anaphors in this category are used to refer to a banana palm that is clearly assumed by the interlocutors to be non-unique, but is in fact unique on both maps. Another indefinite *one*-anaphor is used about an abandoned monastery which the interlocutors suspect may be one of several instances of this landmark. Another indefinite *one*-anaphor is used in a situation where the speaker has temporarily overlooked the landmark in question because there is another landmark before it on his map. These cases account for more than half of the indefinite *one*-anaphors in the 1:1 category, and can be argued to belong in a distinct category of asymmetric uniqueness (the interlocutors' suspicion being that each has a unique instance of the category in a different location). This provides a kind of indirect support for the asymmetric uniqueness hypothesis. Furthermore, two of the referents in this category are used as proper indefinite pronouns in the sense of for instance Haspelmath (1997), i.e. with the intended meaning 'someone.' In this way, 7 of the 8 referents in this category can be accounted for by alternative classifications.

The 1:0 category contains many landmarks referred to using unaccented definite pronouns. There is no obvious explanation for this, but note the following example, where three definite pronouns are used in close succession. One might have been sufficient. They all showed up in the sample, and obviously have the same sharedness status.

- (13) I₁: *altså den er to takker oven for væltet stengærde*
 'so **it** is two steps above overturned stone wall'
 I₂: *og den er tre tra- tre takker hø- oven for granitbruddet*
 og så er den sådan cirka midt imellem
 'and **it** is three st- steps a- over the granite quarry
 and then **it** is about midways between the two'

In sum, the identifiability results to some extent support the asymmetric uniqueness hypothesis, especially when the data are scrutinized more closely. More statistical power in the form of larger data samples would

clearly be desirable in order to obtain reliable evidence for whether a difference exists between accented definite pronouns and indefinite *one*-anaphors with respect to identifiability or not. At least such a tendency is found.

3.3 Discussion

The empirical investigation of the two hypotheses yielded encouraging results. The identifiability hypothesis was supported by clear tendencies in the data. The accessibility hypothesis was supported by most measures (distance, repeated mention, and morphology and lexical explicitness of antecedents), where the observed differences seemed to have to do with accenting rather than accessibility. Statistically non-significant differences in antecedent lexical explicitness lacked a straightforward explanation, whereas differences in the syntactic characteristics of antecedents seemed to be a matter of identifiability. There was thus no evidence against the new model of givenness marking presented in section 2.3. The data are consistent with the feature-based view of givenness, according to which referring expressions with the [+pron] feature should map onto approximately the same region of the accessibility dimension of the model whether they have the [+def] or the [-def] feature. Referring expressions must necessarily map onto the accessibility continuum in a categorical fashion. The mapping is not necessarily straightforward (for example, corresponding expressions in different languages are likely to cover different portions of the accessibility continuum, see e.g. Gundel et al. (1993)), but this is a different story. The claim here is simply that indefinite *one*-anaphors and accented definite pronouns cover about the same portion of the continuum in spoken Danish.

Accented and unaccented expressions obviously need to be differentiated (as we have seen several times, there are clear differences between *den* and *dén*). This question goes beyond the scope of this thesis, but the fact that accenting often plays a significant part in the patterning of referring

expressions is very important to keep in mind for future investigations of anaphora in spoken Danish.

The amount of tokens analyzed is unfortunately rather small. As it happens, the indefinite anaphor *én/ét* has several different meanings or functions, and not all of them are even really anaphoric. Thus, in the 30-token sample in this study, there are instances of *én* in the function where the word means ‘any person, someone,’ and there are modified versions (*sådan én* lit. ‘such one,’ *én til* ‘one more,’ and *én der ...* ‘one that/who ...’), as well as more numeral-like uses (*én* meaning ‘(only) one as opposed to two or more’). These are not ‘pure’ forms of anaphoric *én*, and are thus somewhat problematic to have in a direct comparison with pure exemplars of stressed and unstressed definite pronouns. However, since all the above-mentioned variants of *én/ét* do have an antecedent,⁷ and can thus be assumed to have a degree of accessibility comparable to that of a pronoun, it was decided to include them.

Finally, it remains to be demonstrated whether accessibility correlates with lexical explicitness, i.e. whether the antecedent distance of anaphoric full noun phrases is higher than that of pronouns, for instance. This would be expected based on any theory of accessibility. Also the repeated mention measure would be expected to show a clear effect. Crucially, the model outlined in section 2.3 predicts that such a correlation should not be influenced by identifiability and should thus be equally strong for indefinite and definite forms. These questions will not be further addressed here.

Although the data presented are admittedly too sparse to be taken as conclusive evidence—a common problem in corpus studies—the predictions of the model seem to hold reasonably well. Thus, at least in this quite distinct type of spoken dialogue, indefinite *one*-anaphors do seem to have approximately the same degree of accessibility as other (accented) pronouns, and are clearly different as far as identifiability is concerned. Whether the results can be replicated in other spoken styles such as more

⁷ Even the ‘someone’ uses can be analyzed as having an antecedent.

informal conversation, or even in written narrative, are open questions. But intuitively it seems that the function of indefinite *one*-anaphors should remain the same across styles and genres: the expression of a referent whose category is given, but which itself has not yet been individuated. The basic function of definite pronominal forms would likewise be expected to be relatively robust: the expression of a referent that is accessible AND uniquely identifiable in the discourse model. I will not speculate about how the effect of accenting might modulate results in other genres. This question deserves a study of its own.

These results are promising, and it seems worthwhile to investigate the matter further, both using other corpus resources (other genres, e.g. oral narrative), and psycholinguistic experimentation. The next chapter is devoted to a review of a number of psycholinguistic studies of referential processing and a historical overview of a method of studying spoken language use that has become wide-spread within the last decade, namely the psycholinguistic *visual world* paradigm. This sets the stage for two chapters investigating various aspects of identifiability, accessibility, definiteness, and pronominalization using this new methodology.

Chapter 4

Referential processing and the visual world

Referential form presumably correlates with givenness in no small part because of the way the cognitive mechanisms of reference resolution work. The best way to understand these mechanisms is by studying the online processing of reference. For lack of direct access to cognitive processing, close investigation of the timing of measurable events is commonly used to make inferences about the underlying causal mechanisms. In this chapter we turn to the study of reference in online language processing. Corpus-based studies like the one reported in the last chapter can reveal important correlations of grammatical form and communicative function, but they can never capture the moment-by-moment dynamics of the status of referents in the minds of interlocutors. The present chapter aims to provide some background knowledge of the online study of reference through a review of a number of classical psycholinguistic studies of reference in written and spoken language. Then, a historical review is given of the *visual world* paradigm, the recent experimental framework used within psycholinguistics to study online spoken language processing. A special section is devoted to the statistical analysis of visual world data. These sections provide the necessary theoretical and methodological background for the eye-tracking studies presented in the next chapters.

4.1 Referential processing

A central question within the field of referential processing is whether anaphoric reference resolution happens through a process directly linking the anaphoric expression to its discourse referent in the situational part of the discourse model, or whether it is linked more indirectly via the linguistic antecedent in the textual representation. Questions of this kind about possible processing architectures underlying reference resolution motivate studies of its exact timing. In the following, we will first take a closer look at the motivating distinctions from linguistics, and then review some of the findings from psycholinguistic studies of reference.

Model-interpretive anaphor resolution

Do anaphoric expressions point directly to discourse referents, or do they rather point to a linguistic representation, which then activates the corresponding referent? The linguist Ivan A. Sag and his colleagues (Sag, 1979; Sag & Hankamer, 1984; Oakhill, Garnham & Vonk, 1989; Garnham & Oakhill, 1996) made certain observations which indicated that these two kinds of processing distinguish different types of anaphors, labeled “deep anaphors” and “surface anaphors.”

Deep anaphors are called *model-interpretive* because they point directly to referents in the situational representation, which in Sag et al.’s terminology is simply called the discourse model. Deep anaphors include many definite noun phrases, pronouns, *do it*, and null complements. They are characterized by not needing an explicit linguistic antecedent, as long as there is a highly salient, relevant entity in the vicinity. For instance, I can say *he’s a friend of mine* as someone we have not talked about until this moment enters the room. When an explicit linguistic antecedent does exist, a deep anaphor does not need to have a form that can be fleshed out with the elided material to yield the exact form of the linguistic antecedent. If someone says *Those shelves need to be painted*, a perfectly acceptable reply would be *I’ll do it* even though *do it* cannot be expanded to anything in the

explicit linguistic context: the utterance naturally expands to *I'll paint the shelves*, but misses the intended meaning if it is expanded to *I'll need to be painted* or *I'll be painted*.

Sag and colleagues' second type of anaphor, surface anaphors, are null complements and elliptical verbal constructions other than *do it*. They need an explicit linguistic antecedent to flesh out material that has been elided. Thus a response to *Those shelves need to be painted* could not be *I will Ø*, with a null complement after the verb. This response would only be appropriate in response to an utterance with a suitable antecedent like *Someone needs to paint those shelves*.

Garnham and Oakhill (1996) question the pure surface-dependence of elliptical verbal constructions on the basis of the following example.

- (1) AG: Are you going to explain your theory of text comprehension to me.
JO: I will, but can we leave it till tomorrow?

Here, the response *I will* expands to *I will explain my theory ... to you*, not *I will explain your theory ... to me*, even though the latter contains the explicit linguistic form used in the antecedent. Even in verb ellipsis, it seems, some of the antecedent information represented pertains to referents rather than linguistic forms.

On the other hand, the purely model-interpretive nature of deep anaphors can be questioned on the basis of research on languages with arbitrary grammatical gender (Garnham, Oakhill, Ehrlich & Carreiras, 1995). While in English, for instance, gender-marked pronouns such as *she* and *he* are generally used to refer to females and males, i.e., entities of real-world or semantic feminine and masculine gender, gender marking in languages such as French and Spanish is much more arbitrary. *Elle* and *il* need not refer to females and males, and even nouns for inanimate objects must have one or the other gender. In fact, the same object may be referred to using nouns of different genders (e.g. *le paquet*, masculine; *la boîte*, feminine). If there was no linguistic mediation in the processing of anaphoric refer-

ence, one might not expect arbitrary gender to play any role in pronoun resolution. But it clearly does. In the fragment *La cape a protégé le manteau parce qu'elle ...* 'The.FEM cape protected the.MASC coat because it.FEM ...,' the pronoun can only refer to the cape, with which it agrees in (arbitrary, nonsemantic) gender. A similar argument can be made for semi-arbitrary number marking on certain English nouns such as *scissors*, *pliers*, *trousers*, etc.

In production, the gender of a French pronoun without an antecedent is determined by the noun that would most naturally be used to refer to an object, again suggesting linguistic mediation. On the other hand, if the semantic gender of a referent and the linguistic gender of an expression used to refer to it conflict, as in *le ministre* used about a female government minister, then a pronoun of either gender may be used. As seconds pass, however, the likelihood of using a masculine anaphoric form—reflecting the grammatical gender of the expression in the textual representation—decreases. These facts suggest that grammatical gender is indeed a part of the discourse model representation of entities, at least for a time, and thus imply that at least some purely linguistic information is encoded.

This complicates the picture of how exactly the discourse model is actually structured internally. Therefore, some caution should be exercised when making inferences about the processing architecture of reference resolution on the basis of the distinction between deep and surface anaphors. Nevertheless, the hypothesis that faster resolution indicates more direct access to discourse referents has motivated many studies of the timecourse of reference resolution. We now turn to a review of a number of these studies.

Referential processing in written language

The timecourse of especially anaphoric processing has been widely studied in psycholinguistics in the 1980's (Corbett & Chang, 1983; Garrod & Sanford, 1985; Garrod, Freudenthal & Boyle, 1994; Gernsbacher, 1989; McDonald & MacWhinney, 1995; Sanford, Garrod, Lucas & Hen-

derson, 1984; Tyler & Marslen-Wilson, 1982). See (Sanford & Garrod, 1989; Garnham, 1999; Nicol & Swinney, 2003) for reviews. Most of the literature is on reading, but there are also some studies of referential processing in spoken language, which I will consider in the next subsection.

One widely cited set of results comes from Gernsbacher (1989). She reported a series of probe verification experiments where people read sentences such as (2).

- (2) a. Bill handed John some tickets to a concert ^{BILL/JOHN}
but he ^{BILL/JOHN} took the tickets back immediately.
- b. Bill handed John some tickets to a concert ^{BILL/JOHN}
but Bill ^{BILL/JOHN} took the tickets back immediately.

The sentences were presented on a screen one word at a time, each word visible for a duration proportional to its length. The superscripts represent visual recognition probes presented at the top of the screen instead of the next word. The task of the participants was to verify these probes, i.e. indicate by button-press whether the probe had appeared in the sentence or not. The dependent measure of the experiments was the response time of the button-press.

Gernsbacher found that pronouns showed no facilitation of their antecedent: the time it took to verify the probe *BILL* (which is the most likely antecedent in (2-a)) at the second probe position was no shorter after than before the pronoun. There was no difference in response time to the non-antecedent probe *JOHN* either. On the other hand, the probe *BILL* was facilitated after reading the proper noun *Bill*, whereas the probe *JOHN* took considerably longer to verify. Gernsbacher interpreted these results in terms of the two cognitive mechanisms of *enhancement* and *suppression* of the antecedent and the non-antecedent, respectively. The proper nouns were said to enhance the activation of their sentential antecedent while effectively suppressing the activation of the non-antecedent, thus causing an overall gain in the activation of their referent. Pronouns also eventually caused enhancement and suppression, but only at a much later stage

in processing: the pronouns' enhancement and suppression effects were only detectable when probes were shown further downstream in the sentence. An additional finding in Gernsbacher's article was that new names, i.e. names not mentioned previously in the sentence, also triggered suppression of other referents. In combination with other findings from the literature, Gernsbacher explained her findings in terms of an *explicitness principle* stating that the more explicit a form is, the more likely it is to trigger enhancement and, especially, suppression. Thus, she quotes results from Dell, McKoon, and Ratcliff (1983) that show attenuated enhancement and suppression effects for full noun phrases relative to proper nouns, and results from Corbett and Chang (1983) that show even less enhancement and suppression for zero anaphors than for pronouns. The results reported by Gernsbacher would seem to indicate that pronouns are not re-activated immediately at all, but are rather resolved further downstream. This does not fit the findings in this thesis particularly well, and indeed, other findings in the literature complicate the picture considerably.

Garrod, Freudenthal, and Boyle (1994) investigated the processing of anaphoric expressions using a reading task where participants were eye-tracked. They investigated how discourse focus, linguistic properties of anaphors, and pragmatic inference influenced reading times at regions of interest in the critical sentence of small discourses. In their experiment 1, they investigated the processing of pronominal anaphors using materials like the following.

(3) *A dangerous Incident in the Pool*

Elisabeth₍₁₎ was an inexperienced swimmer and wouldn't have gone in if the male lifeguard₍₂₎ hadn't been standing by the pool. But as soon as she got out of her depth she started to panic and wave her hands about in a frenzy.

- a. Within seconds she₍₁₎ sank₍₁₎ into the pool.
- b. Within seconds she₍₁₎ jumped₍₂₎ into the pool.
- c. Within seconds he₍₂₎ jumped₍₂₎ into the pool.
- d. Within seconds he₍₂₎ sank₍₁₎ into the pool.

The numbers in parentheses indicate discourse links between linguistic items. The pronouns *she* and *he* are linked to their antecedents via their linguistic form, i.e. their gender marking. The verbs *sank* and *jumped* are linked to the two characters in the story through pragmatic inference, i.e. inferences about who is most likely to perform the action mentioned in the context.

Garrod et al. found an immediate increase in first pass reading time on the verb when the focused character in the story (Elisabeth) was referred to with a pronoun but was followed by a pragmatically incongruent verb (i.e. the (b) sentence above). No such increase was observed in connection with the analogous matching pronoun/mismatching verb configuration for the non-focused character (the male lifeguard in the (d) sentence above). In this condition, first pass reading times on the verb were as elevated as on the congruent verb with the non-focused-character pronoun (the (c) sentence above).

In a second experiment, reading time was recorded for proper nouns and full noun phrases as in the following discourse, which has the same structure as the one above, only with different referring expression types in the critical utterances.

(4) *Flying to America*

Joan₍₁₎ wasn't enjoying the flight at all. The dry air in the plane made her really thirsty. Just as she was about to call him, she noticed the steward₍₂₎ coming down the aisle with the drinks trolley.

- a. Right away Joan₍₁₎ ordered₍₁₎ a large glass of coke.
- b. Right away Joan₍₁₎ poured₍₂₎ a large glass of coke.
- c. Right away the steward₍₂₎ poured₍₂₎ a large glass of coke.
- d. Right away the steward₍₂₎ ordered₍₁₎ a large glass of coke.

For these more explicit types of referring expression, no verb congruency effect was found on first pass reading time. The proper nouns were generally fixated slightly longer than the full noun phrases on first pass

reading, but there were no reliable differences due to verb congruity. Only in more offline measures like total reading time (first pass and regression reading combined) and total regression duration were there any effects of the pragmatic anomaly introduced by the incongruent verbs.

In sum, the only case where the pragmatic anomaly of the verb caused immediate increases in reading time was when discourse focus and pronominal gender marking converged on one participant (in terms of example (3) above: Elisabeth) who then had to be understood as performing a highly incongruent action (namely, jumping into the pool even though the context clearly specified that she was already in it). Thus it seems that only pronominal reference, and then only to the entity in discourse focus, was immediately resolved to such an extent that the anomaly of the action denoted by the verb with respect to this entity could be detected as the verb was read.

The findings seem to contradict the findings of Gernsbacher mentioned above. Recall that she found that more explicit noun phrases like proper nouns are activated faster and more strongly than less explicit noun phrases such as pronouns. Garrod et al. account for this contradiction in terms of depth of processing: pronouns supposedly reactivate 'deeper' content than more explicit forms. They cite a study by Cloitre and Bever (1988) where it was shown that 'content-heavy' tasks such as category decision yielded early effects of reactivation through pronouns but not through noun phrase anaphors, whereas more 'superficial' tasks such as lexical decision yielded the reverse pattern. Gernsbacher's results can thus be seen as reflecting enhancement and suppression of lexical surface information, whereas Garrod et al.'s data can be seen as reflecting effects of integrating deeper semantic/pragmatic information into the discourse.

Sanford and Garrod (1981) proposed and have argued for the so-called *Memory Focus* model of discourse processing in order to account for data like those summarized above. In this model, entities mentioned in a discourse are represented in a privileged partition of currently activated memory labeled 'explicit focus,' where they are directly accessible when referred to using content-meager expressions such as pronouns. A dia-

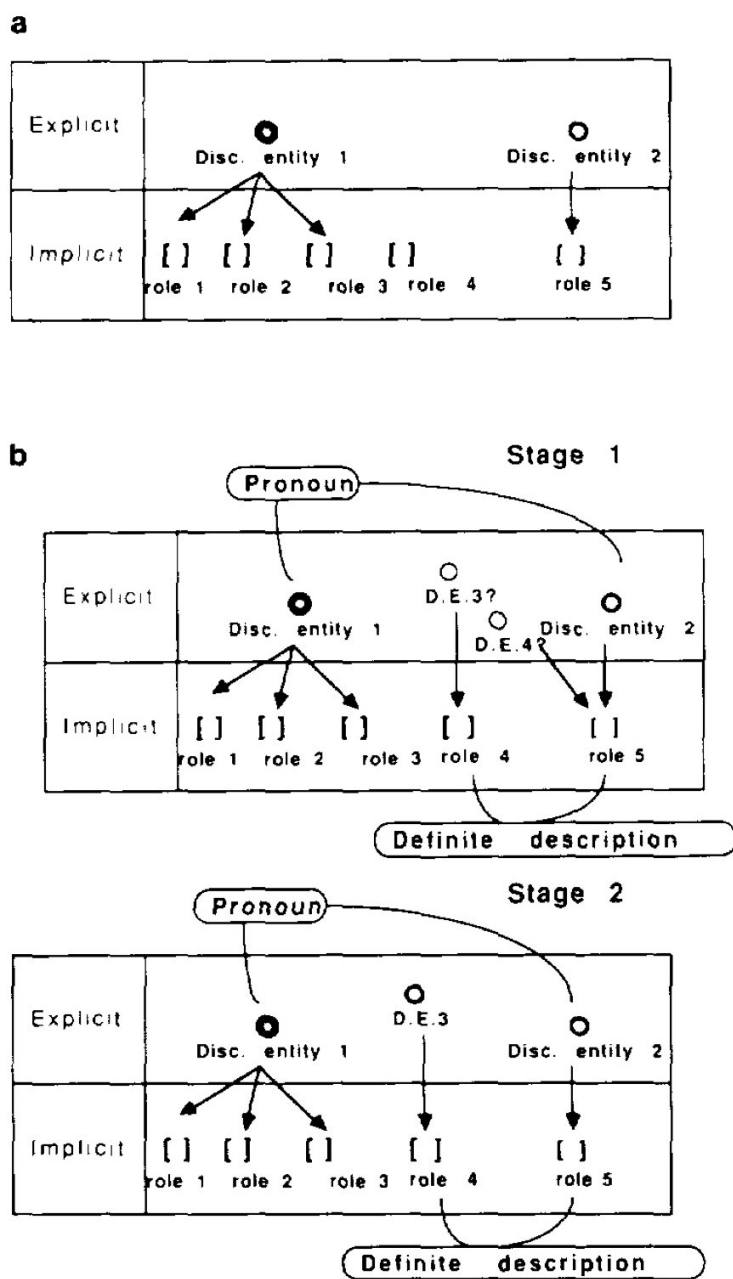


Figure 4.1: Garrod et al.'s Memory Focus model of referential processing. From Garrod et al. 1994.

gram of the model is reproduced in figure 4.1. In addition to explicit focus, the model has another memory partition labeled 'implicit focus,' which contains currently activated background knowledge in frame-like structures called *scenarios*. A scenario, for instance a 'restaurant' scenario, contains *role slots* specifying roles such as waiters, guests, food, money, etc. as well as typical relations between these roles such as ordering, eating, paying, etc. Both of these partitions of currently active memory are conceptualized in Garrod and Sanford's model as search spaces in reference resolution. Explicit focus is restricted to the most salient entities, and thus provides the highly constrained search space or referential domain needed for inexplicit pronominal reference to be successful.

Definite pronouns are seen as encoding a set of instructions for the discourse processor to retrieve from explicit focus an entity token matching the grammatical features specified by the pronoun, such as gender and number. Information about this entity then immediately becomes available through mappings of the entity into the various role slots it fills in the current scenario. Garrod et al.'s (1994) finding of fast access to pragmatic information from the verb only after pronominal references to highly focused entities is explained by the weaker mapping into implicit focus of less focused entities. These stronger and weaker role mappings are shown in figure 4.1 (a) as more arrows emanating from the highly focused discourse entity 1 than the less focused discourse entity 2.

Definite noun phrases, on the other hand, contain more information in themselves, and may be used to resolve reference with respect to implicit focus as well as explicit focus. Garrod et al. (1994) assume that full noun phrases initially affect the implicit focus partition by depositing there the information they contain, possibly filling a role slot of an entity that has not been mentioned yet. An example of this would be filling the 'judge' slot in a 'court' scenario without having encountered any explicit reference to the judge yet. Immediately a new discourse entity is added to explicit focus. This is what happens with discourse entity 3 in figure 4.1 (b). If a definite noun phrase is used to refer to an entity that is already in explicit focus, the initial process is the same. Information from the noun phrase is

integrated into the active scenario, and a new discourse entity is added to explicit focus and mapped to the new information in implicit focus. Only in a secondary processing stage, stage 2 in figure 4.1 (b), the processor works out that the new entity is identical to an existing entity in explicit focus, and unifies the two (discourse entities 2 and 4).

Sanford and Garrod's referential processing model gives an account of how it might be that sometimes reactivation of pronoun referents is actually faster than reactivation of more explicit referential forms, contrary to Gernsbacher's (1989) findings. The verb congruency effects in their first pass reading times require quite 'deep' processing, in their model conceptualized as operations more or less directly on the mental model representation of the situation under discussion. Gernsbacher's probe recognition task might reflect more 'shallow' processing on linguistic surface strings.

There are results from Garrod and Sanford themselves, however (Garrod & Sanford, 1985), that do not quite support this account. Using materials identical to the Elisabeth/lifeguard and Joan/steward discourses above, they measured how fast participants were at detecting spelling mistakes in the verb immediately following the critical referring expression. For full noun phrases and proper nouns, the spelling mistakes were detected at the verb, and detection was faster when the verb was congruous than when it was incongruous. This was taken as evidence for early resolution of full noun phrases and proper nouns. For pronouns the results matched those of Garrod et al. (1994): only after pronominal references to the main character were spelling mistakes detected faster in congruous than in incongruous verbs.

Overall, a rather complex picture emerges from the various studies of pronominal and more explicit anaphoric reference resolution in written language. In most studies, there is evidence for the more explicit forms being completely resolved immediately. For the pronominal forms, indications of immediate resolution are primarily found for highly salient 'main characters.' But the findings from reading are complicated even more when one considers the literature on anaphor resolution in spoken language, to which we now turn.

Referential processing in spoken language

A widely cited study of spoken reference by Tyler and Marslen-Wilson (1982) showed how the naming of continuation probes after various types of anaphor was immediately facilitated in the following way. Participants heard small discourses like the one below.

- (5) As Philip was walking back from the shop, he saw an old woman trip and fall flat on her face. She seemed unable to get up again.
- a. Philip ran towards ...
 - b. He ran towards ...
 - c. Running towards ...

After the different fragments the participants were presented with a visual continuation probe on a screen: either an appropriate one (e.g. *her*, yielding a natural continuation of the fragments) or an inappropriate one (e.g. *him*). In all three cases, the appropriate continuation probes were named faster than the inappropriate ones, indicating that a quite deep understanding of the fragments, including their anaphoric subject, had been achieved at this point. Thus, Tyler and Marslen-Wilson's result suggests that both repeated name anaphors (*Philip*), pronominal anaphors (*he*), and even zero anaphors (the zero subject before *running*) quickly integrate anaphoric referents into the understanding of the discourse.

In a review of the literature on anaphor processing, Nicol and Swinney (2003) cite several studies using the cross-modal priming paradigm which show that semantic representations of pronominal referents are immediately reactivated upon hearing the pronoun—albeit only if the potential antecedent matches the relevant grammatical features of the pronoun. Thus, for instance, they cite results from Nicol (1988) showing that only number-matching antecedents were semantically primed after a pronoun in materials like the following.

- (6) a. The *boxers* told the *skier* that the doctor for the team would blame them * for the injury.

- b. The *boxers* told the skier that the doctor for the team would blame him * for the injury.

The sentences were presented auditorily, and at the point corresponding to the asterisk a visual probe semantically related to the potential antecedents was displayed for lexical decision (i.e. is it a word—yes or no?). In the (a) type sentences, only probes related to the plural antecedent (*boxers*) elicited faster lexical decision times than unrelated probes, indicating semantic priming. In the (b) type sentences, only probes related to the singular antecedent resulted in semantic priming.

Nicol and Swinney review similar findings for grammatical markers of gender, number, and animacy as well as syntactic coreference constraints on reflexive and non-reflexive pronominal forms.

All in all, the findings from written and spoken language processing studies form a complex picture which seems to suggest that relatively explicit types of referring expressions such as proper nouns and full noun phrases can be processed immediately by utilizing the information that is inherent in such expressions. Pronouns are more ambiguous, and probably immediately trigger resolution processes, which may however take longer to complete.

A firm consensus about the timecourse of anaphoric reference resolution has yet to be formed. More studies of referential processing are needed, and the recent development of advanced methods in psycholinguistics provides the opportunity to shed light on the problem from new angles. The *visual world* paradigm is one such method which will be adapted in this thesis with that goal in mind. In order to provide the proper background for the visual world-inspired studies reported in the next chapters, I will review a number of visual world experiments in the following.

4.2 The history of the visual world paradigm

Spoken language processing used to be studied indirectly through such methods as detection, cross-modal priming, or probe tasks, which are all

invasive in one way or another relative to the processing of linguistic input (Eberhard, Spivey-Knowlton, Sedivy & Tanenhaus, 1995). They all imply a risk of the participants paying special attention to the linguistic input in a way they would not normally do. The visual world paradigm made it possible to study ongoing language processing without drawing attention to the linguistic signal itself. The following is a series of short reviews of studies within the paradigm, selected to illustrate the kind of findings it can produce.

The inception of the visual world paradigm in psychology

The first article reporting results on the close coordination of spoken language and eye movements was published in 1974 (Cooper, 1974). The main hypothesis in this article was as follows:

When people are simultaneously presented with spoken language and a visual field containing elements semantically related to the informative items of speech, they tend to spontaneously direct their line of sight to those elements which are most closely related to the meaning of the language currently heard.

(Cooper, 1974, p. 85)

This hypothesis was tested by showing participants four different grids containing line drawings as in figure 4.2, while they heard stories where objects and events related to the depicted entities were mentioned.

Furthermore, two comprehension tests, one non-announced, and one announced, were auditorily presented after the third and fourth grid/story, respectively. During the presentation of these audiovisual stimuli, the participants' eye movements were recorded so as to see whether their fixations corresponded to the entities being mentioned, and in the case of the comprehension tests, whether the eye movements would reveal anticipatory fixations on the entities relevant to the answers of the comprehension questions. A control group heard the same stories and

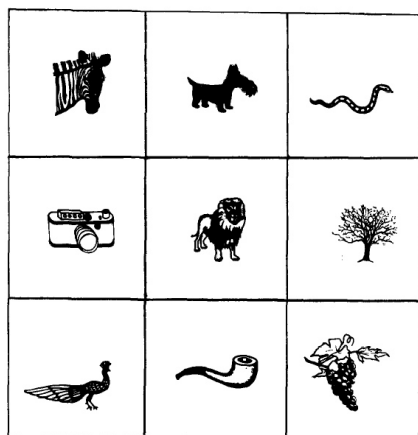


Figure 4.2: Stimulus picture from Cooper (1974).

comprehension tests. They also saw the same grids of drawings, but in a different order so that the entities on their grids were irrelevant to the auditory stimuli.

The results were reported in terms of frequencies of correct word-fixation relations, i.e. how often participants fixated a picture corresponding to an entity mentioned in the story either during the referring expression or shortly after. Percentages of correct word-picture relations were obtained by dividing the number of referring expressions accompanied by an appropriate fixation by the total number of referring expressions in a story. In addition to this, frequencies were scored for indirect word-picture relations such that, for instance, a fixation on a lion would be scored as correct if the corresponding word was *king* (because of the association through the idiom *king of the beasts*). The control group's fixations were scored as "correct" if they landed in the grid cell that would have contained the correct picture if the grid had been the one matching the story, but which now in fact contained a completely irrelevant picture. If the null hypothesis that eye movements are independent of the language heard was correct, then the control group's fixation frequencies in these irrelevant cells would not be expected to differ significantly from the experimental group's frequency of fixations to the same cells with pictures relevant to the story.

The results showed that the frequency of correct word-fixation relations was generally higher when the visual stimuli were relevant to the language heard. The effect was stronger for the direct word-picture relations than for the indirect ones. An analysis of how frequently the correct fixations occurred either early or late during the relevant words or shortly after revealed that most correct fixations occurred late within their relevant words or immediately after.

In the comprehension tests, the questions were formulated so as to contain a cue word early in the utterance. For instance, one completion question would be "In the grass was a ...?" The correct answer was "Snake," and "grass" was a cue word. It was found that the amount of anticipatory fixations to relevant pictures during these cue words was larger in the experimental group than the amount of fixations during the same time to irrelevant pictures in the same position in the control group. Cooper notes that anticipatory verbal responses to the comprehension questions, on the other hand, never occurred.

These results provide the first demonstration of what has since become well-known in the psycholinguistic community: that eye movements are closely time-locked to linguistic input. They also show for the first time that the eye movement system is anticipatory, i.e. sensitive to upcoming information predicted on the basis of current linguistic input. As soon as information that might be(come) relevant to a visual entity in the scene is encountered, the likelihood of fixating that entity increases.

After these early insights were published, the visual world paradigm was all but forgotten for some twenty years. But after this pause, Cooper's findings were rediscovered and built upon when the visual world paradigm was revitalized within psycholinguistics from the mid 1990'ies and onwards.

The visual world paradigm in psycholinguistics

The first articles reporting psycholinguistic results produced within the visual world paradigm appeared in 1995 (Tanenhaus, Spivey-Knowlton,

Eberhard & Sedivy, 1995; Eberhard, Spivey-Knowlton, Sedivy & Tanenhaus, 1995). Michael Tanenhaus and colleagues established that during the comprehension of instructions to manipulate real-world objects, eye movements are time-locked to linguistic input in an incremental fashion. Thus, a referring expression such as *the yellow starred square* would trigger eye movements to the relevant block in a workspace as soon as enough information to disambiguate the reference had been heard. For instance, if there was only one yellow starred block in the workspace, eye movements to the referent would be initiated immediately after hearing *starred*, whereas if there was both a yellow starred rectangle and a ditto square, eye movements would tend to be initiated after hearing *square*. This effect is known within the visual world paradigm as the *point of disambiguation* effect, because reference resolution clearly occurs shortly after the point in a referring expression where it is disambiguated relative to the visual scene.

The point of disambiguation effect is even found within single words. If a scene contains a candy and a candle, for instance, an instruction to *pick up the candle* will trigger eye movements to both items immediately after the first syllable /kæn/, which is ambiguous relative to the names of the two entities. Only when the disambiguating second syllable has been heard, a preference for the candle begins to emerge. It takes longer to zero in on the intended referent when a cohort competitor is present in the scene than if there is no such competitor.¹

Tanenhaus et al. built on these findings to design a test of the informational encapsulation of syntactic processing, a central question in linguistic theory. They did this by utilizing the syntactic ambiguity of utterances in the following way. Utterances like *put the apple on the towel in the box* contain an ambiguity: they can be understood as either 'put the apple onto the towel that is inside the box' or 'put the apple that is on the towel into

¹ The term *cohort* denotes the set of words within a language that share initial phonemes. Thus, the cohort for the syllable /kæn/ in English consists of words such as *candle, candy, cancer, candidate*, and so on. The cohort is narrowed as more phonemes are uttered.

the box.’ On the former reading, the phrase *on the towel in the box* is a goal argument of the verb *put*. On the latter reading, it is the phrase *in the box* that is the goal argument of *put*.

One reading will make sense in some contexts, while the other reading will make sense in other contexts, depending on such factors as how many apples and towels are present, if there is an apple on a towel, if there is a towel in a box, and so on. Tanenhaus et al. used two contexts. In one context, the participants’ workspace contained an apple on a towel, a towel without an apple on it, a pencil, and an empty box, as shown in figure 4.3.

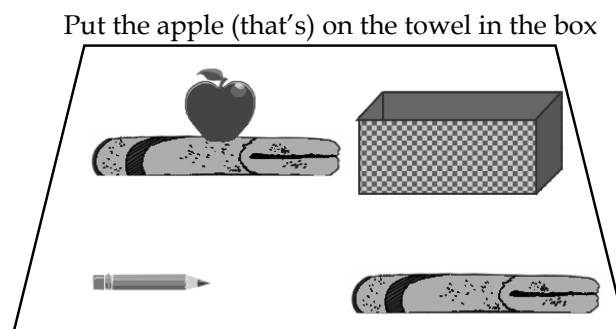


Figure 4.3: Visual world setup from Tanenhaus et al. (1995). Garden path context.

In this context, the sentence *put the apple on the towel in the box* is temporally ambiguous, a ‘garden path’ sentence in psycholinguistic jargon: until the phrase *in the box* is heard, *put the apple on the towel* may mean ‘put the (only present) apple onto the (other) towel’ or ‘put the apple that is on the towel [somewhere not specified yet].’ One of the experimental results of Tanenhaus et al.’s study was that the participants often looked at the ‘empty’ towel shortly after hearing the word *towel*. This suggests that they were considering it as the goal location for the apple. In contrast, they never looked at the towel when they heard the almost-identical unambiguous sentence *put the apple that’s on the towel in the box* in the same context.

The crucial result was obtained when the participants heard the same two sentences in a second context. Now the workspace contained two ap-

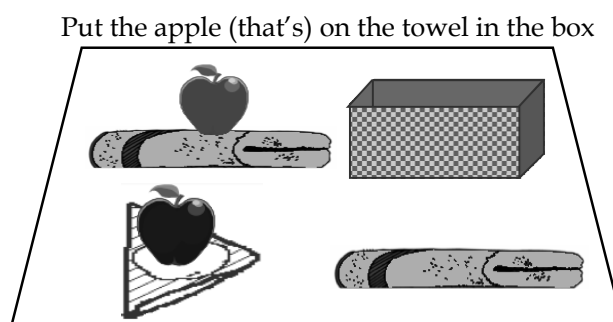


Figure 4.4: Visual world setup from Tanenhaus et al. (1995). Non-garden path context.

ples: there were an apple on a towel, an apple not on a towel, a free towel, and an empty box, cf. figure 4.4. Here, the fact that the scene contained two apples made the phrase *on the towel* relevant as information contrasting the two apples. The phrase served as a modifier disambiguating which of the apples was meant. This was indeed the interpretation adopted by the participants, as indicated by their eye movement patterns: there was no difference between the ambiguous and the unambiguous sentence in the time it took to identify the correct apple, and the participants tended to look directly at the box after hearing *towel*, not at the free towel. This indicates that the prepositional phrase was interpreted as a modifier of the noun *apple*, and not as a goal for the putting action, a result that is unexpected under the hypothesis of informational encapsulation of syntactic processing. Under this hypothesis, the temporally ambiguous instruction would be expected to lead to looks to the apparent goal temporarily suggested by the syntactic structure regardless of any contextually induced sensitivities to contrasting information.

Tanenhaus' group practically reinvented the visual world paradigm after it had failed to attract much attention during the past twenty years. Their psycholinguistic studies initiated the use of the paradigm to study core problems within linguistic theory. At the same time, advances in eye tracking technology had made it possible to transition from eye trackers with head rests fixing the participants' head to head-worn eye trackers

allowing head and body movements and providing a scene image from the wearer's perspective via a likewise headworn scene camera. This new freedom allowed for more natural interaction with the visual stimuli, which could now be real everyday objects placed in a workspace for the participants to manipulate, as in the study summarized above.

Anticipatory eye movements

Yuki Kamide and colleagues (2003) studied the effects of case marking in spoken German and voice in spoken English on participants' ability to predict an upcoming grammatical argument in a sentence. For instance, participants heard the German sentence *der Hase frisst gleich den Kohl* ('the hare.NOM eats soon the cabbage.ACC') in the context of a picture like the one in figure 4.5.

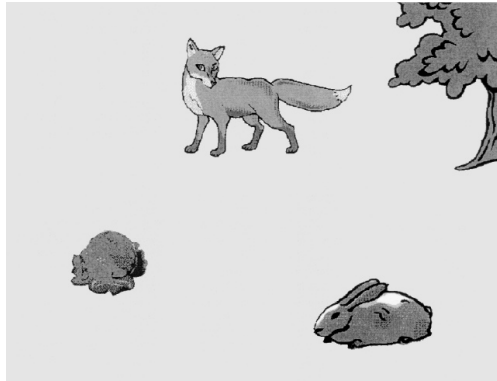


Figure 4.5: Stimulus picture from Kamide et al. (2003).

It contains a hare, a cabbage, a fox, and a tree. In the temporal region of the adverb 'soon,' i.e. before the utterance of the grammatical object 'cabbage,' the percentage of trials with a fixation on the cabbage was significantly higher than the percentage of trials with a fixation on the fox.

When participants heard *den Hasen frisst gleich der Fuchs* ('the hare.ACC eats soon the fox.NOM'), this preference disappeared: the percentage of trials with a fixation on the fox during the adverb increased to the level of the the corresponding percentage for the cabbage.

This finding suggests that participants are able to exploit information in an unfolding utterance to predict what may be mentioned next. More specifically, it seems that they are able to rapidly integrate the following pieces of information, and use them to anticipate the mentioning of the cabbage:

- The grammatical knowledge that a semantic agent, coded as a noun phrase in the nominative case, and an action like eating, coded as a transitive verb, are usually followed by a semantic theme or patient (coded as an accusative noun phrase).
- The general world-knowledge that hares are more likely to eat cabbages than foxes or trees.

In other words, participants are able to integrate the information that something will be eaten and that the eater is a hare, and from this infer that the most likely ‘eatee’ is going to be the cabbage. In the accusative-first sentences, the anticipation of the fox being mentioned as the final constituent is not as strong as in the nominative-first sentences, a fact that Kamide et al. speculate may be due to a bias to perceive the first referent of a sentence as a semantic agent—despite the explicit accusative case marking.

Kamide et al. found a result similar to the German one for English sentences alternating between active and passive voice. When participants heard *The hare will eat the cabbage*, there was a preference for the cabbage in the main verb region preceding the noun phrase (i.e. ‘eat’), whereas when they heard *The hare will be eaten by the fox*, the percentage for the fox increased to almost that for the cabbage. Again, an agent-first bias might be responsible for the relatively weak anticipation of the fox.

Although the more unusual (or marked) constructions (inverted accusative-first sentences in German, and passive sentences in English) thus do not show any evidence of anticipation, the more ordinary, agent-first constructions demonstrate that it is sometimes possible to use the information in an unfolding utterance to home in on the next element about to be mentioned.

Bridging the language-as-product and language-as-action traditions

The visual world paradigm plays a central role in an emerging movement within psycholinguistics to reconcile two partly opposing traditions in the study of language use, labeled by Clark (e.g. Clark (1996)) as the 'language-as-product' and 'language-as-action' perspectives (Trueswell & Tanenhaus, 2005).

The language-as-product tradition comprises studies of language use focusing on the mechanistic aspects of the processes underlying the 'products' of language use: the linguistic representations in the minds of speakers and listeners. The product tradition is thus more or less synonymous with what one normally understands by psycholinguistics. This tradition springs from the information-processing approach to language initiated by Noam Chomsky during the cognitive revolution in the late 1950'ies, and has consequently had an emphasis on sentence processing (as opposed to reference processing, for instance) and the conjectured informational encapsulation of syntactic processing.

The language-as-action tradition is focused on contextualized language use—the social aspect of language. In this tradition, language is studied as an interactive exchange of conversational acts (speech acts, as discussed by Austin, Grice, and Searle (Austin, 1962; Grice, 1975; Searle, 2000)). The tradition is exemplified by the scholarly framework of conversation analysis.

The two traditions are separated by fundamental methodological differences. Whereas studies in the product tradition typically use fine-grained measures of online processing of well-defined language stimuli in controlled laboratory settings, studies in the action tradition usually study language as it happened in a natural communicative setting using offline transcription-based measures. Both approaches have their strengths and weaknesses. The more well-defined studies in the product tradition have greater internal validity (as reflected by the standard reports of statistical significance levels in psycholinguistic articles), and can pinpoint processing differences at a fine-grained level. On the other hand, they typically

use decontextualized stimuli which may have little to do with language use in the real world. Real-world language users are not often only speakers or listeners, and generally do not utter or listen to long sequences of unrelated sentences in their everyday lives. By comparison, the studies in the action tradition have much greater external validity. They generalize to a greater extent to 'real,' contextualized language use, but lack the methodological rigor of controlled laboratory experiments. Any of a host of contextual factors could be responsible for the patterns observed in studies of unconstrained language use, and it is thus much more difficult to isolate the individual contributing factors in this type of studies.

Trueswell and Tanenhaus (2005) constitutes a first step toward bridging the language-as-product and language-as-action traditions. The basic methodology in the visual world paradigm—the recording of people's eye movements during the production and comprehension of spoken language—is ideally suited for this purpose. The existence of precise head-worn eye-trackers makes it possible to record eye movements not only during the comprehension of pre-recorded 'laboratory language,' but also in fairly natural conversational settings, thus combining the internal validity from the product tradition with the external validity of the action tradition. Tanenhaus and Trueswell (2005) list seven desiderata for a response measure bridging the action and product traditions:

1. Measure can be used with *conversational language*.
2. Measure can be used to monitor *language production and language comprehension*.
3. Measure should not *interrupt* or *interfere* with the primary task of engaging in conversation.
4. Measure must be *sensitive* to rapid, unconscious processes underlying production and comprehension.
5. Measure should be closely *time-locked* to the input (for comprehension) and output (for production).

6. Measure should have a well-defined *linking hypothesis*.
7. Measure can be used with young *children* and *special populations*.

All of these desiderata are fulfilled by the recording of eye movements during spoken language use.

Eye-tracking unscripted spoken dialogue

Brown-Schmidt et al. (2005) report a study that illustrates the bridging of the product and action traditions. The study is an exploration of “the feasibility of examining real-time comprehension processes during natural, unscripted, interactive conversation” (ibid., p. 156).

The study focuses on definite reference within domains of interpretation defined by the conversational context: is it possible, in the context of a large board with blocks of different colors and shapes (including several red blocks), to refer to, say, “the red one” and still be understood because the domain of interpretation of the referring expression is constrained to ‘the small subarea of the board that we are talking about at the moment?’ In other words, will referents of definite descriptions be perceived as uniquely identifiable in the visual context even though the referring expression is technically ambiguous? This is possible if the conversational circumscription of the referential domain (Chambers et al., 2002) is tight enough to render other potential referents (in parts of the scene other than the one currently in focus) irrelevant.

This question was investigated in a relatively natural setting, in accordance with the aim of bridging the product/action gap. Four dyads of undergraduate students participated in a standard referential communication task with few restrictions. Each interlocutor had an identical board with stickers marking where to place blocks of different shapes and colors, and instructed the other about where to place them. Where one interlocutor had a sticker, the other had an empty space, and the interlocutors could only see their own board. One of the interlocutors had his or her eye movement recorded, and the speech of both was recorded.

In the analysis, Brown-Schmidt et al. looked for three things: cohort effects, point of disambiguation effects, and factors affecting the specificity of the definite referring expressions used. The cohort effect is a standard finding within the visual world paradigm (Tanenhaus et al., 1995; Eberhard et al., 1995; Allopenna et al., 1998). It was briefly mentioned above as a point of disambiguation effect within single words: the instruction *pick up the candle* triggers eye movements to both candles and candy before the disambiguating second syllable. The finding of equal amounts of looks to two cohort competitors is found in standard visual world experiments where the stimuli are decontextualized instructions like *pick up the candle*. Brown-Schmidt et al.'s question was whether the same effect would show up in a natural interactive setting. This relates to the circumscription of referential domains in the following way: if the cohort effect were indeed observed in a conversational setting, this would indicate that potential referents other than the intended one were considered by the comprehender, thus providing quite strong evidence against the tight conversational circumscription of the domain of interpretation.

In order to test for cohort effects, a number of the blocks to be placed had pictures of easily nameable objects pasted on them, and were chosen such that they formed cohort competitor pairs. Thus, an instruction to place a block "near the candle," for instance, might potentially lead the listeners to temporally consider the candy as the referent, reproducing a cohort effect 'in the wild.' But no such effect was found. The failure to find any cohort effect in the data² was interpreted as an indication of the tight conversational circumscription of the referential domain of the referring expressions used. In fact, the interlocutors were so well in agreement about the part of the board currently discussed that cohort competitors as close as 3.5 inches away from the intended referent attracted no more attention than other non-intended blocks in the vicinity.

The investigation of point of disambiguation effects proceeded along

² Except—quite crucially—on one occasion during the verification of the calibration of the eye-tracker, where the participant was requested to *look at the cloud*, *look at the lamb* etc. Here, looks to cohort competitors like a clown, a lamp, etc. could readily be observed.

similar lines, now analyzing the complex noun phrases used to refer to simple colored blocks of different shapes and sizes (such as *the small blue square*, for instance). Unlike the labeled cohort competitor blocks, the simple blocks could be described in various ways, and this resulted in noun phrases of varying explicitness. Some were unambiguous and thus contained a point of disambiguation somewhere in the noun phrase, whereas others were technically ambiguous. Similarly to the cohort analysis, Brown-Schmidt et al. found that when references were ambiguous, no difference between looks to competing potential referents and unrelated blocks could be found, while at the same time there was a clear preference for the intended block. So, if a green brick was mentioned, there was no difference between looks to non-intended green blocks and e.g. blue or red blocks, whereas there was a strong preference for the intended green block. For the non-ambiguous expressions, there was a similar preference for the intended referent over non-intended blocks matching the expression. However, there was a general increase in looks to competitors relative to unrelated blocks, which suggests that other potential referents were considered to some extent. At the point of disambiguation of the non-ambiguous expressions there was a marked increase in looks to the intended referent. The well-known point of disambiguation effect was thus replicated for non-ambiguous noun phrases in relatively natural discourse. Brown-Schmidt et al. interpreted this pattern of results in terms of referential domains: the less explicit noun phrases seem to have a tighter referential domain than the explicit ones. This suggests that speakers choose more explicit forms when the referential domain has not yet been conversationally negotiated among the interlocutors.

Brown-Schmidt et al. also analyzed which factors contributed to the varying levels of explicitness used when referring to blocks on the board. The factors considered were recency of mention, proximity of the last-mentioned block, and task compatibility of the reference. Recency of mention might influence the explicitness of noun phrases in that a recently mentioned referent might be more salient upon subsequent mention, leading to a less explicit form. Proximity of the last-mentioned block might

play a role in that a block close to the last-mentioned block should be likely to be in the same referential domain, thus reducing the need for a fully explicit form. Finally, a block might be referentially circumscribed by task compatibility, for instance by being the only one compatible with the goal of, say, aligning a block being placed with it (as in the question *should* [the block being placed] *be directly lined up with the square*, with several squares present, but only one that has room for a block next to it). However, none of these factors directly predicted the use of more vs. less explicit referring expressions. Rather, the closer and more task compatible any *competitor* blocks were, the more likely the speakers were to disambiguate the intended referent. Thus, two of the factors studied had an indirect effect on the explicitness of expressions, whereas recency of mention did not have any statistically significant effect.

The picture that emerges from this study of natural unscripted conversation is that the interlocutors become very well tuned to each other during the course of the interaction. Speakers tend to choose more explicit forms primarily when there are potentially confusing competitors in the vicinity, and tend to produce less explicit, technically ambiguous expressions otherwise. More importantly, listeners are hardly ever confused by these ambiguous expressions. The findings suggest that interlocutors develop closely matched referential domains, as it is also proposed in the interactive alignment model of dialogue by Pickering and Garrod (2004).

The study represents an important methodological step forward in that it adds ecological validity to the visual world paradigm. It shows that temporally ambiguous expressions indeed create some uncertainty about the identity of the referent up until the point of disambiguation, even 'in the wild' in referentially circumscribed conversation—uncertainty that is presumably the very reason for not leaving these expressions ambiguous.

The next section will give an overview of the different types of data analysis within the visual world paradigm and their development until the present day and beyond.

4.3 Analysis of visual world data

Many measures are available within eye movement research, and a number of these have been employed as indicators of linguistic processing within the visual world paradigm. Different measures require different kinds of data analysis. It will therefore be important to take account of the methodological side of the paradigm. This section will present some of the currently used eye movement measures along with the corresponding methods of data analysis within the visual world paradigm.

Eye movement frequencies

The pioneering work by Cooper (1974) made use of a measure that is still used today in different guises: eye movement frequencies, i.e. counts of how often eye movements are made in immediate response to relevant pieces of linguistic input. Cooper operationalized this measure in terms of percentages of correct word-picture relations, which were calculated on the basis of the total number of possible correct word-picture relations. To test the significance of the difference between his experimental group and his control group he employed the Mann-Whitney U test, a nonparametric test which tests the null-hypothesis that two observed frequencies come from the same distribution of a not further specified nature (i.e. not necessarily a normal distribution).

The early studies by Tanenhaus and his colleagues used eye movement frequencies as well. In the experiment with the instruction *put the apple (that's) on the towel in the box*, for instance, they measured the percentage of trials in which the participant looked at the free towel in the two different contexts. Recall that looks to a free towel were taken as an indication of it being considered as the goal of the putting action requested—an interpretation much less relevant if there were two apples, one of them on a towel. The experimental design of Tanenhaus et al.'s study is more complex than the simple group comparison in Cooper's study. More specifically, Tanenhaus et al. studied the effect of two crossed factors (utterance ambiguity—

as induced by the presence or absence of *that's*—and visual context), the interaction of which cannot be tested using a statistic such as Mann-Whitney U. Instead they used the analysis of variance (ANOVA). This is worth noting, since it constitutes a methodological step forward relative to the study by Cooper—even though the ANOVA is not designed for nonparametric frequency like the number of looks to certain objects. The main reason why Tanenhaus and colleagues used ANOVAs is probably that this test allowed them to deal with the interaction between their two independent variables. Thus they were able to show not only that there were far more looks to the empty towel when the utterance was temporarily ambiguous (a 'garden path' sentence), but were also able to provide evidence that this difference was not due to a purely syntactic preference. Because the difference between the ambiguous and non-ambiguous conditions disappeared in the appropriate context—thus giving rise to a significant interaction in the results—the visual context was shown to have a crucial influence on whether a syntactic garden path arose or not.

With the use of ANOVAs came the ability to handle two important factors: the random 'subjects' and 'items' factors. This has fairly wide-ranging methodological implications, and in order to see why this is so, it is necessary at this point to temporarily digress into the technicalities of the analysis of variance as employed in psycholinguistics.

Since an influential article on statistics in psycholinguistics by Herbert Clark (1973), it has been customary within psycholinguistics to report statistical significances according to two different F ratios: F1 and F2.³ This is in order for the result to be generalizable both to other language users than the ones that participated in a given experiment, and to other linguistic materials of the type used in the experiment. F1 reflects the analysis of data aggregated by subject, F2 by item. For F1 this concretely means that data from all experimental items are averaged to yield one data point per subject (i.e. participant). For the F2 analysis, data from all subjects are averaged to yield one data point per item. As an illustration, consider the

³ The F ratio is the test statistic of the analysis of variance.

following fictitious example borrowed from Rietveld and van Hout (2005). The numbers may be thought of as response times in milliseconds in a lexical decision experiment—a continuous measure that is free to vary, and therefore immediately suitable for the ANOVA, unlike frequency-based eye movement data, as we shall see.

	Nouns			Verbs		
	Noun 1	Noun 2	Noun 3	Verb 1	Verb 2	Verb 3
S 1	600	630	650	630	640	660
S 2	590	610	600	600	620	630
S 3	620	600	580	640	610	600
S 4	580	620	620	600	630	630

Table 4.1: Fictitious data from four participants (S 1 - S 4) each responding to three items in two different categories.

For the F1 analysis, the data in table 4.1 would be aggregated as shown in table 4.2 by averaging over all the nouns and all the verbs for each participant.

	Nouns	Verbs
S 1	627	643
S 2	600	617
S 3	600	617
S 4	607	620

Table 4.2: The fictitious data aggregated by subject (avgd. over items) for calculating F1.

The average response times for this particular set of three nouns and three verbs vary from participant to participant. If an ANOVA were performed on these varying averages, a significant F1 ratio would show that the noun group generally has lower values than the verb group. What this means is that additional participants' response times for the same nouns and verbs are likely to fall within similar ranges as the other participants'. The result is generalizable to the larger population of language users.

Had the three nouns and three verbs been the only nouns and verbs in the language, then this analysis would be sufficient, since there would be no need to generalize the result to other nouns and verbs. But there are usually more than three verbs and nouns in a language. The items for a study like the fictitious one at hand would thus probably be randomly sampled from a much larger set of nouns and verbs, which the study would probably be designed to make a general statement about. This makes the items in the study a *random* factor, as opposed to a fixed factor (a factor is fixed when the levels under study are the only levels of interest). Subjects are also a random factor, and for reasons that are beyond the scope of this excursus, ANOVAs of the type required for this kind of data⁴ can only contain one random factor at a time (Rietveld & van Hout, 2005). Therefore, in order to include the items factor as a random factor, the data must be arranged so as to treat the subjects factor as if it were fixed, that is, as if the four participants in the study were the only language users in the language community—just like the nouns and verbs were treated as if they were the only ones in the language in the ‘by subjects’ analysis. Thus for the ‘by items’ analysis, the data are aggregated by averaging over the values from all participants for each noun and verb.

	Nouns			Verbs		
	Noun 1	Noun 2	Noun 3	Verb 1	Verb 2	Verb 3
All S's	597	615	612	617	625	630

Table 4.3: The fictitious data aggregated by item (avgd. over subjects) for calculating F2.

The group of participants has a different average response time for each of the three nouns and verbs. This random item variation would be dealt with in an ANOVA on these varying averages, and the resulting F2 statistic would show that the difference between the two word types is only marginally significant. It is thus uncertain whether the same participants

⁴ I.e. a *mixed effects* ANOVA: an analysis of variance which contains both random and fixed factors. Subjects and items are random factors, and word type (noun or verb) is a fixed factor because only these two word types are of interest in the study. Hence a mixed effects model is needed.

would show a similar difference in response time with new nouns and verbs.

A significant F1 ratio thus means that the result is generalizable to a larger population of subjects (participants), whereas a significant F2 indicates that the result is generalizable to further linguistic items of the same type. In order to make meaningful statements about language processing, both F-ratios should therefore preferably be significant.

To summarize our little digression, ANOVAs were adapted to the analysis of visual world data for two main reasons: in order to be able to analyze the interaction of crossed variables, and in order to be able to account for both subject and item variability.

The advantages of being able to evaluate interaction effects and generalize to both subjects and items come at a cost in the case of measures based on frequencies. Normalized frequencies expressed as percentages or proportions are bounded within the range from 0 to 100 or 0 to 1, respectively. Because of this, there is a risk of floor or ceiling effects. What this means is that as an average proportion approaches 0 or 1, the room for variance decreases. The ANOVA was not designed to handle data where the variability changes as a function of the values of the data analyzed, and the reliability of the test decreases as proportions analyzed approach 0 or 1. An example of what kind of data this applies to is in order. In the *put the apple on the towel...* study, for instance, the proportions analyzed reflect the number of trials during which an eye movement was made toward the false goal (the free towel) out of all the trials in the relevant condition, by each subject (in the F1 analysis, that is). So, if participant 1 saw 20 items of the type “*put the apple that’s on the towel in the box / 2 apples present,*” and looked at the empty towel only in one of these trials, then the proportion measured for this participant would be 0.05.⁵ The F1 analysis would then be an ANOVA over all the participants’ proportions, comparing this and the other 3 conditions. Provided that few of them would ever look at

⁵ For the F2 ratio, the analysis would be analogous. So, if item 1 was seen by 33 subjects and only one of them looked at the empty towel, the data point for this item would be the proportion 0.03, etc.

the empty towel in this and/or other conditions, the floor effect problem would arise.

One way to recover from the problem of floor or ceiling effects is by transforming the proportions from the bounded range between 0 and 1 to an unbounded range. The idea is to produce a transformed version of the data where the variance is essentially independent of the observed proportions, which is not the case with 'raw' proportions. Different versions of the arcsine transformation are often used in the literature. Another transformation used is the logit transformation.

However, even when the data are appropriately transformed, ANOVAs may lead to spurious results (T. Florian Jaeger, p.c.). An alternative method exists for statistically analyzing categorical data: *mixed logit modeling*. A mixed logit model, i.e. a mixed-effects logistic regression model, is a special case of a generalized linear model which can describe the probability of a categorical outcome. Mixed logit models incorporate the logit transformation as an intrinsic element, and make it possible to account for random subject and item effects in one and the same analysis without the data aggregation required by F1 and F2. In addition to eliminating floor and ceiling effects, and yielding fewer spurious results, they therefore preserve statistical power. This method will be employed in the experimental study in the next chapter to analyze the binomial response variable of *inspections* in time windows, i.e. whether or not an eye fixation on a certain AOI starts during a given time window.

But before moving on to my visual world studies, let us have a look at two additional ways of analyzing visual world data. In the next subsection, I will consider the temporal aspect of visual world data. The final subsection concerns the continuous eye movement measure of the timing of the first target fixation.

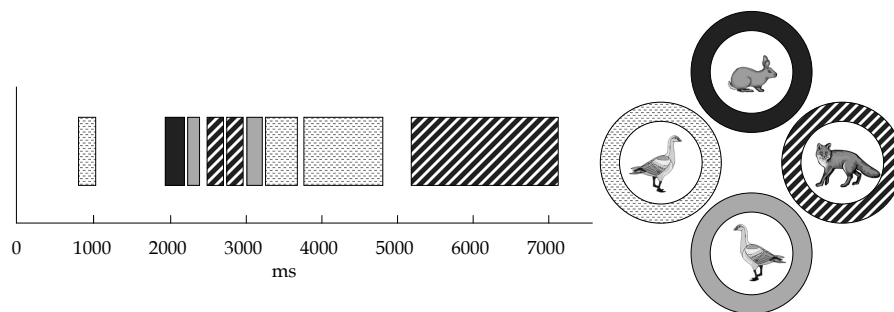
Proportions of fixations over time

A different way of analyzing visual world data that is essentially frequency-based is in terms of *proportions of fixations over time*. In con-

ducting visual world experiments one is interested in measuring the allocation of visual attention over time to different areas in the visual world, driven by linguistic input. Proportion of fixations over time curves provide a way of visualizing eye movement data averaged over multiple participants and/or items.

This kind of graph shows the proportion of gazes that goes to each of a number of areas of interest (AOIs), moment by moment. The raw input for the curves consists of sequences of 'hit' and 'miss' values for each of the AOIs in the study. Years ago (see for instance Eberhard et al. (1995)), these hits and misses were hand-coded using frame-by-frame analysis of scene video recordings with overlaid gaze position information, yielding one data point per video frame. At the time of writing, the preferred method is to analyze eye movement data by computer directly from eye-tracking data files, potentially yielding many times as many data points as the manual approach because of the higher sampling rates of modern eye-trackers.

The hits on different AOIs during one trial can be visualized as a 'scarf plot' like the one shown in figure 4.4.⁶



Ræven er sulten og vil gerne æde gæssene. Klik på den for at fortsætte.

'The fox is hungry and wants to eat the geese. Click on it to continue.'

Figure 4.6: Scarf plot.

The plot shows fixations as bars of a length proportional to their duration. The different AOIs in the stimulus display to the right are indicated with different color patterns. The purpose of proportion of fixation over

⁶ For the inspiration for this type of plot, see (Richardson & Dale, 2005).

time curves is to visualize the ‘average’ of many such trials. To do this, the raw ‘hit or miss’ data—coded as binomial data points (1 or 0)—are essentially averaged for each sampling time. As an illustration, consider the fictitious data for just one AOI presented in table 4.4.

Sample time	1	2	3	4	5	6	7	8	9	10
Trial 1	0	0	0	1	1	1	1	1	1	0
Trial 2	0	0	0	0	0	1	1	1	0	0
Trial 3	0	0	0	0	0	1	1	1	1	1
Trial 4	0	0	0	0	1	1	1	1	1	1
Trial 5	0	0	0	0	0	0	1	1	1	1
Trial 6	0	0	0	0	0	0	0	0	1	1

Table 4.4: Hits and misses relative to a fictitious area of interest.

Each row represents hits and misses for this sole AOI over time for one trial. (The data can be thought of in different ways: either as the same subject seeing 6 different items, or as 6 subjects seeing the same item, or even as e.g. 2 subjects seeing the same set of 3 items.) If these hits and misses are averaged for each sample time, the result is a sequence of values between 0 and 1, which gives the proportions of hits, or target fixations, over time.

Sample time	1	2	3	4	5	6	7	8	9	10
Proportion of hits	0	0	0	.167	.333	.667	.833	.833	.833	.667

Table 4.5: Proportions of target fixations over time.

This sequence can now be visualized as a time series showing how attention to the AOI inclines and declines as a function of time (figure 4.7). Typically, proportion of fixations over time graphs show curves for several AOIs, which is easily done by simply including data from ‘hit or miss’ analyses from additional AOIs.

The statistical analysis of proportion of fixations over time data presents its own unique set of problems. Analyzing gaze positions over time in-

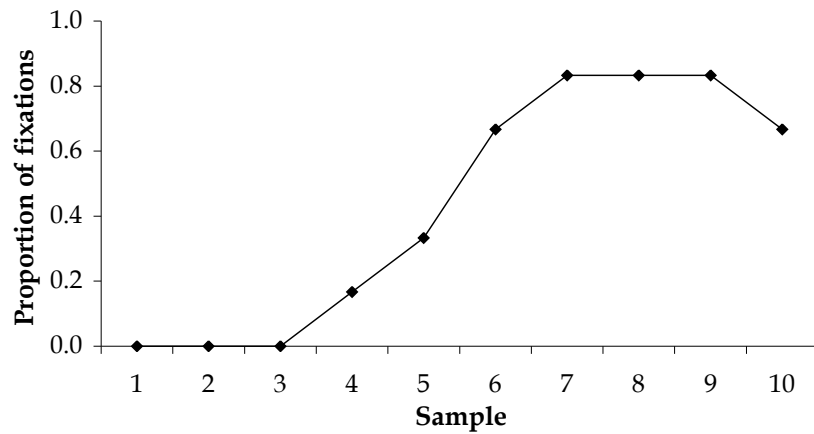


Figure 4.7: Proportion of fixations over time curve for the fictitious data.

volves a distinctive set of variables of a kind that are not familiar in cognitive psychology or psycholinguistics (Barr, forthcoming). First of all there is the continuous variable of time, which is inherent in the fundamentally temporal phenomenon of language: language unfolds over time, and when studying language processing one is obviously interested in what happens during this processing as a function of time, i.e. with time as an independent variable. Then there is the variable used to assess the cognitive processes of interest in a visual world experiment: typically a set of AOIs—an inherently categorical variable. (Being within a well-defined AOI is not a matter of degree. The gaze position is either in the AOI or not.) Leaving aside for the moment any additional independent variables, a visual world experiment is thus characterized by containing a continuous independent variable and a categorical dependent variable. This is precisely the opposite of what is usually seen in experimental psychology, where typically what is measured is the effect of categorical independent variables (experimental conditions) on a continuous dependent variable (e.g., response time).

Because of this state of affairs, the standard statistical techniques of experimental psychology cannot be used straightforwardly on visual world data. The customary statistical tests used for hypothesis testing in exper-

imental research, such as Student's *t* test or ANOVA, are designed for handling one or more independent variables of a categorical nature and a continuous dependent variable. The way this situation is handled in most visual world studies is by grouping and transforming the data so as to make the continuous time variable categorical and the categorical AOI response variable continuous. Time is made categorical by defining time windows, say sample 3 through 6 in the fictitious data above. If we say that table 4.4 represents a number of trials from the same participant, then table 4.5 would give us the varying proportions of hits in a particular AOI for this participant. The varying proportions in our defined time window (0, 0.167, 0.333, 0.667) would then be used as continuous response values (probably arcsine or logit transformed) from this participant. Their average would be suitable input for the F1 version—aggregating by subjects—of a repeated measures ANOVA, together with similar data from other participants. The average and variance of these by-subject aggregates would then typically be used in the verification of whether the AOI was looked at more or less than in other experimental conditions. The data would be aggregated analogously for the F2 ANOVA. The common practice in most visual world studies is to perform one such repeated measures ANOVA for each of a number of time windows, e.g. a baseline time window before the onset of the linguistic material of interest, and one or more time windows after. It can thus be determined within which time window e.g. the proportions of target fixations in different conditions start to differ.

Among other problems (most notably the temporally coarse-grained nature of the analysis), the extensive aggregation of data in the ANOVA approach is costly in terms of statistical power (Barr, forthcoming). In this thesis, an alternative method will be used to analyze eye movement data statistically in the temporal domain: mixed logit modeling (T. Florian Jaeger, p.c.). While this inspection analysis is not temporally fine-grained, it at least preserves statistical power by avoiding the aggregation of data required to do by-subjects and by-items ANOVAs. At the time of writing, a shift is occurring toward data analysis using different variants of generalized linear models instead of ANOVAs in psycholinguistics (Baayen,

Davidson & Bates, forthcoming (b); Barr, forthcoming, T. Florian Jaeger, p.c.). Open source software for statistical modeling of categorical linguistic data in the R statistical framework is available (Baayen, 2007; Bates, 2007; R Development Core Team, 2007), and it has recently been demonstrated how it can be used for temporally fine-grained binomial analysis of visual world data as well (Barr, forthcoming). A multinomial version of this analysis is on the horizon (T. Florian Jaeger, p.c.).

These developments have been so recent that the present thesis has not been able to benefit from them in full. As a proxy for temporally fine-grained inferential statistical analyses of proportions of fixations over time, visual examination of proportions of fixations over time graphs provides a valuable tool for explorative analysis of eye movement data. We shall see its usefulness in the analysis of controlled experimental stimuli as well as unscripted dialogue in the following two chapters.

Time to first target fixation

Eye movement measures do not have to be frequency-based and thereby categorical. One way of obtaining a continuous measure of eye movements is to measure their timing. A particularly convenient measure is the time elapsed from the onset of a complex stimulus until the initiation of the first fixation on a target area of interest. Eberhard et al. (1995) used this measure to document point-of-disambiguation (POD) and cohort effects: the later the POD, the longer the average eye movement latency of the first fixation on the referent of stimulus word or phrases.

This measure requires that participants in fact look at the target entity at some point. It is therefore most well-suited for studies where the experimental task is likely to elicit such target fixations. Eberhard et al.'s instructions to *touch the starred yellow square* etc. are a good example of such a task: in order to touch an object in the workspace, participants have to look at it first. In a computerized experiment like the one reported in chapter 5, the instruction to click on one of the depicted entities on the screen elicits target fixations in the same way.

The time to the first target fixation, measured in milliseconds, is a continuous variable, and is therefore actually quite well suited for the standard psycholinguistic 'by subjects' and 'by items' ANOVAs. However, both the subject and the random effect can be incorporated into one single mixed effects linear regression model, which has the advantage of increased statistical power relative to F1 and F2 ANOVAs (Baayen, Davidson & Bates, forthcoming (b)). The mixed effects modeling approach will therefore be preferred in this thesis.

After considering these important methodological and statistical notions, let us now turn to the field in which they will be applied: the empirical study of givenness and givenness marking in spoken language.

Chapter 5

The processing of givenness marking in the visual world

The nature of reference resolution continues to be a puzzle in the study of language processing. What are the mechanisms and processing architecture underlying reference? When exactly does the language processor represent what? Referential status—givenness—will be an important aspect of any coherent account of reference resolution. What is on the speaker's and the listener's minds when an expression is uttered affects the choice as well as the interpretation of referring expressions.

In order to study givenness, it is important to try to disentangle variation in givenness *per se* (identifiability and accessibility of referents) from variation in givenness marking (definiteness marking and pronominalization). Several studies of givenness and referring expressions in functional linguistics argue for a correlation between the two on the basis of corpus studies of natural discourse (see chapter 2). Psycholinguistic studies of referential processing, on the other hand, make a point of investigating the effect of referring to the same referents (in the same contexts) using different expression types, as reviewed in the last chapter. Most studies in this area focus on the [\pm pron] feature, i.e. the difference between pronominal and more explicit types of anaphoric expression. (And with good reason: indefinite and definite forms are not natural in the same contexts.) It is

generally found that the resolution of both explicit and pronominal forms is initiated immediately, whereas the complete resolution of pronouns can sometimes be delayed.

A recent study (Karabanov, Bosch & König, forthcoming) focused on the processing of definite full noun phrases and definite pronouns in a visual world setup. They found that pronouns and full noun phrases are processed approximately equally fast, suggesting that pronouns do not require an additional processing step to link up the anaphoric reference to the antecedent, as suggested by for instance Gernsbacher (1989) (see chapter 4). An example of the verbal stimuli in their study (in their translation from German) is shown in (1), with two of the referring expressions studied in boldface.

- (1) It's market day in the village.
The market woman is quibbling with the worker.
She's just saying that he should not make any trouble and should give the new bike back that he borrowed.

Karabanov et al. found immediate increases in visual attention on referents of both full noun phrases and pronouns, and found no difference in the timing of maximal attention on the referents of the two expression types. However, they found an approximately 10% higher proportion of fixations on referents of definite full noun phrases. The full noun phrase referents were always new, i.e. the noun phrases that were investigated mentioned the referents for the first time, whereas the referents of the pronouns were given, as required for felicitous anaphoric reference. Since the two types of referring expression were not studied under similar givenness conditions, the variables of referential form and mental accessibility are not disentangled in this study. Perhaps the fast eye movement response to given referents is dependent on those referents being coded as pronouns. Likewise, the 10% effect could be due to givenness, referential form, or a combination of the two. It is impossible to know since the two variables are confounded. It is thus an open question how full

noun phrases with given referents will compare to pronouns with given referents in a visual world setting. Will 'the rabbit' elicit a different eye movement pattern than 'that' in a context where the rabbit has just been mentioned? And what about 'a rabbit' and 'one'?

Fewer psycholinguistic studies have examined the [\pm def] feature. One visual world study that contains data revealing the processing of indefinite noun phrases is (Chambers, Tanenhaus, Eberhard, Filip & Carlson, 2002). Chambers et al. focused on how contextual information can constrain the understanding of different types of full noun phrase, and apart from their main findings, their results showed that indefinite noun phrases in a context with two potential referents (e.g. *a can* in "put the cube inside a can" with two compatible cans present) directed the participants' visual attention to an appropriate referent approximately as fast as definite noun phrases in a context with one possible referent (e.g. *the can* in "put the cube inside the can" with one compatible can present). When indefinite and definite noun phrases switched contexts, both expression types took longer to process. The referents were always new, and thus Chambers et al.'s data do not reveal anything about the effect of linguistic accessibility. But within this 'new' context, and with the appropriate number of compatible referents present, indefinite and definite full noun phrases elicited similar eye movement patterns. If anything, this would lead to the expectation that indefinite and definite forms also have similar processing characteristics in appropriate contexts with given referents. So, a noun phrase such as 'the goose' in a context where a goose has been mentioned would be expected to yield a similar eye movement pattern to the one elicited by 'a goose' where a set of two geese has been mentioned.

A question of particular interest here is whether a definite accented pronoun (equivalent to 'that') will be processed similarly to an indefinite *one*-anaphor ('one') in contexts with given referents. As we have seen, many studies have addressed the question of whether more or less explicit anaphoric expressions are processed differently, and at least one has indirectly approached definiteness marking. But to my knowledge, none have considered the interaction of the [\pm def] and [\pm pron] features. The pro-

cessing of definite pronouns has never been compared to the processing of indefinite *one*-anaphors. Neither has the processing of indefinite *one*-anaphors been compared to the processing of indefinite full noun phrases. The goal of this chapter is to systematically compare the four combinations of the two features of givenness marking of interest in this thesis: [\pm def] and [\pm pron].

A good indicator of what is on a person's mind is his or her pattern of eye movements. The psycholinguistic 'visual world' paradigm is based on the insight that eye movements are closely time-locked to linguistic input, as described in the previous chapter. This has been established for full definite noun phrases, and has been harnessed to investigate numerous aspects of online language processing. However, few studies have focused on whether or not eye movements are time-locked to linguistic input in a similar fashion when other types of referring expression than definite noun phrases are heard, not to mention referring expressions in contexts with given referents, such as pronouns.

The following sections present eye movement data of comprehenders being instructed to click on entities visible on a screen. The entities are referred to by means of different types of referring expression. The questions explored in these sections are how patterns of visual attention are associated with the use of different types of referring expression in contexts with linguistically given referents. Do listeners look more, faster, or otherwise differently at referents of expressions such as *a rabbit*, *the rabbit*, *one*, and *that* in similar usage contexts? Different types of referring expression tend to occur in certain contexts (pronouns must have given antecedents, and full noun phrases tend to be used about not yet introduced entities), but is there something inherently different about the way we understand expressions of different types? If this is the case, one would expect differences in processing among different types of referring expression in similar contexts. On the other hand, a similar level of referent givenness might lead to small or no processing differences between different expression types. This would suggest that it is not the linguistic form itself that is important in the comprehension of referring expressions, but rather the cognitive sta-

tus of the referent. In order to study different expressions, their referents must be given, since only then both full noun phrases and pronouns are pragmatically felicitous.

5.1 Eliminating accenting as a factor in the study of reference

The following is an analysis of the linguistic characteristics of the three types of anaphoric referring expression already studied in chapter 3: the unaccented pronoun *den* 'it,' the accented pronoun *dén* 'that,' and the (obligatorily accented) indefinite *one*-anaphor *én* 'one.' The purpose is to verify whether accenting plays an independent role in the discourse function of pronouns. If so, it may not be meaningful to compare indefinite *one*-anaphors (which are obligatorily accented in spoken Danish) to unaccented definite pronouns with respect to givenness, and the unaccented *den* form should therefore be dropped from further study.

It has been shown repeatedly in earlier work that accenting changes the meaning of pronouns from referring to the most salient entity in the discourse model to the least salient entity—informally speaking, to 'the other guy,' as in example (2) (Venditti et al., 2001; Venditti et al., 2002; Kristiansen, 1996).

- (2) a. John hit Bill and then he hit George. (he = John)
b. John hit Bill and then HE hit George. (HE = Bill)

The Danish definite pronouns *den* and *dén* can be expected to function the same way. If heard in a context with two potential antecedents of different salience, e.g. functioning as grammatical subject and object, it would be expected that an unaccented pronoun *den* would prefer the most salient referent (the subject), while accented *dén* would prefer the less salient referent (the object). On the assumption that accenting is indeed the feature that signals this meaning difference, one might expect it to have a sim-

ilar effect regardless of definiteness. Indefinite *én* is minimally different from definite *dén* in precisely this respect. The question, then, is whether the antecedent preferences of *én* will pattern with *dén* as expected, with unaccented *den*, or altogether differently.

This question was investigated using data from the experiment to be further discussed in the next section. The following is a brief recapitulation of this experiment. An experimental trial was organized as follows (see figure 5.1). Four pictures of animals were shown in the middle of a screen. Two verbal utterances were heard, the first (the *context utterance*) containing a statement involving two or three of the pictures, the second (the *critical utterance*) an instruction to click on one of them.

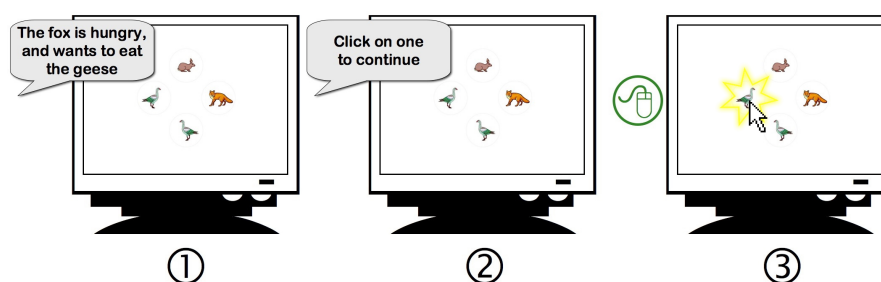


Figure 5.1: Experimental stimuli. Schematic of one trial with a singular subject/plural object context utterance, and an indefinite *one*-anaphor in the critical instruction.

When the participants had heard the critical utterance (the instruction), they clicked on the entity that they perceived as the intended referent—the target. The target could be a subject referent or an object referent of the context utterance, or an entity not mentioned in the context utterance. The targets of all trials were recorded and tallied. Antecedent preferences were measured in terms of the frequency of subjects and objects chosen as antecedents.

Table 5.1 below shows the antecedent preferences of the three different types of anaphor in a context with a singular subject and a singular object as potential antecedents, as in example (3) (note that the context utterance now refers to the two singular entities). An overall χ^2 test reveals statis-

tically reliable differences among the frequency distributions of the three expression types ($\chi^2(4) = 24.81, p < 0.0001$).

- (3) a. Ræven_i er sulten, og Ø_i vil gerne æde kaninen.
 Fox.DEF_i is hungry, and Ø_i wants to eat rabbit.DEF.
 b. Klik på den/dén/én for at fortsætte.
 Click on it/that/one to continue.

Anaphor	Target gram. role			Total
	Subject (sg.)	Object (sg.)	NonSubjObj	
<i>den</i>	68 (51.5%)	55 (41.7%)	9 (6.8%)	132 (100.0%)
<i>dén</i>	40 (30.3%)	80 (60.6%)	12 (9.1%)	132 (100.0%)
<i>én</i>	31 (23.5%)	87 (65.9%)	14 (10.6%)	132 (100.0%)

Table 5.1: Antecedent frequencies. The grammatical subject and object of the context utterance are both singular.

When one compares accented *dén* and unaccented *den*, the pattern is as expected. The frequency distributions of the two expressions are significantly different ($\chi^2(2) = 12.32, p < 0.005$). Just over half of the chosen antecedents of *den* are subjects, whereas only 41.7% are objects. The pattern thus goes in the expected direction, but the effect is surprisingly weak. This pattern suggests that the higher recency of the object plays an important role, perhaps more so in spoken than in written language. Spoken language unfolds dynamically in time and has a transient, ‘fast-fading’ nature (Moss & Gaskell, 1999), which may well enhance the salience of recent referents in spoken language compared to the frequently observed salience of subject referents in studies of written language.

As for the two accented forms, *én* and *dén* clearly have similar patterns compared to *den*. The difference between the frequency distributions of *én* and *dén* is not statistically reliable ($\chi^2(2) = 1.59, p \approx 0.45$), and the frequency distribution of *én* differs significantly from that of *den* ($\chi^2(2) = 22.13, p < 0.0001$). Both *én* and *dén* are interpreted as coreferential with the object in a little less than 2/3 of the cases, and with the subject in around 1/4 of the cases. A non-mentioned entity is selected as the referent for the

two types of accented anaphor a similar amount of times. This suggests that *én* and *dén* do indeed pattern together with respect to antecedent preferences. This supports the idea of accenting as a factor affecting the meaning of pronominal forms independently of definiteness. This means that it will be sensible to compare only the accented pronominal forms when looking for differences between definite and indefinite forms, pronominal and otherwise.

This is exactly the purpose of the next section. We will therefore now turn to the investigation of accented *én* and *dén* and indefinite and definite full noun phrases in the visual world-type setup that we have already come across in this section.

5.2 Definiteness and pronominalization

The question in this section is whether there are processing differences between the four expression types which exhibit the possible combinations of the $[\pm\text{def}]$ and $[\pm\text{pron}]$ features: definite and indefinite full noun phrases, and definite and indefinite pronouns, i.e. the accented pronoun *dén* and the obligatorily accented indefinite *one*-anaphor *én*.

In accordance with Chambers et al.'s (2002) findings, the hypothesis with respect to definiteness would be that there should be no difference in timing between indefinite and definite forms when presented in appropriate contexts, i.e. in contexts with several potential referents for the indefinite expressions and only one potential referent for the definite expressions. The indefinite and definite forms will be studied here in such appropriate contexts in order to preserve some of the naturalness of the different expressions. The comparison between indefinite and definite full noun phrases can be seen as a kind of replication of this aspect of Chambers et al.'s experiments. The interesting question is whether indefinite AND pronominal forms (i.e. indefinite *one*-anaphors) will differ more from definite pronouns than indefinite full noun phrases differ from definite full noun phrases, in other words whether the $[\pm\text{def}]$ and $[\pm\text{pron}]$ features

have interacting effects.

The question of whether full noun phrases and pronominal forms are processed differently in the context of already-mentioned referents has been extensively studied in earlier psycholinguistic research (see chapter 4). It is generally found that pronoun resolution is initiated immediately, but that the final commitment to an interpretation is often delayed, postponing the typical final resolution of pronouns compared to proper noun and full noun phrase anaphors. Accordingly, the expectation in this study is that pronominal forms are not processed faster or more slowly than full noun phrase forms initially, but may take longer to resolve completely. If there is a difference after all, it can be attributed with some certainty to the referential form of the expressions itself, since the accessibility of the potential referents is the same (unlike in Karabanov et al. (forthcoming)).

Whether the variables of definiteness and pronominalization interact is an open question. The null hypothesis is that they do not, but it is conceivable that givenness marking in the two dimensions ‘accumulates’ so that expressions that are both definiteness marked and pronominally marked (definite pronouns) are more given than expressions that are only marked for one of these features (definite full noun phrases and indefinite *one*-anaphors), which are in turn more given than expressions that are not givenness marked in any of these dimensions (indefinite full noun phrases). In that case, an interaction effect between definiteness and pronominalization would be expected, by the way suggesting a place for indefinite *one*-anaphors somewhere in the middle of Gundel et al.’s Givenness Hierarchy rather than at one of the extremes.

In sum, the major hypotheses for this section are:

- (4) **H₀ No effect of appropriate definiteness** There is no overall processing difference between definite and indefinite forms in the presence of unique and non-unique referents, respectively.
- H₁ Effect of uniqueness and/or definiteness marking itself** Expressions with different appropriate definiteness marking yield overall processing differences.

- (5) **H₀ No effect of pronominalization** There are no overall processing differences between full noun phrases and pronominal forms with previously mentioned referents.
- H₁ Effect of pronominalization** Pronouns and full noun phrases with previously mentioned referents are processed differently.
- (6) **H₀ No interaction effect between appropriate definiteness and pronominalization** Any processing differences between appropriate indefinite and definite forms will be statistically equal whether the forms are pronominal or not, and differences between pronominal forms and full noun phrases will be the same whether the forms are definite or not.
- H₁ Interaction effect between appropriate definiteness and pronominalization** The magnitude of the effect of appropriate definiteness depends on pronominalization and vice versa.

A visual world-type data collection arrangement was set up in order to test these hypotheses, using stimuli similar to those already encountered in the last section. A number of measures were used—eye movement-based and otherwise. The eye movement-based measures described in section 4.3 were used: proportion of fixations curves, proportions of inspections of the target entity in relevant time windows, and average time to first target fixation. In addition, the mouse response time in the experiment was measured, i.e. how fast the participants clicked on the perceived target entity.

Experimental materials and procedure

It is a challenge to design linguistic materials which allow one to compare the four expression types with the different combinations of the [\pm def] and [\pm pron] features: there is a trade-off between the similarity and the naturalness of the linguistic context in which the expressions are presented. In order to maximize naturalness, it is desirable to present the different expression types in their canonical context, which differs from expression to

expression, as shown by numerous studies of the correlation of givenness and referential form (see chapter 2). On the other hand, it is necessary to present the different expression types in maximally similar contexts in order to be able to attribute processing effects to referential form rather than givenness. The experimental materials described in this subsection represent a compromise between these desiderata.

The experiment consisted of a sequence of displays of animals which participants were given pre-recorded spoken instructions to interact with using a computer mouse. The displays in the experiment had three animal types: two solitary animals and a pair of identical animals. The animals in a trial were always semantically associated, typically through predator-prey relationships. This kind of relationship made it possible to prevent the participants from guessing what the grammatical object would refer to once they had heard the grammatical subject: there were always two equally likely prey animal types when a predator had been mentioned as the subject.¹

There were two context variants. Each of the two types of context utterance left the remaining animal unmentioned. This animal served as a distractor. As a shorthand, the context where the subject is singular and the object plural is labeled $S_1O_2X_1$, and the plural subject/singular object context is labeled $S_2O_1X_1$ (S for Subject, O for Object, and X for neither, i.e. the distractor).

The grammatical number of the two linguistic referents was different because this ensured that the choice of antecedent for pronouns yet to be encountered would not be free thus potentially leading to pre-selection of antecedents. With possible antecedents with two different numbers, the participant would have to guess if a definite form (e.g. *dén* referring to the unique referent) or an indefinite form (*én* referring to a non-unique referent) would be used.

After the context utterance an instruction followed to click with the mouse on one of the animals, which was referred to using either a defi-

¹ This was the judgment of the author. No formal tests of how well the predators and preys fit together were performed.

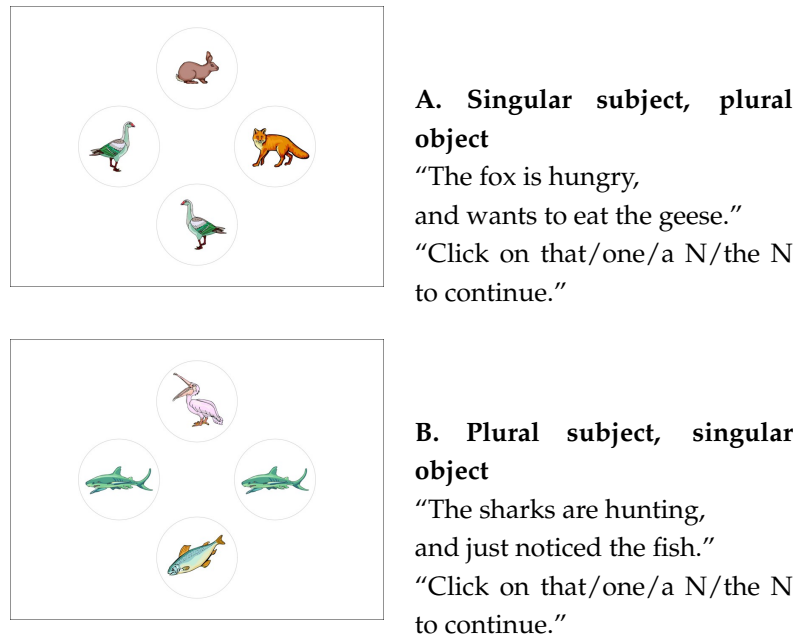


Figure 5.2: The four types of context utterance presented to participants.

nite full noun phrase, an indefinite full noun phrase, an accented definite pronoun or an accented indefinite *one*-anaphor. Unaccented definite pronouns were used as a fifth type, but these are not analyzed here.

The visual stimuli were prepared from colored clip art pictures publicly available on the world wide web.² The size of each depicted entity was held as constant as possible. Colored pictures were used in order to achieve maximal identifiability of the animals. No attempt was made to equalize the luminance or contrast of the pictures, and not all animals were equally common, so biases due to these factors cannot be ruled out.

The auditory stimuli were recorded utterances in Danish, read by the author. Examples are shown below.

- (7) a. Ræven_i er sulten, og Ø_i vil gerne æde gæssene.
 Fox.DEF_i is hungry, and Ø_i wants to eat geese.DEF.

² See www.barrysclipart.com

- (8) a. *Hajerne_i er på jagt, og Ø_i har lige opdaget fisken.*
 Sharks.DEF_i are hunting, and Ø_i have just noticed fish.DEF.

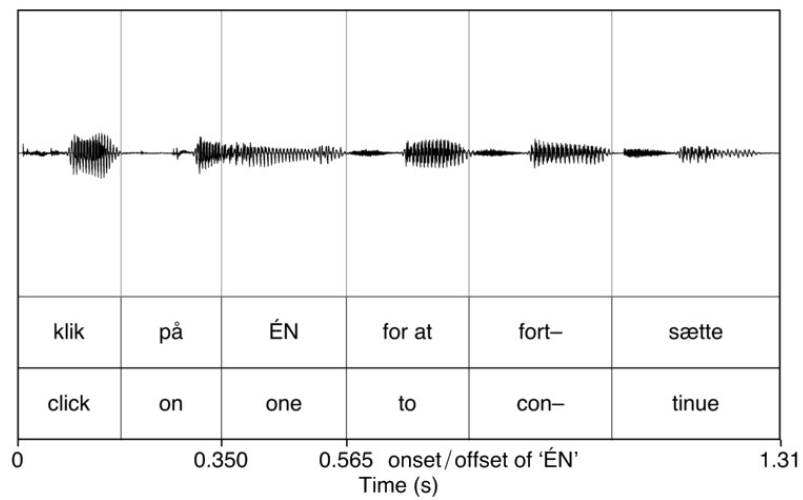
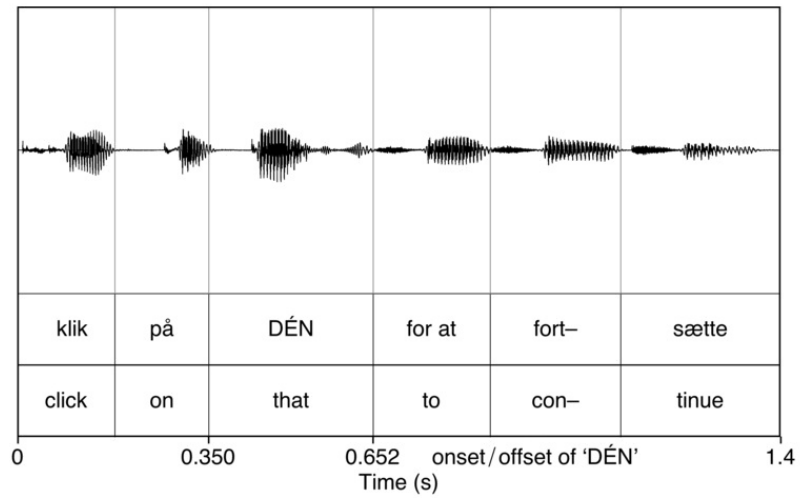
The context utterances were designed as conjoined clauses with a copula clause characterizing the subject, followed by a conjoined clause with a coreferential ‘null subject’ and an object. The subject was always a semantic agent, the object a patient. This configuration was chosen in order to ensure that the pragmatic role of topic was as clear as possible, and that the semantic, syntactic, and pragmatic roles of agent, subject and topic coincided so as to produce interstratal consistency in a potential semantic/syntactic/pragmatic salience bias. I.e. I wanted both semantics, syntax, and pragmatics to favor the subject participant as the most likely or ‘default’ pronoun antecedent.

All the spoken materials were recorded by a native speaker of Danish (the author). Intonation was kept relatively homogenous. The utterances containing anaphors were then modified in the following way. The most neutral-sounding instance of the preposition *på* (‘on’) + each of the three anaphor types *den*, *dén*, and *én* was selected and spliced into the frame “click [on X] to continue.” The word *på* (‘on’) was included because it is deaccented before accented *dén* and *én*, but not before unaccented *den*. This procedure ensured that nothing but the prepositional phrase containing the anaphor differed in the utterance. No attempt was made at equalizing the durations of the anaphors themselves, and thus they had different durations, see figure 5.3. It was informally tested on a number of colleagues whether the spliced utterances could be identified among non-spliced ones, and this was not the case.

The four types of noun phrase analyzed had the durations shown in table 5.2.

Anaphor duration		Avg. full NP duration	
<i>dén</i>	<i>én</i>	Def. NP	Indef. NP
302 ms	215 ms	513 ms	534 ms

Table 5.2: Average durations of noun phrases.

Figure 5.3: Onsets and offsets of *dén* and *én*.

Contexts were counterbalanced across the three anaphor types so that 10 participants heard *den*, 11 heard *dén*, and 12 heard *én* in a particular context. The 10 participants that heard *den* in one context heard *dén* in another context and *én* in another, and so on for the other two groups of participants. This was done in order to control for biases due to factors such as familiarity of the animals, attentional cues due to color etc. The experiment was thus presented in three different versions. This arrangement yielded the following frequencies of items presented in each condition (showing only *dén* and *én*):

Context	Version 1		Version 2		Version 3	
	<i>dén</i>	<i>én</i>	<i>dén</i>	<i>én</i>	<i>dén</i>	<i>én</i>
S ₁ O ₂ X ₁	5	4	6	3	5	5
S ₂ O ₁ X ₁	3	2	3	2	3	2

Table 5.3: Item frequencies for anaphor trials in the three different versions of the experiment.

The full noun phrase trials were the same for all 33 participants, and the frequencies were as shown in table 5.4.

Context	N.DEF	<i>en</i> N
S ₁ O ₂ X ₁	3	3
S ₂ O ₁ X ₁	3	4

Table 5.4: Item frequencies for the full noun phrase trials.

Unlike in the pronoun conditions, in the full noun phrase conditions the critical referring expressions were of course different from trial to trial. This calls for a larger number of trials in the full noun phrase conditions, since the variability in processing from noun phrase to noun phrase can be considerable. However, only a few different trials with full noun phrases were analyzed, in order to keep the experiment reasonably short, and in order to keep the amount of full noun phrases and pronominal forms balanced. It should be noted already at this point that this reduces the validity

of the full noun phrase results to a 'proof of concept' level. Thus, the attentional patterns associated with the full noun phrases will be used to show how at least some noun phrases can be processed, whereas broader generalizations are postponed to a different occasion.

All in all, 27 or 28 trials were analyzed in the different versions of the experiment. There were 93 or 92 additional trials in the experiment (including the trials with unaccented *den* not analyzed) which served as fillers, yielding a total of 120 trials. The filler trials had the same structure as the experimental trials, with the exceptions that sixty of the filler trials had inanimate entities instead of animals, and that most of the fillers had either two singular or two plural entities in the context utterance.

The stimuli were presented as a sequence of 12 blocks of 10 trials each. The first of these blocks was a training session, and was identical for all participants, whereas the rest of the blocks were presented in random order. This was done in order to control for ordering effects. The order of trials within each block was fixed.

The relative positions of the entities on the screen were not systematically randomized, but were balanced so that a perceived pattern (e.g. 'the two identical entities are always next to each other') would not interfere with the task.

Eye movements were recorded with a SensoMotoric Instruments iView X high speed eye tracking system running at a sample rate of 240 Hz. Participants used a chin rest to hold their heads still. The visual stimuli were presented on a 19" flat panel LCD computer monitor. The eye tracker was positioned so that there were 56 centimetres between the screen and the subject's eyes. The auditory stimuli were presented through headphones.

The presentation of the experimental stimuli were controlled by a PC running E-prime. The stimulus PC controlled the eye-tracking PC through commands issued by the E-prime experiment script, which were sent over a serial connection. A computer mouse was used for the interaction with the stimuli. The response time and position of the mouse responses were recorded on the stimulus PC by the E-prime script.

Thirty-three Danish university students, aged around 28, volunteered

for the experiment. All were monolingual native speakers of Danish. All participants had normal or corrected-to-normal vision. They received a lottery ticket for their participation. They read a written instruction sheet that explained how they were to listen to the utterances, and react to the critical utterance by clicking on the entity they perceived to be the intended referent of the noun phrase. They were instructed to react as spontaneously as possible, and were told that even though some of the referring expressions might sound ambiguous, there would be no ‘wrong’ answers in the task. They were also told that although it would be preferable if they tried to complete the experiment as fast as possible, they were allowed to take all the time they needed to select a referent.

The written instruction was talked through with the participants, and they then sat down in front of the eye-tracker and made themselves comfortable with their head on the chin rest. The eye-tracker was calibrated to the participants’ left eye using a 13 point calibration procedure.

The 10 practice trials were presented, and after completing this practice block, the participants saw a screen with a written instruction encouraging them to ask now if they had any additional questions. After clearing up remaining doubts and questions the experiment proceeded with the remaining 11 blocks of trials without interruptions. Each experimental session took 10-15 minutes plus calibration.

The data collected in this setup were not analyzable without some pre-processing. The following subsection describes how the data were grouped for statistical analysis.

Grouping of the data for analysis

In order to analyze the language contingent eye movements of the participants, areas of interest (AOIs) had to be defined for the four entities on the screen, and in order to yield a meaningful analysis, this had to be done in a response-contingent way—in effect after the eye movement data had been collected. Whatever entity the participant clicked on, thereby indicating his or her understanding of the reference, had a special status. This

was labeled the *target* AOI. The other AOIs were labeled as *target twin* (i.e. the second entity of the same type as the target, if applicable), *other linguistic referent(s)* (entities also mentioned in the context utterance), and the *distractor* (the entity in the visual display not mentioned in the context utterance). This presupposes the elimination of those trials where a non-mentioned entity was clicked on. Fifty non-subject, non-object target trials were discarded out of a total of 1056 trials, corresponding to 4.7% of the anaphor trials.

The target was sometimes a syntactic subject, sometimes a syntactic object. Data for these two types of target should preferably be pooled in order to eliminate grammatical role as a factor influencing the processing of reference. Since targets were not always of the same number, the data had to be split by definiteness and then grouped by number in the following way.

Target grammatical role	Anaphor type		
	<i>den</i>	<i>dén</i>	<i>én</i>
Subject (<i>sg.</i>)	121 (99.2%)	141 (97.9%)	18 (13.8%)
Object (<i>pl.</i>)	1 (0.8%)	2 (1.4%)	102 (78.5%)
NonSubjObj	0 (0.0%)	1 (0.7%)	10 (7.7%)
Total	122 (100.0%)	144 (100.0%)	130 (100.0%)

Table 5.5: Antecedent preferences. Context: $S_1O_2X_1$: the subject of the context utterance is singular, the object plural.

Target grammatical role	Anaphor type		
	<i>den</i>	<i>dén</i>	<i>én</i>
Subject (<i>pl.</i>)	5 (5.1%)	3 (3.0%)	56 (84.8%)
Object (<i>sg.</i>)	94 (94.9%)	92 (92.9%)	10 (15.2%)
NonSubjObj	0 (0.0%)	4 (4.0%)	0 (0.0%)
Total	99 (100.0%)	99 (100.0%)	66 (100.0%)

Table 5.6: Antecedent preferences. Context: $S_2O_1X_1$: the subject of the context utterance is plural, and the object singular.

In the $S_1O_2X_1$ and $S_2O_1X_1$ contexts, the target was largely determined by the definiteness of the referring expression: definite *dén* preferred the unique referent, whereas indefinite *én* preferred a non-unique referent, as can be seen in tables 5.5 and 5.6. For the proportion of foveation analyses of these two contexts, the data were grouped by definiteness in accordance with these target preferences, as illustrated in figure 5.4 below.

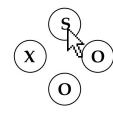
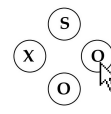
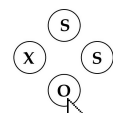
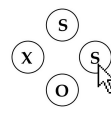
	DÉN → Unique target	ÉN → Non-unique target
$S_1O_2X_1$		
$S_2O_1X_1$		

Figure 5.4: Data grouping by definiteness (columns) in the $S_1O_2X_1$ and $S_2O_1X_1$ conditions.

Only trials where the preferred target was clicked on were included. Consequently, the four areas of interest in trials with *dén* could be categorized as the target, two other linguistic referents (plural expression), and a distractor. This categorization applies to the two cells in the left column of figure 5.4. There were a total of $141 + 92 = 233$ trials of this type. For the *én* trials there were a target, a target twin, another linguistic referent, and a distractor (right column of figure 5.4). There were $102 + 56 = 158$ trials of this type. The conditions thus arrived at are shown below.

1. N.DEF in the $S_1O_2X_1$ and $S_2O_1X_1$ contexts. Areas of interest: Target, two other linguistic referents, distractor. 198 trials total.
2. *dén* in the $S_1O_2X_1$ and $S_2O_1X_1$ contexts (only trials with preferred (= unique) target). Areas of interest: Target, two other linguistic referents, distractor. 233 trials total.

3. *en N* in the $S_1O_2X_1$ and $S_2O_1X_1$ contexts. Areas of interest: Target, target twin, other linguistic referent, distractor. 230 trials total.
4. *én* in the $S_1O_2X_1$ and $S_2O_1X_1$ contexts (only trials with preferred (= non-unique) target). Areas of interest: Target, target twin, other linguistic referent, distractor. 158 trials total.

Note that these combinations of expression type and context do not yield a true factorial design, since it is not possible to create conditions in which definite and indefinite forms are processed under equal circumstances. When analyzing indefinite and definite expressions in their preferred context, one will in effect be comparing identification of unique referents with selection among a pair of non-unique referents. This confounding of expression type and referent uniqueness is unfortunate, but unavoidable. That said, the $S_1O_2X_1$ and $S_2O_1X_1$ contexts approximate a neutral backdrop for the comparison in that they are felicitous for both indefinite and definite forms, since trials of this type involve a choice between a preferred and a dispreferred antecedent for both indefinite and definite anaphors.

The following subsections present the results of the analyses of these data.

Proportions of fixations over time

Proportions of fixations over time curves can be used to visualize how much attention each area of interest in a particular condition receives from all the participants, moment by moment. At a sampling rate of 240 Hz, the eye-tracker sampled the gaze position in the calibration geometry approximately every 4 ms. These raw data were converted to sequences of fixations and saccades/blinks using specialized software. These fixations were connected to the data from the Eprime experiment presentation software using a custom-built software script, thus providing data which contained information about which grammatical role was looked at when, and when the target eventually clicked on was looked at. The fixations

were sliced into to 20 ms samples, each associated with one of the four areas of interest (AOIs). These samples formed the basis for proportion of fixations analyses. For instance, for a certain condition, the samples with a participant's gaze position on the target AOI were counted and this number divided by the total number of samples at time 0, i.e. the utterance onset of the critical instruction. This yielded a proportion of target fixations at this particular time slice. This procedure was repeated for samples at 20 ms, 40 ms, and so on until 2600 ms after utterance onset, and for the different AOI categories as well as irrelevant samples (i.e. fixations outside the calibration geometry, saccades, blinks, as well as fixations in the geometry, but not in one of the AOIs). This analysis was carried out for each of the four types of referring expression. Below follow the proportion of fixations analyses of the conditions described above.

Figure 5.5 shows proportions of fixations of full definite noun phrases and accented definite pronouns. The target proportion in both conditions starts to increase during the articulation of the referring expressions. The full noun phrase target proportion exhibits a steeper increase which means that the two target proportions cross 50% approximately simultaneously even though the increase starts a little later in the full noun phrase condition. The full noun phrase condition reaches a higher peak target proportion than the pronoun condition. Furthermore, in the full noun phrase condition the target proportion is noticeably higher than the proportion of the two other referents even before the onset of the critical referring expression. There is thus a tendency for the singular referent (which is the target in these conditions) to be preferred before the referring expression is produced, but only in the full noun phrase condition. The reason why I refer to the target here as "the singular referent" is that an early bias in favor of the singular referent can be observed in other conditions as well, as we shall see shortly.

Figure 5.6 shows proportions of fixations of full indefinite noun phrases and indefinite *one*-anaphors. The two graphs are similar overall, with subtle differences. The full noun phrase target proportion increases more steeply and reaches a higher peak than the anaphor target proportion. The

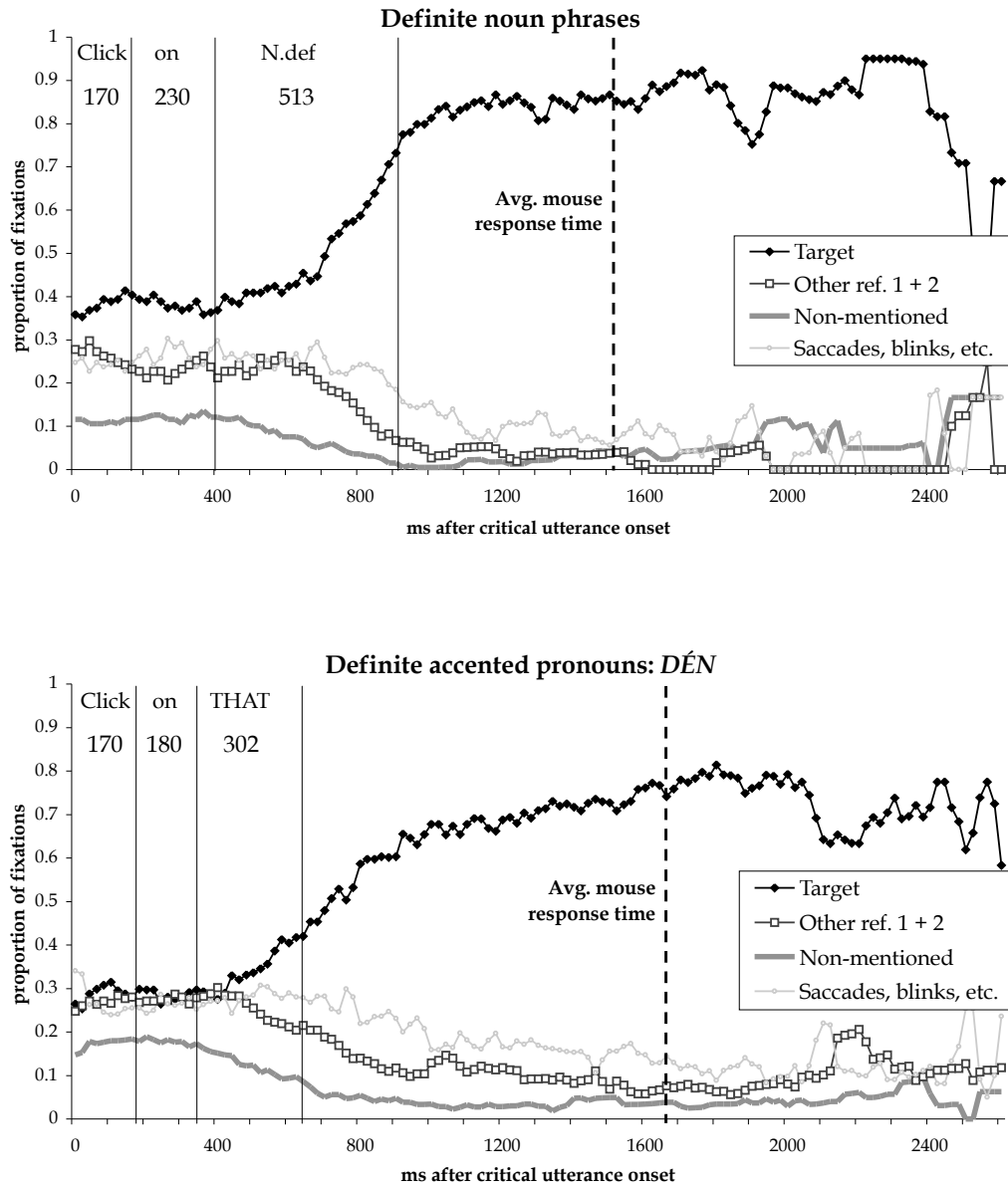


Figure 5.5: Proportion of fixations over time analysis of eye movements associated with definite noun phrases (top panel) and accented definite pronouns (bottom panel) in the $S_1O_2X_1$ and $S_2O_1X_1$ contexts.

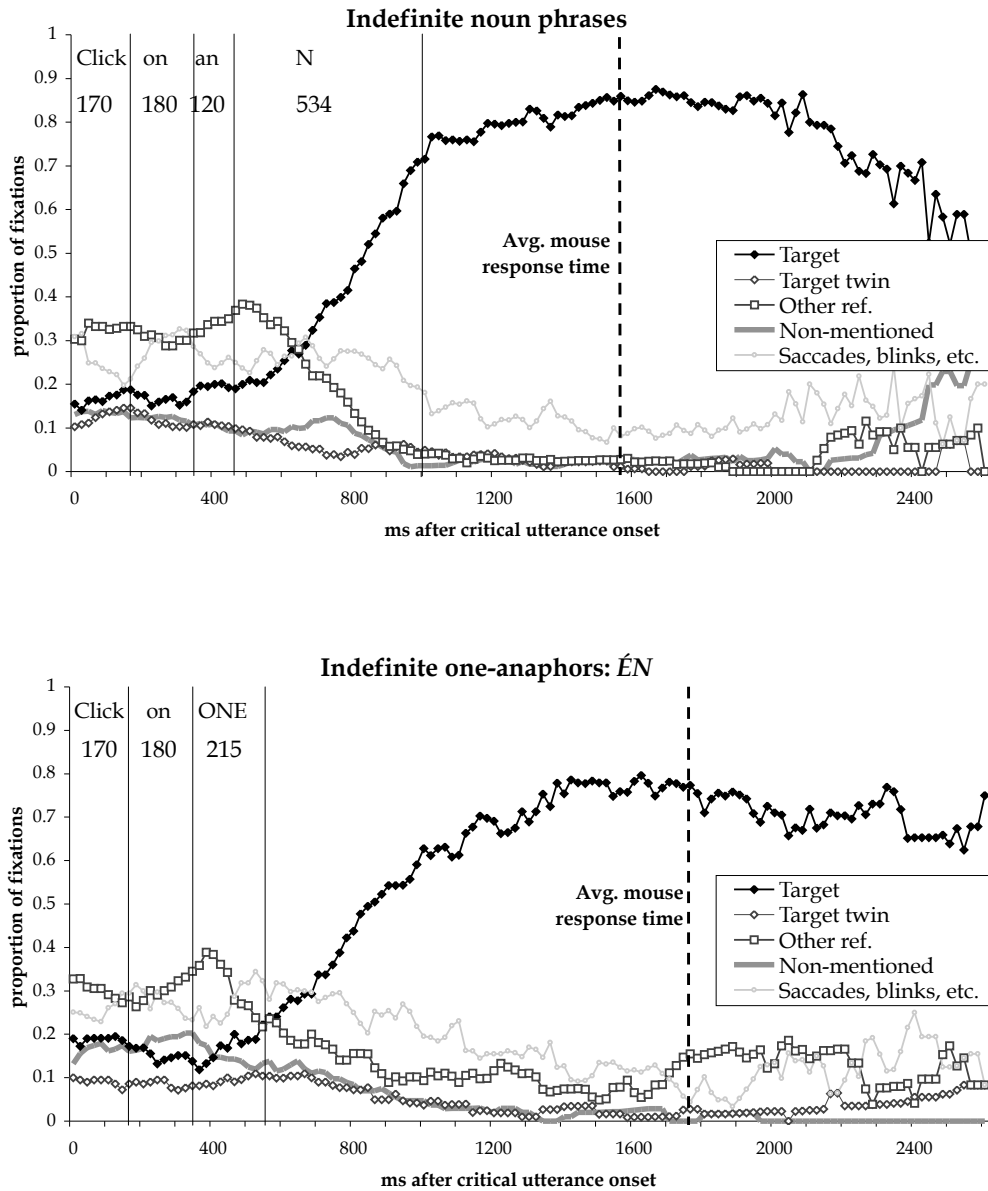


Figure 5.6: Proportion of fixations over time analysis of eye movements associated with indefinite noun phrases (top panel) and accented indefinite *one*-anaphors (bottom panel) in the $S_1O_2X_1$ and $S_2O_1X_1$ contexts.

target proportion increases during the referring expression in both cases, but slightly later in the full noun phrase condition. The two curves cross 50% about simultaneously. In both conditions, there is an early preference for the target entity over the target twin. This suggests that participants tend to select a favorite among the two identical entities even before the onset of the referring expression. Also in both conditions, the 'other referent' has an early increase which continues into the time window of the referring expression. Part of the reason is of course that there are two entities that have to share the attention to the target category, so to speak. But if the two identical-entity curves were combined, there would still be a bias toward the other referent which emerges before the onset of the referring expression. Taken together with the finding in the definite full noun phrase condition, there thus seems to be a tendency toward an initial preference for the singular referent.

Proportions of target inspections

Proportions of target inspections is a measure derived from eye movement frequencies (see section 4.3). The measure can be used to compare different conditions with respect to how many fixations were initiated on a certain area of interest (AOI) during a particular time window. The measure gives the proportion of such 'target' fixations relative to the total number of fixations initiated in the eye-tracking geometry during the relevant time window. Here, the AOI is the entity that the participant later clicks on, thereby indicating his or her ultimate understanding of the referring expression used in the instruction. The time windows used here are four 300 ms time windows: the first, labeled the *pre-PP* time window, starts 100 ms prior to the onset of the prepositional phrase in the instruction (*Click on ...*). In allowing for 200 ms of eye movement planning, fixations detected in this time window reflect linguistic material encountered during the 300 ms before the prepositional phrase onset. The second time window, the *PP* time window, starts 200 ms after the onset of the prepositional phrase. This time window reflects linguistic material encountered from the onset

of the prepositional phrase and 300 ms onwards. The *PP+300* time window reflects the following 300 ms, and the *PP+600* window the 300 ms after that.

The pre-PP time window should show no difference in target fixations, since there is no systematic difference in the linguistic material heard before the onset of the prepositional phrase. The PP time window represents the earliest time where differences due to the different referring expressions could influence the participants' looks to the eventual targets. The preposition is conservatively chosen as the onset of the time window because the different referring expressions may modulate the pronunciation of the preposition, thereby possibly making the preposition a subtle cue for which expression type is about to be uttered. The preposition has a duration of about 200 ms, so the PP time window will reflect processing of the preposition and about 100 ms of the ensuing referring expression. Thus we might expect an increase in target fixations already here. The following 300 ms in the *PP+300* window reflects processing of the remaining 'tail end' information from the pronominal expressions, and 300 ms of information from the 'middle' of the full noun phrases. One would expect this information to be enough to determine which expression type is being uttered, and thus relatively high proportions of fixations should be observed. Full noun phrases contain explicit information about the referent, and they can thus be resolved with more certainty than pronominal forms. On this basis, a higher proportion of fixations would be predicted in response to full noun phrase than in response to pronominal forms in the time windows where the relevant unambiguous information is available, i.e. primarily in the *PP+300* window. Fewer new fixations would be expected in the *PP+600* window, since participants are now more likely to be already looking at the target. If the processing of pronominal forms is indeed delayed, then a higher proportion of target inspections would be expected for pronouns in this time window. In all time windows from the PP window and onwards, we might expect higher proportions of target inspections on referents of the [+def] forms, since they are unique and thus do not have an entity 'twin' to compete with. These predictions do

not give rise to any expectations of interaction effects between the two factors of definiteness and pronominalization. While an effect of definiteness might be expected because there are two referent candidates for indefinite forms, this effect is not expected to differ between the two levels of pronominalization.

The results were as follows. Table 5.7 shows the proportions of target inspections in the four time windows. The four expression types are represented as combinations of the binary features of $[\pm\text{def}]$ and $[\pm\text{pron}]$.

	Pre-PP		PP		PP+300		PP+600	
	$[-\text{def}]$	$[\text{+def}]$	$[-\text{def}]$	$[\text{+def}]$	$[-\text{def}]$	$[\text{+def}]$	$[-\text{def}]$	$[\text{+def}]$
$[\text{+pron}]$	0.16	0.23	0.36	0.40	0.34	0.33	0.16	0.15
$[-\text{pron}]$	0.12	0.20	0.31	0.36	0.53	0.48	0.08	0.10

Table 5.7: Proportions of inspections.

The pattern in the pre-PP time window shows a tendency toward higher proportions of target inspections on the definite forms, but it does not reach significance ($[\pm\text{def}]$: $z = 1.748$, $p = 0.08$; other z 's $< \pm 1$, p 's > 0.4). In the PP window the proportions of inspections have increased considerably, but there are no statistically reliable differences between the four expression types (z 's $< \pm 1$, p 's > 0.5). In the PP+300 window, there is a clean main effect of the $[\pm\text{pron}]$ feature: the proportion of target inspections is higher for full noun phrase forms ($[\pm\text{pron}]$: $z = -2.964$, $p = 0.003$; other z 's $< \pm 1$, p 's > 0.4). Finally, in the PP+600 time window, there is a slight tendency toward higher proportions of target inspections on pronominal forms, discernible on the backdrop of a general, marked decrease ($[\pm\text{pron}]$: $z = 1.640$, $p = 0.1$). But none of the effects reach significance (other z 's $< \pm 1$, p 's > 0.5).

For the pre-PP time window, the lack of effects is as expected since the inspections recorded here cannot be driven by the different referring expressions. The tendency toward higher proportions of target inspections for the $[\text{+def}]$ forms may stem from a general preference for unique entities. The general increase in the PP window suggests that the very

earliest information from the referring expressions, or maybe even anticipatory information from the preposition, leads to increased attention on the eventual target entity for all the expression types. The pattern in the PP+300 window suggests a firmer commitment to the referents of full noun phrases than to those of pronouns. Pronouns maintain proportions of inspections similar to the previous time window. On the other hand, the proportions of inspections for pronouns decrease relatively moderately in the last time window, where those of the full noun phrases decrease much more. The whole pattern suggests immediate activation of target referents in response to the very earliest information in the linguistic signal, but with less immediate commitment to a particular entity for the pronominal forms. The fixations to the pronoun targets are more 'spread out,' which is also consistent with the more gradual slope of the proportion of target fixations in figures 5.5 and 5.6 above.

Time to first target fixation

We now turn to a different type of assessment of the earliest processing of the four different types of referring expression. Here the question is whether the time to the first fixation on the entity eventually clicked on differs between the different types of referring expression. If definiteness/uniqueness or pronominalization have an effect on processing which is not dependent on the givenness of the referent, then it might be detected using this measure.

The time is measured from 200 ms after the onset of the prepositional phrase, again conservatively taking this point as the earliest possible time where the type of referring expression about to be uttered might be detected on the basis of coarticulatory information in the preposition. The results are shown in figure 5.7.

Since the preposition + pronoun combinations take about 500 ms, the first looks to the target on average seem to occur in response to linguistic material encountered around the offset of the pronouns, and for the full noun phrases, about 300 ms into their realization. Although there is

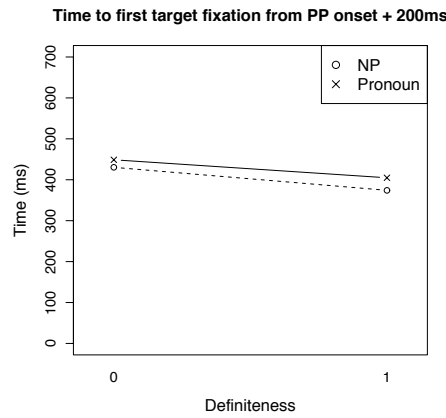


Figure 5.7: Time to the initiation of the first target fixation after the onset of the prepositional phrase + 200 ms.

a slight trend toward faster responses to definite forms, none of the differences observed are significant according to a linear mixed model with subjects and items as random effects and definiteness, pronominalization, and their interaction as fixed effects (t 's < 2, p 's > .3).³

Mouse response time

The mouse response time is the time it takes the participants to click on the entity they perceive as the intended target. It is measured from the onset of the prepositional phrase. This is strictly speaking not an online measure, since the mouse response typically occurs after the completion of the whole instruction containing the different types of referring expression. Language processing is highly transitory, and therefore one must be careful in interpreting results that are not derived from strictly online measures. On the other hand, the only thing that differs in the four different conditions considered here is which type of referring expression is used in the instruction. Therefore, any systematic patterns in the mouse response data are still of interest. The results are shown in figure 5.8 below.

³ The p values in this and the next subsection are estimated using Markov Chain Monte Carlo sampling, see (Baayen, Davidson & Bates, forthcoming (a)).

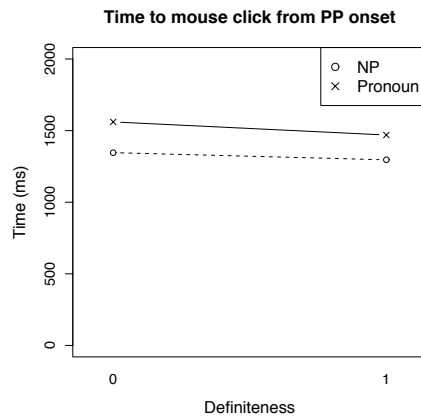


Figure 5.8: Mouse response time relative to the onset of the prepositional phrase.

As can be seen in figure 5.8, the mouse responses to the pronominal forms are generally somewhat slower than those to the full noun phrases. A mixed linear model with subjects and items as random factors and definiteness and pronominalization and their interaction as fixed factors showed this effect of the $[\pm\text{pron}]$ feature to be marginally significant ($t = 3.079$, $p = 0.0501$). A slight tendency toward faster response times to definite forms can be seen, but neither definiteness nor the interaction between definiteness and pronominalization showed significant effects (t 's $< \pm 2$, p 's $> .5$).

5.3 Discussion

The main finding in this section is that pronominal forms are by and large processed as fast as full noun phrases in contexts with given referents, certainly not a lot slower, as some findings might suggest (e.g. Gernsbacher (1989)). No significant differences could be detected in those measures sensitive to the earliest moments of referential processing. The very earliest moments of processing were indicated to be relevant by the proportion of fixations curves that showed very early rises of target proportions relative to the proportions of the other entities. Compared to the definite

conditions, target proportions generally passed the 50% mark on the proportion of fixations over time curves somewhat later in the indefinite conditions, but this is readily accounted for by the two potential target entities competing for the attention in these conditions. There were no significant differences in favor of the definite forms compared to the indefinite forms either in the frequency-based measure of target inspections or in the time to the first target fixation, although slight tendencies in this direction could be observed. Also there were no reliable signs that indefinite forms require special processing to select a referent from a set of two. This lack of differences generalizes the eye-tracking results of Karabanov et al. (forthcoming) to indefinite forms: the results presented here suggest that neither definite nor indefinite pronominal forms involve a special mechanism for linking up pronouns to their antecedent.

Some differences did emerge further downstream in the linguistic signal, beginning in the time window starting 100 ms into the referring expressions. Here, there were significantly more fixations to the target entity for full noun phrase forms than for pronominal forms. This corresponded well with the proportion of fixations over time curves, where full noun phrases were consistently different from pronominal forms in that these conditions always reached substantially higher target proportions than the pronouns. Furthermore, full noun phrase referents were clicked on significantly faster than those of pronominal forms. The direction of this difference suggests that it is not the length of the referring expressions that plays a role: if this was the case, one would have expected the longer full noun phrases to yield longer rather than shorter response times.

These findings taken together with Karabanov et al.'s similar finding that full noun phrases referring to new entities received more attention than pronouns referring to given entities suggests that the higher maximal proportion of attention on full noun phrases in their data in does have to do with the linguistic form of the referring expression, and not the givenness of the referent. The results in this chapter also echo earlier psycholinguistic findings of fast shallow processing but slower deep processing of full noun phrase anaphors (Cloitre & Bever, 1988). (See chapter

4.) The findings can be explained in the following way: full noun phrases are by definition more explicit than pronominal forms. A full noun phrase thus leaves little doubt as to which entity or entity type was intended, whereas a pronominal form might in principle refer to something other than the most likely referent. Thus, the most obvious suggestion for what influences the response times is the grammatical [\pm pron] feature and the difference in explicitness associated with it. It is conceivable, for instance, that a pronominal form might be perceived for a while to refer to an entity that just so happens to be in the participant's focus of attention, perhaps because of salient visual features or higher level semantic interestingness. The point is that there are more opportunities for thinking twice about the referents of pronominal forms than for those of fully explicit noun phrases, and this potential uncertainty may be what is reflected in the inspections data and mouse response times. This interpretation is supported by the proportion of fixations over time curves, where full noun phrases consistently receive a higher peak proportion of attention than pronominal forms. It would furthermore lead to the expectation of a higher proportion in the 'saccades, blinks, etc.' category for the pronominal forms. If one looks closely, such a pattern can indeed be identified after the onset of the referring expressions, although it is not dramatically visible. This suggests that participants look around slightly more to find a referent for a pronoun than for a full noun phrase.

Also in the proportion of fixations over time curves, a number of early biases could be observed over and above the generally very similar main patterns. Entity uniqueness was one factor that apparently had an early influence: unique entities tended to attract more attention than two identical entities combined. Furthermore, early biases seemed to emerge because people tended to select a favorite entity before hearing the referring expression that identified the target or target category. All in all, however, what stands out is the similarity of the processing patterns for the four types of referring expression.

This chapter showed remarkably few differences in processing times for the different combinations of the [\pm def] and [\pm pron] features in contexts

where the cognitive statuses of the referents were the same, at least with respect to accessibility. The next chapter explores the cognitive statuses of referents of different expression forms in unscripted dialogue, where givenness is free to vary, and where different combinations of givenness marking (i.e. different expression forms) might therefore correlate more naturally with varying degrees of givenness. The question is whether different degrees of givenness will actually show up in the eye movement record.

Chapter 6

Accessibility and anaphoric *én* in visual world dialogue

Most studies of the use of referring expressions in spoken language rely on text counts of different noun phrase types, which are then correlated with theoretical categories of referential status/givenness based on notions of consciousness, attention, and memory. The present chapter takes a new approach to measuring the cognitive states assumed to underlie the use of expressions with different accessibility marking. Visual attention is measured by monitoring the eye movements of both speaker and listener in a quasi-natural ('unscripted'), task-oriented dialogue setting, a genre of dialogue studies that has so far mostly been conducted without the benefit of the powerful measure of eye movements (Anderson et al., 1991; Grønnum, 2006), and otherwise only measuring eye movements of one conversation partner (Brown-Schmidt et al., 2005). In the study reported here, both interlocutors in a task-oriented dialogue had their eye movements recorded, and the question was whether the use of referring expressions with different degrees of accessibility marking would be associated with different patterns of visual attention in the speaker as well as the listener.

6.1 Givenness and indefinite expressions

Studies of givenness and the use of referring expressions usually deal with definite expressions of various types (see section 2.1), and generally find that 'heavier' and more informative referring expressions such as full noun phrases tend to refer to less given entities than more reduced, less informative forms such as pronouns. One of the few exceptions to the prevalent focus on definite reference is Wright & Givón (1987), where different indefinite referring expressions ('one'-marked vs. zero-marked indefinites) are shown to correlate with varying levels of thematic importance in Krio (an English-based creole spoken in Sierra Leone), Mandarin Chinese, and English. Evidently, referential status also plays a role in the use of different types of indefinite expression.

Gundel et al. (1993) report discourse frequencies of both definite and indefinite referring expressions in five languages: Mandarin Chinese, English, Japanese, Russian, and Spanish. All these languages show clear distributional patterns suggesting that pronouns and definite descriptions require higher degrees of givenness than indefinite expressions. However, the data also suggest that this tendency does not reflect a one-to-one correlation. Whereas neither the English nor the Spanish sample contain indefinite full noun phrases used about given entities, each of the three other languages contains some uses of indefinite noun phrases to refer to given entities.¹ Rather, the pattern is a matter of markedness so that indefinite forms are not strictly ungrammatical when referring to uniquely identifiable entities, whereas definite forms are ungrammatical when referring to non-uniquely identifiable entities (except in the case of generics). Gundel et al. propose that referring to given entities using indefinite forms is generally possible, but usually ruled out by the Gricean maxim of quantity. Thus, the reason why indefinite noun phrases tend not to be used for given referents is that this would be over-informative.

¹ If 'given' is understood here as the two highest categories on Gundel et al.'s Givenness Hierarchy (*In focus* and *Activated*), the counts for the three languages are as follows. Chinese: 29 of 104 (28%) indefinite noun phrases have given referents; Japanese: 46 of 223 (21%); Russian: 54 of 191 (28%)

In the present chapter it will be investigated whether there are different attentional patterns associated with referents depending on which of three types of indefinite noun phrase of various explicitness is used to refer to a new entity of a type which is given. Consider the following examples.

- (1) Put a **blue two-brick** in the upper left corner.
- (2) Put a **red one** in the upper right corner.
- (3) Now place **one** on the right below.

In each of the examples, the indefinite referring expression is used to refer to a lego brick from one of six stacks, where the stack has been singled out in a prior utterance. The entity type, i.e. the type of brick in a stack, is given, whereas the entity token, i.e. the specific brick referred to, is new. (Note that the three examples are not three successive utterances from the same speaker—utterances of each of the three types are used about the first brick in a stack as well as successive bricks.)

When an entity type is given, i.e. when a set or class of entities has been introduced into the discourse and is consequently the current topic, how can an entity of that type be referred to felicitously? It follows from the description by Gundel et al. that it may be referred to using an indefinite full noun phrase, since it is type identifiable. But it is type identifiable even if the type is not given at all, so givenness is by no means a necessary condition. Alternatively, a pronoun can be used, but in order to function in this context, it must be indefinite—thus, an indefinite *one*-anaphor (Dahl, 1985). Here, givenness (but only ‘type givenness’) is necessary for felicitous use. An intermediary option exists between an indefinite full noun phrase and an unmodified indefinite *one*-anaphor: a modified indefinite *one*-anaphor (e.g. *en rød* ‘a red’).

If these three types of indefinite referring expression can be elicited under similar conditions, will they be processed differently? This question was investigated in an unscripted dialogue setting reminiscent of the setting in (Brown-Schmidt et al., 2005) (see section 4.2, p. 106), except not only one but both of the interlocutors were eye-tracked.

Measuring eye movements in spoken dialogue

Twenty-two native speakers of Danish (university students aged 20-32 years) were assigned to dyads, about half with familiar, and about half with unfamiliar partners. The assignment of partners was not systematically randomized, but depended in large part on when it was practical for the individual participants to come to the lab. Two additional individuals could be analyzed linguistically, bringing the total in the linguistic analyses to 24, whereas the data from the interlocutors from the two relevant dyads had to be discarded for technical reasons. All participants had normal or corrected-to-normal vision.

Dyads of participants were seated at computers across from one another, separated by a visual barrier. On the computer monitors (17" LCDs), a Lego building simulation program² displayed a line grid on which six stacks of bricks were placed around a square field in the center of the screen. The six stacks of bricks were identical for the two participants, while the center field was filled with a pattern of additional bricks on one participant's screen (the instructor's) and blank on the other participant's screen (the matcher's). See figure 6.1.

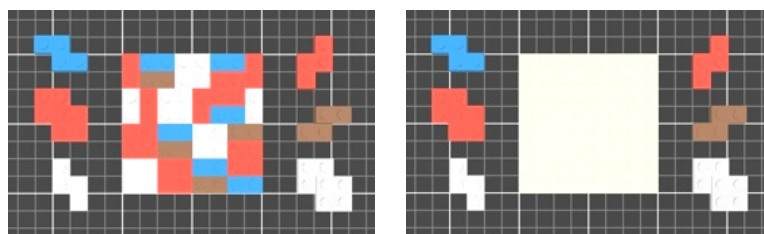


Figure 6.1: The initial brick arrangement of instructor and matcher.

The pattern on the instructor's center field was made up of bricks of the same size and color as the bricks in the stacks around the center field, but had knobs, whereas the bricks in the stacks had a flat surface. The task of the instructor was to pick up a flat brick, place it on a corresponding

² Lego Digital Designer, freely available online. For the most recent version, see idd.lego.com/.

brick with knobs, and simultaneously instruct the matcher to place a brick of the same type at the same location on his or her blank center field. In order to elicit more indefinite *one*-anaphors, a constraint was imposed on the participants: each stack of bricks was to be used up before carrying on with the next. In this way, a certain amount of references to the same type of brick in close succession could be ensured, enhancing the givenness of the referent type. There were two variants of the task, each with 24 bricks in 6 different categories. Two pairs of categories had the same color, but differed in shape, in order to ensure the use of some long descriptive noun phrases. Each participant was the instructor in one of the variants and the matcher in the other variant. Each session took about 10-15 minutes to complete, plus calibration of eye-trackers and handling the recording of scene videos, sound, and eye-movement data.

Two headmounted SMI iView X HED systems with Polhemus head-tracking were used to collect eye movement data at a sampling rate of 50 Hz. Each eye-tracker had a scene camera which recorded the progress of the task on the screen of each participant. Each eye-tracker was controlled by a PC running the iView X control software. The two control PCs were connected via a serial cable so as to enable synchronized onset of the data recordings. A film clapper was used as an extra means of ensuring that it would be possible to synchronize the scene videos and the sound. Each participant wore a head-worn microphone which was used to record the audio side of the interaction. Each participant had a PC running the Lego simulation software.

Utterances containing initial references to the individual bricks were transcribed and annotated to the scene videos using the ELAN multimedia annotation tool.³ Initial references to bricks were always uttered by the instructor, and the instructor will thus sometimes be referred to as the *producer* in the following. The total number of such initial-reference utterances was 446. Linguistic data were obtained from both members of the 11 dyads (i.e. from the two different variants of the task), yielding

³ The tool is developed by the Max Planck Institute for Psycholinguistics, and is freely available for download. See www.mpi.nl/tools/

instructions from 22 sessions, and from only one of the members of two additional dyads, yielding a total of 24 sessions. The average amount of instructions from one person was 19.0.⁴ There are 24 bricks to be placed in each of the two variants of the task, and thus about 24 utterances would be expected per session. Each participant uttered between 10 and 28 instructions. This considerable individual variability can be attributed partly to varying strategies, in that some participants tended to chunk several bricks together in one referring expression (as in “Place a brick in the upper left and upper right corner”). But the primary source of variability was clearly the choice of some participants to leave the handling of the last category of bricks up to the matcher by instructing him or her to “just fill in the rest in the blank spaces.” Two participants uttered more than the expected 24 instructions. In one of the cases, this was due to long sequences of clarification dialogue resulting in a reinitiation of the first reference to some bricks, in the other it was due to a habit of repeating instructions, as in “there should be **one** . err .. up in the uppermost line ... there is a space for two — there should be **one**.”

About one fifth (89 out of 446) of all the utterances containing initial references contained ‘pure’ forms of indefinite *one*-anaphors, i.e. forms with minimal lexical content such as *én* ‘one’ and *én til* ‘another one.’ Nineteen of the 24 participants used at least one such form, and the average amount among these participants was 4.9.⁵

Overall, about half the referring expressions used were indefinite, the other half definite. Most of the indefinite forms and a similar percentage of the definite forms were more or less reduced. There was a large portion of definite *one*-anaphors (modified definite noun phrases without a nominal head). There were about equally many unmodified and modified indefinite *one*-anaphors. A smaller portion of both the indefinite and definite forms were full noun phrases. See table 6.1.

It should be noted at this point that no claims are made about the gener-

⁴ One session is left out from the descriptive statistics reported here, because the audio recording was started late, resulting in the loss of a substantial part of the dialogue.

⁵ Still excluding the partly corrupted recording.

Expression type	Freq.	%
Unmodified indefinite <i>one</i> -anaphors (<i>one (more)</i>)	89	20.0%
Modified indefinite <i>one</i> -anaphors (<i>a blue</i>)	85	19.1%
Full indefinite noun phrases (<i>a (red) square</i>)	52	11.7%
Unaccented definite pronouns (<i>it</i>)	8	1.8%
Accented definite pronouns (<i>that</i>)	10	2.2%
Modified definite <i>one</i> -anaphors (<i>the next blue</i>)	162	36.3%
Full definite noun phrases (<i>the (next) (red) square</i>)	33	7.4%
Other	7	1.6%
Total	446	100.0%

Table 6.1: Frequency distribution of noun phrase types in instructor utterances containing initial references.

ality of this pattern. Thus, it would be misleading to suggest that the use of *one*-anaphors is this widespread in task-oriented dialogue in general. On the contrary, the pattern is probably highly task-specific. The task was intentionally designed to elicit as many indefinite *one*-anaphors as possible as a consequence of previous findings suggesting that this form is actually quite rare in unscripted Danish dialogue (cf. Diderichsen (2007) and chapter 3), and after several different pilot experiments had failed to elicit many *one*-anaphors. There is no reason to believe, however, that participants were somehow sensitive to the intention to elicit *one*-anaphors (which would have been a methodological problem, since heightened awareness of *one*-anaphors would by definition alter the attentional pattern associated with these forms). None of the participants showed any signs of having guessed the purpose of the study during post-experimental debriefing, and can thus be assumed to have reacted naturally to the relatively many *one*-anaphors used.

A subset of the utterances containing indefinite references was extracted for eye movement analysis. In order to compare eye movement patterns associated with different types of referring expression, the context (linguistic and otherwise) for the expressions should be as similar as possible. The linguistic context can be relatively easily controlled by categorizing the data on the basis of any of a host of semantic/pragmatic, syntactic,

and other features. One functional categorization had already been applied, in that only utterances containing initial mentions of the bricks were transcribed. Several fine-grained categorizations are conceivable, such as according to syntactic construction/word order, main verb used, total utterance length, prosody, etc. However, the more fine-grained the categorization, the less instances will end up in each category. Hence the following, relatively coarse-grained categorizations were used to define three groups of indefinite-containing utterances. First, a rough syntactic criterion was applied so that all utterances were included that had a main verb before the indefinite referring expression. Second, no utterances with spatial descriptive content before the referring expression were included. This yielded three sets of utterances with a fairly uniform structure, as exemplified in (4). The frequency distribution of this subset of data is shown in table 6.2 below.

- (4) i. *Full indefinite noun phrases (en Adj N)*
 så tager du **en rød toer** og lægger oven over dén .. så den
 ligger helt oppe i højre hjørne
 then you take **a red two-piece** and put it above that .. so it lies
 all the way up in the right corner
- ii. *Modified indefinite one-anaphors (en Adj)*
 og du lægger **en brun** . lige under . midterlinien ude i højre
 side
 and you put **a brown** . just under . the midline out in the right
 side
- iii. *Pure indefinite one-anaphors (én)*
 og du skal sætte **én** .. lige til højre og én ned i forhold til dén
 du lige har sat
 and you should put **one** .. just to the right and one down
 relative to the one you just placed

Indefinite NP type	Freq.	%	Ss
<i>en</i> Adj N	27	20.8%	8
<i>en</i> Adj	41	31.5%	10
<i>én</i>	62	47.7%	18
Total	130	100.0%	

Table 6.2: Frequency distribution of indefinite noun phrase types selected for eye movement analysis. *Ss* is the number of subjects who produced the referring expressions.

Each of the three types of referring expression starts with the word *en* ‘a/one,’ and this word could thus be used to synchronize the three utterance groups. The onset of *en* for each noun phrase was flagged in the ELAN annotations in order to obtain time indexes for the eye movement analyses.

The eye movement data for each participant in each of the 22 successful dyad sessions were analyzed using iView Analysis. Fixation analyses were performed, and areas of interest (AOIs) defined. There were 7 AOIs: the 6 stacks of bricks and the center area. Fixations outside these AOIs, but inside the eye-tracking geometry were also counted (forming an ‘everywhere else’ category). This category also included blinks, saccades, and fixations outside the defined eye-tracking plane. In order to correct for offsets in eye-tracker calibration, the AOIs were manually adjusted in a symmetrical way based on the overall data pattern for the whole session. Thus, the position of the AOIs relative to each other remained constant from session to session, but the whole set of AOIs could be moved a little up, down, and/or to one side in order to obtain a better fit with the overall eye movement pattern. These adjustments are not seen as problematic, since they affect the analysis of the three types of referring expression studied equally.

The purpose of the eye movement analysis was to investigate when the maximal amount of visual attention on the intended referents of the three expression types occurred. Full noun phrases have been shown to be correlated with peak proportions of fixations about a second before their onset in production of isolated sentences (Griffin & Bock, 2000), and less

than half a second after onset of a referring expression in comprehension (Chambers, Tanenhaus, Eberhard, Filip & Carlson, 2002). However, results for anaphors scarcely exist. Because no specific expectations about the timing of peak proportions of target fixations seemed justified for the reduced referring expressions, a quite large time window was therefore defined for the analysis of eye movement data. The time window started 4 seconds before and ended 4 seconds after the onset of *en* (see figures 6.2 and 6.3 below).

All fixations within the time window were included in the analysis. Fixations which overlapped the beginning and end of the time window were partly included, so that only the part inside the time window was taken into account. The fixations thus obtained were sliced into 20 ms samples, each associated with one of the areas of interest. These samples formed the basis for proportion of fixations analyses. Proportions of fixations for each 20 ms time slice from -4000 ms to +3980 ms relative to *en* onset were obtained for the following four AOI categories: the 'target' AOI (i.e. on the brick type referred to), other referents (i.e. stacks of bricks other than the target stack), the center area, and irrelevant or null data (i.e. fixations outside the calibration geometry, saccades, blinks, as well as fixations in the geometry, but not in one of the 7 defined AOIs). This analysis was carried out for each of the three types of referring expression, and resulted in the graphs in figures 6.2 and 6.3.

Results

The comprehenders' (i.e., the matchers') patterns of visual attention are shown in figure 6.2 below. As can be seen, attention on the target category, i.e. the intended stack of bricks, peaked at different times relative to the common onset of the three types of referring expression. The full noun phrases attracted most fixations about 1 second after the onset of the referring expression. The modified *one*-anaphors peaked shortly after the average onset of the instructions, about 600 ms before the onset of the referring expression. The least explicit forms, the unmodified *one*-anaphors,

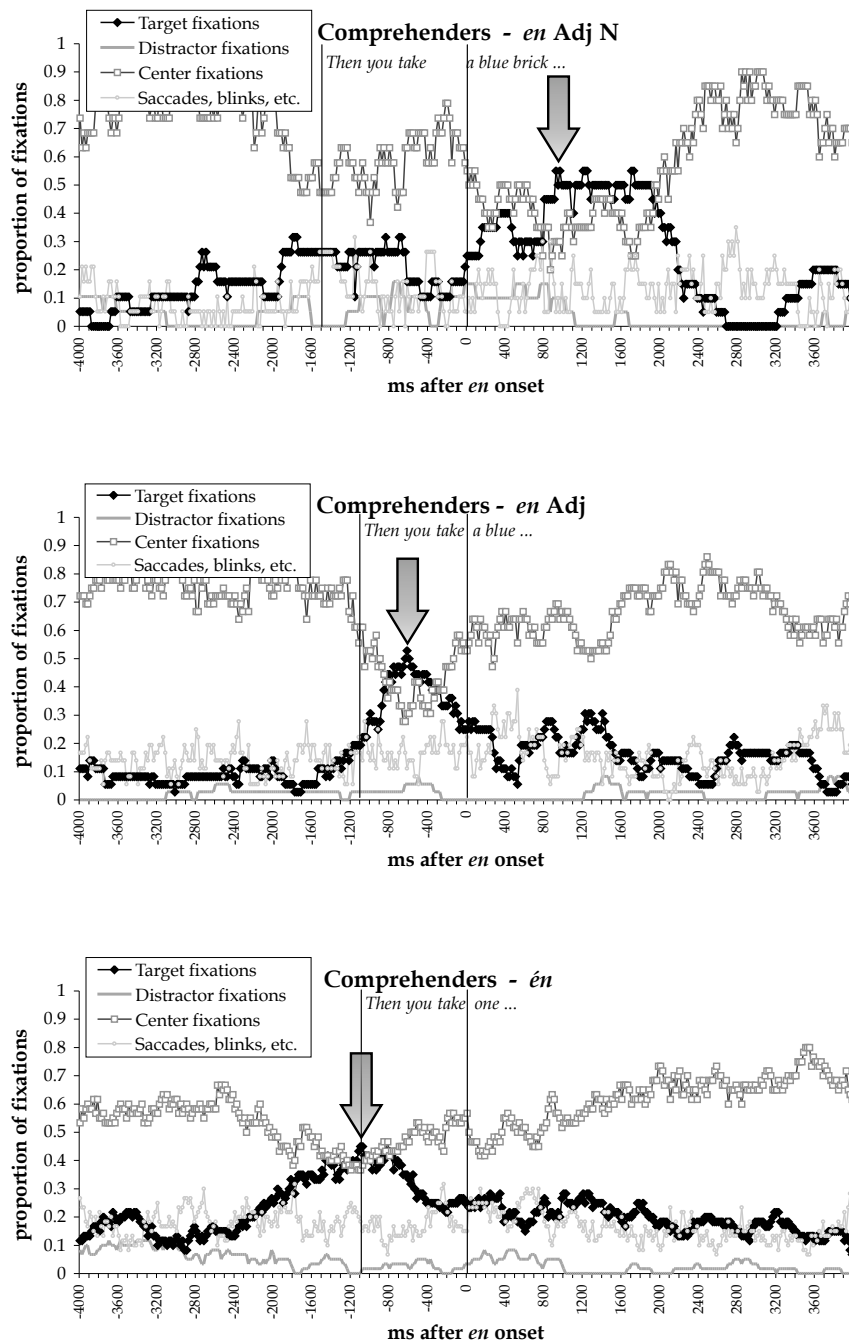


Figure 6.2: Proportions of fixations of the different types of referring expression for the comprehenders (i.e. matchers). The vertical lines indicate the average onset of the utterance containing the referring expression and the average onset of the referring expression itself. The arrows indicate the maximal proportion of target fixations.

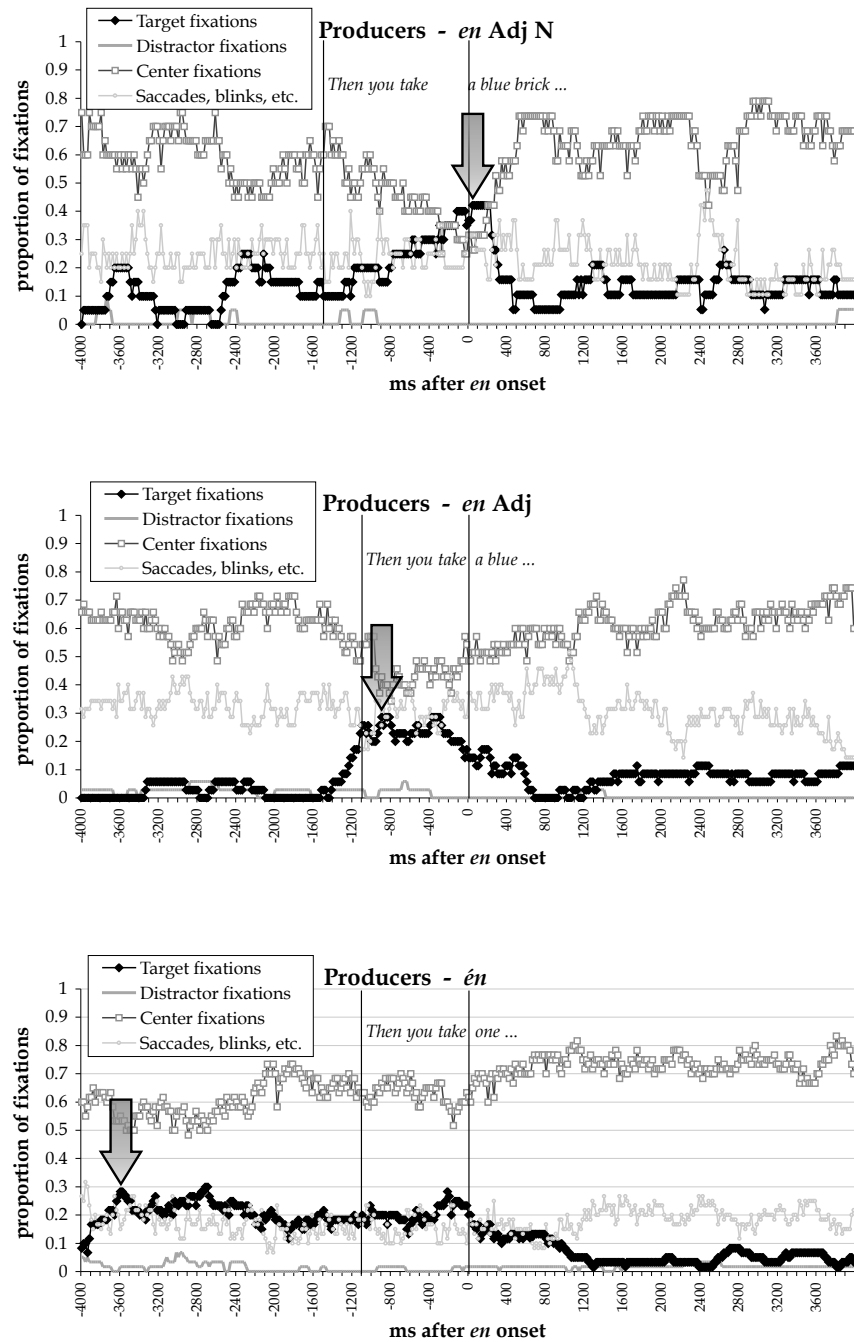


Figure 6.3: Proportions of fixations of the different types of referring expression for the producers (i.e. instructors). The vertical lines indicate the average onset of the utterance containing the referring expression and the average onset of the referring expression itself. The arrows indicate the maximal proportion of target fixations.

reached their peak proportion of fixations on the target even earlier, simultaneously with the average onset of the instructions more than 1 second before the onset of the referring expression.

The producers' (i.e., the instructors') fixations showed a similar pattern, see figure 6.3. The full noun phrases reached their peak target proportion just after the onset of the referring expression. The modified *one*-anaphors had their peak proportion at about 800 ms before onset, just after the average onset of the instructions. And finally, the unmodified *one*-anaphors generally had a high proportion of fixations on the target almost from the very beginning of the time window until the onset of the referring expression.

The pattern of comprehenders and producers were thus qualitatively similar, but there were also differences. The peak target proportions of comprehenders generally occurred later than the corresponding target proportions of producers, and were generally higher than those of the producers, see table 6.3.

Expression type	Instructor	Matcher
<i>en</i> Adj N	.48	.55
<i>en</i> Adj	.31	.56
<i>én</i>	.35	.46

Table 6.3: Peak average proportions of target fixations on the three expression types.

6.2 Discussion

The analyses of the proportions of fixations over time showed clear differences in attentional patterns corresponding to the different referring expressions. There is a general correspondence between earlier target peaks and less explicit coding of the referent.

The patterns for the full noun phrases in both producer and comprehender resemble the patterns seen in previous studies. The producers'

proportion of target fixations increases up to the onset of the referring expression as shown in visual world studies of production (Griffin & Bock, 2000), and the comprehenders' corresponding proportion increases immediately after the onset, as shown in studies of comprehension (Eberhard et al., 1995).

The reduced forms, however, are quite a different story. Here, the peak proportions of fixations are clearly not driven by the referring expression, and for the maximally reduced *one*-anaphors, the peak fixations cannot even be attributed to the onset of the instructions. Something over and above the referring expression itself seems to be at play: givenness, and more specifically, accessibility.

In the comprehenders, both types of *one*-anaphors ('an Adj' and 'One') are associated with target peaks before the referring expression is uttered. This indicates that the comprehenders are able to anticipate which referent type will be mentioned. For instance, the comprehenders tend to look at the target stack as soon as an utterance containing 'one' is initiated—the utterance, not the referring expression. This ability to predict the intention of the producer is not surprising, since the participants were told at the beginning of the experiment that they were to use up one stack of bricks before continuing to the next. Thus, if a stack of bricks had been introduced, they would know which type of brick was going to be referred to next. The remarkable thing is that the peak proportion times vary so systematically with the type of expression used. Why is the referent not anticipated when a full noun phrase is about to be uttered?

There is an early increase in the proportion of target fixations when a comprehender hears a full indefinite noun phrase like *en rød toer* 'a red two-brick.' The increase peaks around the onset of the utterance containing the noun phrase. The target proportion quickly declines again, however, before it begins to increase toward the overall peak around the onset of the noun phrase. One might have expected to see a decrease in the target proportion in response to the indefinite article, in that the beginning of an indefinite noun phrase might conceivably prompt participants to look away from the currently most given entity type in anticipation of a new

referent type. This eye movement behavior would yield a corresponding increase in the proportion of distractor fixations. These patterns are not seen in the data, however. First, the decrease from the early peak occurs too early to be prompted by the onset of the indefinite full noun phrase. Second, the decrease in the target proportion is coupled with a sharp increase in the proportion of fixations on the center area, and only a modest, spread-out increase in the proportion of fixations on the other stacks. Also, the '*en Adj*' condition, where the referring expression is identical to the first part of the full noun phrase, does not contain a similar pattern. So, it does not seem likely that the beginning of the indefinite noun phrase *per se* delays the target peak in the full noun phrase condition.

When the utterance data were inspected, a different explanation suggested itself. The full noun phrases are preceded by disfluencies much more often than the '*en Adj*' and '*én*' forms. This may be what prompts comprehenders to look away from the current brick category. A psycholinguistic study (Arnold, Fagnano & Tanenhaus, 2003) has shown that disfluencies interfere with the processing of given referents. When a disfluent noun phrase such as "thee, uh, camel" is heard, a new referent is fixated significantly more often just after the onset of the head noun (when the noun "camel" is still ambiguous relative to a cohort competitor such as "candle") compared to a given referent. A disfluency is a signal to the comprehender that the speaker may be preparing to talk about something else, since talking about the thing currently in focus should not present any difficulties.

Disfluencies thus plausibly play an important role in the full noun phrase pattern seen in the comprehenders, but then a different question arises: Why are the producers more disfluent before full noun phrases? A possible answer is that the producers may have temporarily lost track of the current category, rendering the category about to be mentioned less activated at the time of utterance planning. This decreased activation on the producer side could be the cause of both the disfluencies and the full noun phrase forms.

The target peaks can be taken as an indication of when the target is most

interesting to the comprehender. Most theories about reference would predict that the producer will reduce a referring expression more the more given the referent is in the mind of the comprehender. If we can make the assumption here that 'longer since the referent was interesting' translates to 'more given/accessible,' then the referents in fact seem to be more accessible in the minds of the comprehenders at the onset of the referring expression the more reduced the form is.

But are producers actually sensitive to the givenness of referents in the minds of comprehenders, and do they encode their referring expressions accordingly? Or do they rather plan their expressions on the basis of the givenness of referents in their own minds?

The producers' target peaks generally occur earlier than the corresponding peaks of the comprehenders. Consequently, the producers' peaks cannot be a direct reaction to the comprehenders' peaks, and it can thus be ruled out that the producers somehow detect the early peak interest of the comprehenders, and plan their utterance accordingly. Rather, the pattern suggests that the two interlocutors are very well 'in tune' throughout the interaction, with the matcher lagging a little behind the instructor because of the nature of the task: the matcher generally reacts to the utterances of the instructor.

The instructors have a higher proportion of fixations on the target during the whole first half of the time window when they are about to produce an utterance containing '*én*.' The target peak in the '*en Adj*' condition is more focused, and the peak in the '*en Adj N*' condition is more focused still. This more sustained attention on referents of more reduced forms might lead to a kind of cognitive habituation: the more the producer's gaze rests on the referent to be mentioned, the more accessible it becomes. This increased accessibility may in turn make the producer less inclined to be explicit, and less prone to disfluencies, for that matter. It must be kept in mind, however, that these data are an aggregate of several participants, so the producers' sustained attention on the referent observed in the *én* condition may be a reflection of individual peaks distributed evenly across time. One thing that speaks against this possibility is that the proportion

of attention is relatively high for a prolonged period of time (compared to the patterns associated with the other expression types). If the pattern consisted of evenly distributed peaks, one would expect a lower average proportion throughout.

What role does frequency of mention play in the attentional patterns observed? Conceivably, the full noun phrases might be used about the first brick or two in a stack, while the rest of the bricks could be referred to with less and less explicit forms, providing a correlation between relative newness and observed peak latency that might partly explain the patterns observed. This is not the case, however. See table 6.4 and figure 6.4.

Expression type	Brick position in stack						Total
	1	2	3	4	5	6	
<i>en Adj N</i>	13	5	4	3	1	1	27
<i>en Adj</i>	6	8	10	8	7	2	41
<i>én</i>	25	18	10	7	2	0	62
Total	44	31	24	18	10	3	130

Table 6.4: Frequencies of expression use relative to the position of the brick in the stack. '1' denotes the top brick, '2' the one beneath, and so on.

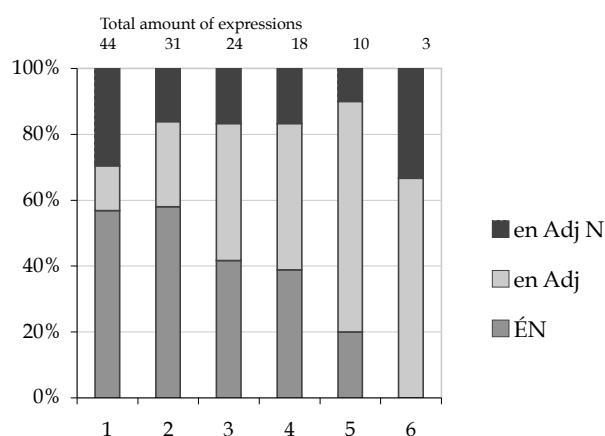


Figure 6.4: The percentages of expressions that are used about the 1st, 2nd, 3rd etc. brick in a stack.

Contrary to what might have been expected, the more frequently the category has been mentioned, the more explicitly the referring expression is coded—at least within the anaphoric forms. *én* tends to be used about early bricks in the stack, whereas *en* Adj tends to be used about later bricks. The full noun phrases are relatively evenly distributed. So, there is a tendency for producers to become more explicit with frequency of mention, not less. This is quite interesting from the point of view of traditional accounts of givenness marking, where the reverse pattern would be expected. A possible explanation for the observed pattern could be something like the following. When a brick category is first introduced, it is often in an utterance like “ok, and then we start on the blue two-bricks.” Utterances like this are not included in the present analyses, since no individual brick is referred to. Only the category is mentioned. But after a category-introducing utterance like this, the category is of course highly accessible. This is a context well suited for the use of indefinite *one*-anaphors: a new brick is about to be mentioned, but the category is highly accessible. As more and more bricks are mentioned, the category information may slip in the background, prompting the producer to renew it using more explicit forms.

Two things weaken this explanation, however. First, no clear increase in the use of full noun phrases for late bricks is observed. And second, participants do not often use different forms about the same category, but tend to use a favorite form for early as well as late bricks. The individual expression frequencies of each participant can be seen in figure 6.5 below. They are arranged into three overall groups: the first containing those participants who used all three expression types in the data sample studied here, the second containing those who only used two types, and the third containing those who only used one type. It is clear that participants seldom use all three different expression types in the context studied here. A somewhat larger minority of the participants use two different forms, but in this group, most participants have a rather clear preference for one or the other form. Overall, the pattern does not suggest that people go from the most explicit to the intermediate to the least explicit form. Rather, the

pattern is characterized by individual preferences. Thus, the stack position of the bricks, and accordingly, the number of times the category has been mentioned, cannot be used to explain the differences in peak target proportions observed. Givenness, or more specifically, accessibility, is not a simple matter of frequency of mention.

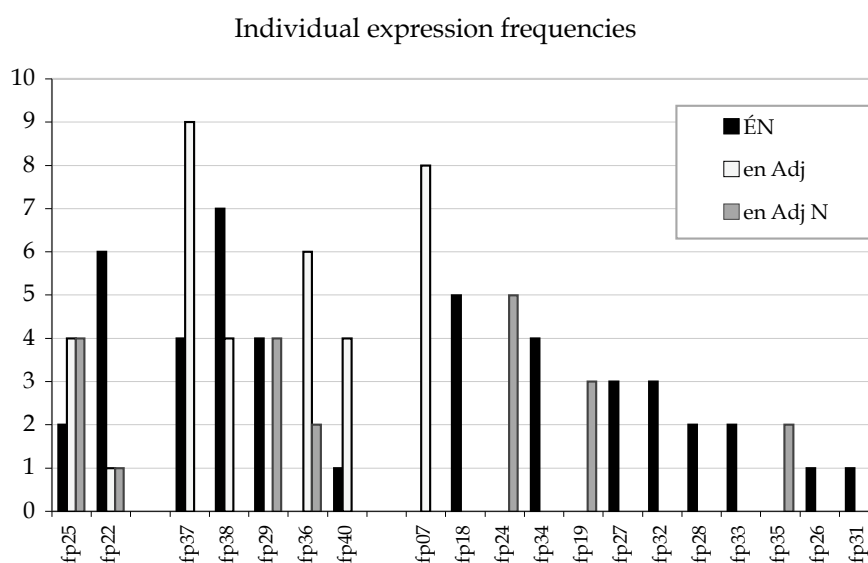


Figure 6.5: Each participant's frequencies of the three types of referring expression used in the context studied. Arranged in three major groups: participants who use all three types, participants who use two types, and participants who use only one type.

All in all, the results suggest that accessibility plays a role in referential processing within the category of indefinite referring expressions. The combined patterns of producers and comprehenders clearly indicate that accessibility plays a role in both interlocutors. The patterns suggest both that accessibility in the mind of the producer plays a role in the encoding of referring expressions, and that accessibility in the mind of the comprehender enhances his or her ability to anticipate the intended brick type.

Furthermore, the results suggest that it may be possible to find a non-linguistic correlate of accessibility marking, namely the different peak target proportion times. This correlate could be developed into a language-

independent measure of givenness, which would be highly desirable for linguistics, where there is always a risk of circularity in the analysis of linguistic data in terms of cognitive categories and vice versa.

This chapter concludes the methodological journey of this thesis from traditional corpus-based research over state-of-the-art visual world experimentation to the innovative use of eye-tracking to study givenness and givenness marking. In the next chapter, the theoretical, methodological, and applied perspectives of the empirical finding of the thesis will be discussed.

Chapter 7

Theoretical, methodological, and applied perspectives

The purpose of this final chapter is threefold: first, to sum up the empirical findings of this thesis and discuss their implications for theories of givenness and givenness marking. Second, to discuss methodological next steps for the empirical investigation of referential processing. And third, to sketch some possible applications of findings of the kind presented here.

7.1 Empirical findings

I have made an effort in this thesis to keep referential givenness separate from grammatical givenness marking. They are two different things, and I have tried in my empirical studies to keep one thing constant while investigating the other. On the other hand, there is of course an essential relation between the two. The grammatical feature [+def] signals unique identifiability, and the feature [+pron] signals high accessibility. I had to take this into consideration in my empirical studies, in that it constrained the number of ways in which givenness and givenness marking could be combined. In order for reference not to break down in the visual world experiment, for instance (chapter 5), definite expressions could not be used about non-unique entities, and pronominal forms could not be used about

non-mentioned entities. Accessibility was kept constant by having the expressions in the experiment refer only to previously mentioned entities. Identifiability was controlled by coupling referents of the 'preferred' identifiability status with the definite and indefinite expressions.

The empirical studies all used different methods for investigating spoken language, and different aspects of givenness and/or givenness marking were held constant in each one. The overall question in the studies was how indefinite *one*-anaphors would pattern with respect to various measures relative to other referring expressions that were minimally different in the grammatical features $[\pm\text{def}]$ and $[\pm\text{pron}]$. The results of the studies can be summarized as follows.

The corpus study of unscripted, task-oriented dialogue reported in chapter 3 investigated definiteness/identifiability by keeping pronominalization constant (only pronominal forms were compared). The results showed no clear indications of differences in accessibility between the three pronominal forms *den*, *dén*, and *én*. On the other hand, there were clear differences due to identifiability.

The visual world study reported in chapter 5 investigated the processing of definite full noun phrases, indefinite full noun phrases, accented definite pronouns, and indefinite *one*-anaphors (which are obligatorily accented in Danish) in contexts with equally accessible antecedents and equally appropriate antecedents with respect to identifiability. The results showed that there were no statistically reliable differences between the four expression types at the earliest possible moments of referential processing, whereas there was a significant difference between pronominal and full noun phrase forms in an immediately subsequent time window, a finding that agreed with a marginally significant difference between pronominal and full noun phrase forms with respect to a downstream response time measure.

The eye-tracking study of task-oriented dialogue reported in chapter 6 investigated pronominalization/accessibility by keeping definiteness marking constant (only indefinite forms were compared). It provided pilot data that suggested differences in referent activation in both speaker and

listener between the indefinite forms '*en* Adj N,' '*en* Adj,' and *én*, as well as interesting signs of close attentional alignment of speakers and listeners.

The new feature-based view of givenness marking that I proposed in section 2.3 has as its central assumption that definiteness/identifiability and pronominalization/accessibility are essentially independent of each other. Therefore, the two studies of unscripted dialogue investigated the correlation between givenness and givenness marking from the point of view of only one of these dimensions at a time. Their focus on different pronominal forms on the one hand and different indefinite forms on the other was motivated by the aim of the thesis to devote some attention to indefinite *one*-anaphors in spoken Danish—a form which is assumed here to possess both the [+pron] and the [–def] feature—in order to see whether different empirical investigations of this expression type would yield results consistent with the feature-based view. In the next subsection I will recapitulate how this was indeed the case.

Identifiability and accessibility independently shape referential form

The lack of processing differences during the earliest possible moments between different types of anaphoric expression heard in similar contexts suggests that the grammatical features [\pm pron] and [\pm def] have little effect in and of itself, at least during the initiation of reference resolution. Givenness, on the other hand, evidently varies with the values of the [\pm pron] and [\pm def] features in unscripted dialogue. One thing that this suggests is that givenness influences givenness marking more than vice versa. Both relations would seem to be integral to the use of referring expressions: the speaker chooses a certain referential form, more or less directly motivated by the assumed givenness of the referent in the mind of the listener. Thus, givenness marking is influenced by givenness. On the other hand, when the referent changes its status in the mind of the listener as a result of the referring expression just heard, givenness is influenced by givenness marking. However, the dyadic eye-tracking study in chapter 6 provided a clear indication that givenness may not always be influenced by givenness

marking in this temporal order. On the contrary, the results suggested that the activation (and thereby also the accessibility) of the referent type about to be mentioned was sometimes already at its peak before the utterance containing a reference to it was even initiated. (Seen from the perspective of the eye movement processor: “No need to look, because I already know what’s there.”) This was the case where bare *én* was used. To be sure, the *identifiability* status of the referent in these cases was presumably updated after and as a result of the referring expression (for instance, the subsequent use of another indefinite form for the same referent would no doubt have caused referential problems because of the implication of a different referent), but its *activation* level appeared to be high already. On this basis, a natural hypothesis would be that the different aspects of givenness can be updated independently of each other. By the way, the opposite pattern is readily observable: a referent may well be uniquely identifiable but not accessible, as in *Did you hear that **the pope** died?*, ***The moon** is the brightest object in the sky except for the sun*, etc. This underscores one of the central ideas of this thesis, namely that givenness is a multifaceted property composed of independent functional features onto which referring expressions with different grammatical features are mapped, as visualized in figure 7.1.

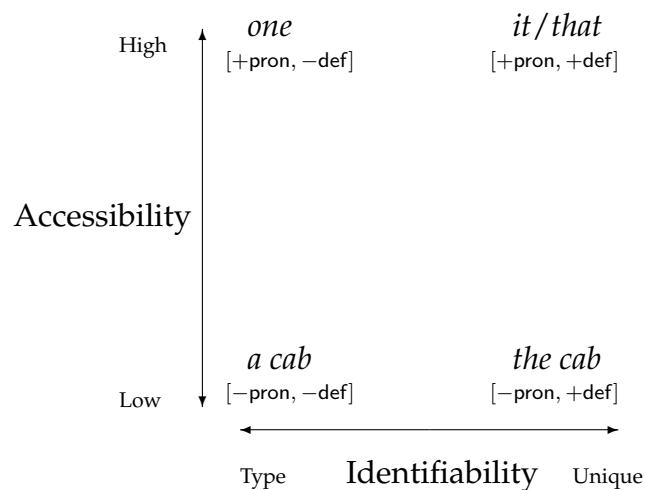


Figure 7.1: Two-dimensional model of cognitive statuses licencing referential form.

Thus, the findings in my studies of the association of givenness and

and referential form are quite interesting in relation to accounts of givenness such as Gundel et al.'s (1993) and Lambrecht's (1994). Gundel et al.'s account treats givenness as a one-dimensional hierarchy of cognitive statuses where all higher-ranking statuses entail all lower-ranking statuses. Lambrecht's account sees givenness as composed of the partly independent properties of identifiability and activation. While this thesis owes much to these accounts—both of which tackle the grammatical features of interest here ($[\pm\text{def}]$ and $[\pm\text{pron}]$)—none of them are able to account very elegantly for indefinite *one*-anaphors, this unusual $[-\text{def}, +\text{pron}]$ form. The findings in this thesis are consistent with a new view of givenness where identifiability and accessibility are independent: no evidence was found for accessibility differences in different types of pronouns, whereas more or less reliable evidence was found for identifiability differences in different types of pronouns and for activation/accessibility differences in different types of indefinite expression. The independence of the two features means that in this view, a highly accessible yet not uniquely identifiable referent is perfectly conceivable. This thesis is not concerned with the additional grammatical features that may be employed to mark referring expressions for other aspects of givenness, e.g. accenting, different types of modifiers in a noun phrase, or the use of proper nouns. But keeping these other features (relatively) constant, the pattern that emerges is that indefinite *one*-anaphors pattern with other pronominal forms with respect to accessibility and differ from definite forms with respect to identifiability.

In the systematic comparison of expression types exhibiting the different combinations of the grammatical $[\pm\text{def}]$ and $[\pm\text{pron}]$ features (chapter 5), a mapping between givenness and referential form was created that on the one hand was as close to the canonical or most natural mapping, and on the other hand allowed the presentation of the different expression types in maximally similar contexts. Figure 7.2 shows the canonical mapping of the four types of referring expression (in boldface), and which deviations from the canonical mapping are pragmatically possible. Indefinite full noun phrases are canonically mapped to low accessible and non-identifiable referents, but may be used anaphorically about an entity

of a previously mentioned type. For instance, *The fox is hungry and wants to eat the geese*. Click on *a goose* is not strikingly anomalous, even though the ‘goose’ concept is accessible, and an indefinite *one*-anaphor is therefore warranted. Likewise, an indefinite full noun phrase used about a uniquely identifiable but inaccessible referent is also quite acceptable: *The fox is hungry and wants to eat the geese*. Click on *a rabbit*, where only one rabbit is visible, and a definite form is therefore warranted.

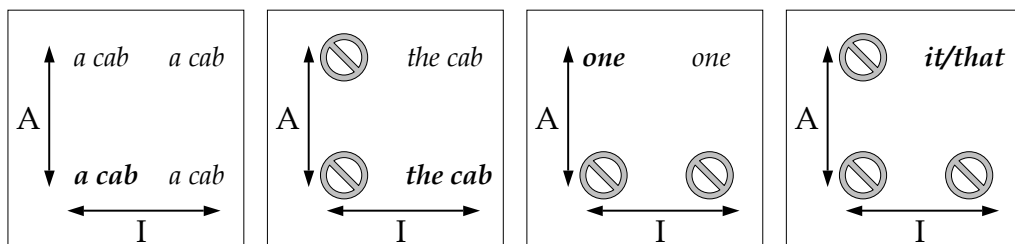


Figure 7.2: Pragmatically possible mappings of givenness and referential form.

Matters get worse when a uniquely identifiable AND highly accessible referent is referred to using an indefinite full noun phrase: *The fox is hungry and wants to eat the geese*. Click on *a fox*, but although indefinite forms are generally strongly dispreferred for uniquely identifiable referents, none of these references are downright incomprehensible in the particular verbal/visual context that was used in the study in chapter 5. The use of definite forms is more restricted: the use of definite forms about non-identifiable referents is infelicitous because it generally makes it impossible for the addressee to resolve the reference. Referring to “the goose” when there are two geese would make the addressee wonder which one was meant, and would almost certainly cause a communicative breakdown in natural conversation. Likewise, referring to “one” or “it” without an antecedent or a highly salient, relevant entity in sight is much more infelicitous than using a full noun phrase about a highly accessible referent: mappings of pronominal forms to inaccessible referents are generally not pragmatically allowed. The combination of the general restrictions on definite and pronominal forms means that definite pronominal forms

can only be used with their canonical mapping: to uniquely identifiable, highly accessible referents.

Figure 7.3 shows the full array of pragmatically possible givenness/referential form mappings illustrating the trade-off between natural mapping and equal referent givenness.

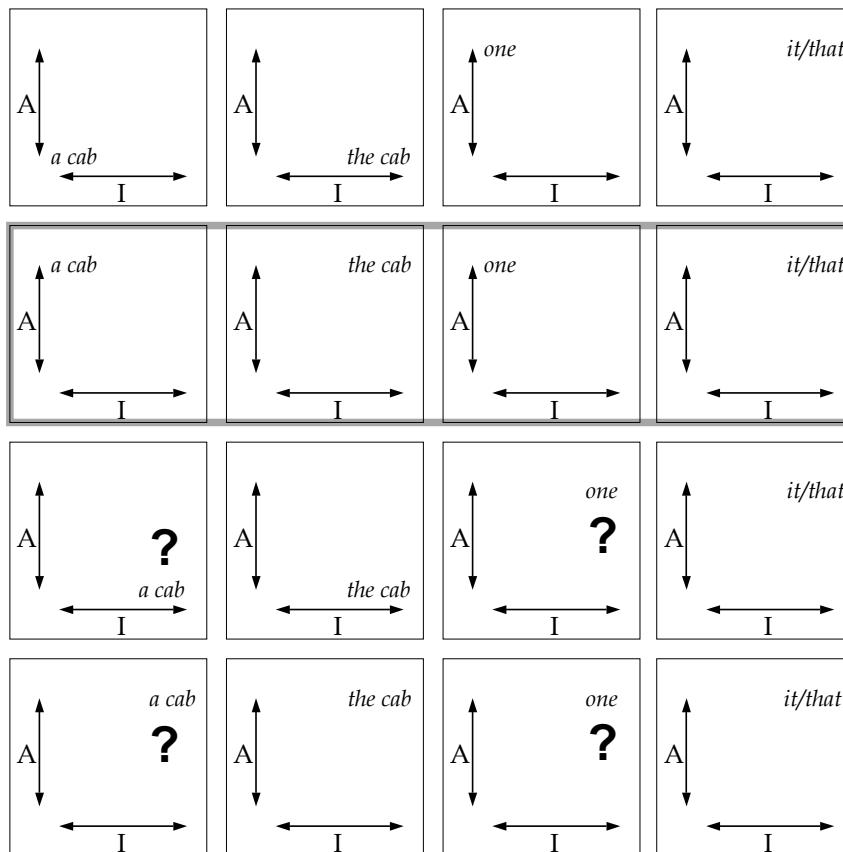


Figure 7.3: Tradeoff between natural givenness/referential form mappings and equal referential givenness.

The top row again shows the canonical mapping, which yields the least similar referents for the four different expressions with respect to givenness, reflected in their positionings in the four corners of the diagram. The next row (highlighted) shows a mapping that is less canonical but more equal with respect to givenness. The full noun phrases have migrated out

of their 'natural habitat' and upwards on the functional map, indicating that they now refer to highly accessible referents. The pronominal forms do not move anywhere: they are still mapped to highly accessible referents. This is the mapping that was employed in the visual world study in chapter 5. A mapping with a similar degree of equality in referent givenness is shown in the third row. Here, the definite forms stay put while the indefinite forms are non-canonically mapped to uniquely identifiable referents. While this mapping is more equal with respect to givenness than the canonical mapping, it also represents a marked step away from naturalness. Indefinite forms referring to uniquely identifiable referents are not incomprehensible the same way a definite form referring to a non-identifiable referent is, but empirical evidence shows that this mapping leads to severe communicative difficulties (e.g. Chambers et al. (2002)). The last row represents a mapping where referent givenness is equal for each of the four referring expressions: they are all mapped to the same location in the diagram. At the same time, this mapping is probably the most unnatural one, in that three of the four expression types are mapped in a non-canonical way.

It is an empirical question whether the different expression types will be processed differently in the less canonical, but more equal mappings. Based on earlier findings, however, one would generally expect processing difficulties associated with indefinite forms mapped to uniquely identifiable referents. This would be in accordance with for instance Gundel et al.'s (1993) Gricean explanation of the rare occurrence of this mapping. They consider indefinite forms referring to uniquely identifiable referents to be grammatically allowed, but argue that this choice is seldom made because speakers adhere to Gricean cooperativity by "not providing more information than is required" (Grice, 1975), i.e. not signalling that a referent is new when it is not. The same line of reasoning is used in the explanation of why full noun phrase forms are seldom mapped to highly accessible referents. This mapping, however, was used in the study in chapter 5, and produced no signs of processing difficulty, on the contrary. It might therefore be worthwhile to repeat the study with the less natural

mappings, just to see whether the language processor might also be immune to presumably more severe violations of the canonical mapping. If it is not, this would of course constitute further evidence against the conflated view of givenness: tolerance for full noun phrases mapped to highly accessible referents, but the opposite for indefinite expressions mapped to uniquely identifiable referents would support the notion that givenness is an at least two-dimensional property of referents.

Indefinite as well as definite pronouns are model-interpretive

There are several proposals in the literature concerning the mechanisms by which pronouns are interpreted in relation to the discourse model, based on the timecourse of pronoun resolution (cf. chapter 4). The findings in chapter 5 indicate that both pronominal and full noun phrase anaphors, both indefinite and definite, immediately lead to higher proportions of fixations on the referent to be selected, and suggest that the completion of the resolution process takes a little longer for both indefinite and definite pronominal forms. The findings in chapter 6 suggest that the activation of concepts referred to can sometimes be 'more than immediate,' i.e. anticipatory.

The results suggesting general early initiation of resolution processes are consistent with the many findings in the literature of immediate resolution of explicit anaphoric expression types, and favors the studies finding immediate initiation of pronominal resolution processes over those finding delayed processing of pronouns. This supports the so-called model-interpretive account of anaphor processing, which hypothesizes that pronouns are interpreted via a direct referential link to an entity in the mental model of discourse rather than via a textual representation of its antecedent. On the other hand, the delayed referential commitment found for pronouns supports the accounts that suggest that the completion of pronominal reference resolution may take longer on account of the relative lack of semantic content of pronominal forms.

A central question in the debate about which kinds of anaphoric refer-

ence are model-interpretive and which kinds are not, is what the nature of the mental model representation of discourse is. Specifically, how much information about the textual representation of the entities comprising it does it contain? Does it only contain the entities and their semantic or 'real-world' properties, or does it contain linguistic features such as their most likely grammatical gender as well?

The findings of this thesis suggest that indefinite *one*-anaphors are processed as fast as definite pronouns, which are usually assumed to be model-interpretive. But can indefinite *one*-anaphors be model-interpretive? The [-def] feature signals the assumption that the listener need not or cannot uniquely identify the referent in the discourse model, either because it is not unique in the current referential domain or because it is simply not there (yet). In this case, there can clearly be no direct referential link between the anaphor and a particular entity in the discourse model. If indefinite *one*-anaphors are to be considered model-interpretive anaphors, then discourse models must make available type information as well as token information about the entities in it. This is perhaps not unreasonable. Surely it is part of a person's representation of an entity what kind of entity it is. Nevertheless, this information cannot be entirely semantic: in fact it does depend to some extent on the linguistic representation of entities. Consider example (1).

(1) I saw an old bum near the station, and I saw **one** in the alley as well.

Three entities are mentioned in the first clause (the speaker, an old bum, and a railway station), and the indefinite *one*-anaphor in the second clause refers to a different entity of the same type as the second entity: a person of a certain age and with additional traits that we can easily imagine, however prejudiced our visualization may be. We 'know the kind.' But then consider example (2).

(2) I saw John near the station, and I saw ***one** in the alley as well.

Now the indefinite *one*-anaphor cannot refer to an entity of the same type

as John (a male human being), no matter how well we know John in the 'real,' nonlinguistic world, and what kind of person he is.¹ We would have to use a form such as *someone exactly like him* or a similar phrase. This simple example demonstrates that the type description of entities provided by mental models cannot be entirely language-independent, which in its turn confirms Garnham et al.'s (1995) finding that linguistic information about entities may sometimes be encoded in the mental model of discourse.

The timecourse of anaphoric reference resolution in written and spoken language is not easy to straightforwardly account for. The many findings in the literature have yet to be reconciled in a solid, unified account. In light of the symmetric results reported in chapter 5 regarding pronominalization of indefinite and definite expressions, further study of indefinite *one*-anaphors is needed because they exhibit the unique and rarely studied combination of indefiniteness and pronominal form. It would be particularly interesting to explore the implications of the processing of indefinite *one*-anaphors for detailed proposals such as Gernsbacher's (1989) enhancement and suppression mechanisms or Sanford and Garrod's (1981) Memory Focus model of text understanding. As we have seen, a multitude of methods have been employed to study referential processing in written as well as spoken language, and it would undoubtedly refine the picture that has emerged from these studies if the various experiments could be replicated with indefinite *one*-anaphors. We will leave the actual design of such studies for future research, and now turn to yet another methodological contribution to the field: the eye-tracking methodology used for studying reference in spoken language in this thesis.

¹ Interpreting the *one*-anaphor as "a John" (i.e. a customer of a prostitute, see e.g. www.urbandictionary.com) will not work either, although this would make sense in the example. In order to get this interpretation, *John* would have to be preceded by the indefinite article *a*.

7.2 Methodological aspects

As much as this thesis is a study of some rarely considered and particularly interesting aspects of reference, it is also a methodological feasibility study which has explored the use of methods of increasing technical complexity to study these aspects. The study reported in chapter 3 was a traditional corpus-based study, and served as a point of departure of limited methodological interest. Chapter 5 was an application of the relatively new, but well-established visual world paradigm to the area of referential processing. Few visual world studies of different referring expressions have been conducted, and certainly the application of this method to the study of reference is still largely untried. But the method itself is not revolutionary. However, the study represents a substantial step toward the ultimate methodological ambition of this thesis, namely to use the eye-tracking technique to study referential processing in a maximally natural context. This aim was achieved in the third empirical study reported in chapter 6, which was characterized by true methodological innovation. In this study, both participants in an unscripted task-oriented dialogue task were eye-tracked simultaneously, something that was still only being tried out in different laboratories at the time when the study was conducted (Hadelich & Crocker, 2006).

The study in chapter 6 showed a striking symmetry between the patterns of visual attention of the speaker and the listener in a dialogue. The fact that the combined measures of speakers' and listeners' eye movements thus seem to be sensitive to the interlocutors' cognitive alignment in dialogue is a methodologically very promising finding. The main methodological implication of this thesis is thus that it is possible to study joint communicative activity (Clark, 1996) using realtime measures. At the time of data recording, the setup was at Lund University's eye-tracking laboratory's limit in terms of technical complexity, the aim being to synchronize 6 data streams with millisecond accuracy. (The six streams were the audio channel, the scene video, and the eye movement record for both interlocutors.) It is no small feat that usable data could actually be obtained

from this setting. On that note, a small word of advice is in order here for those who might be considering undertaking studies in the future using dyadic eye-tracking. I used visual stimuli on computer screens in the Lego building study in order to be able to precisely control the grid in which the participants were working. Researchers intending to conduct similar studies are well advised to use physical lego bricks, preferably the super-sized Duplo bricks (e.g. along the lines of Brown-Schmidt et al. (2005)) in order to get a better view of the scene on the eye-tracker scene video. In my study, the bricks could not be zoomed to an optimal size because of the limited screen area, and the pattern of bricks was often hard to make out on the scene video because of poor lighting conditions.

After this brief consideration of the methodological contributions of this thesis, we now turn to a final, equally brief consideration of the possible applications of the results and methodology produced.

7.3 Possible applications

The bulk of this thesis has been devoted to the empirical investigation of subtle intricacies of language use, and to the exploration of new methods for such research. It may thus come as a bit of a surprise, but one can in fact identify some applied perspectives of the findings, in addition to the theoretical and methodological ones. The dyadic eye-tracking methodology finally arrived at in the work for this thesis has important potential applications within the field of human-computer interaction. The ability to couple signature eye movement patterns in interlocutors deeply engaged in dialogue with the use of referring expressions with different specific types of givenness marking should be interesting to people working on next-generation multimodal user interfaces in a self-evident way. Spoken dialogue systems already exist, and so do eye-controlled interfaces²—the obvious next step suggested by the findings in this thesis is to combine the two so as to produce a spoken dialogue system sensitive to communicative

² See e.g. www.cogain.org

constraints due to visual attention, a prospect that is already beginning to be studied empirically (Divjak & Carbonell, 2007). The concept is simple: based on the preliminary findings in chapter 6, a dialogue system trying to resolve the intended referent of an expression might prefer an object which had been looked at a few seconds before if the expression was a pronominal form, whereas it might prefer an object which had been looked at immediately before the onset of the referring expression if the expression was a full noun phrase. Likewise, it might tailor its own referring expressions to the amount of visual attention that a referent had received from the user. The dyadic eye-tracking setup makes it possible to capture the visual attention of the speaker and the listener in one go, and crucially in association with the very same referring expression. This makes the resulting data highly suitable for the modeling of both comprehension-in-(joint)-action and production-in-(joint)-action.

The coupling of language with eye movement patterns is conceivable for a variety of areas: communication interfaces for people with certain disabilities, hands-free heads-up interfaces for car information systems, high-immersion interfaces for first-person computer games, intuitive and more efficient interfaces for complex graphic design software packages, better interfaces for small handheld devices, etc. In many of these application areas, the 'Midas touch' problem is a well-known obstacle to smooth operation of eye movement-based interfaces. The problem is that when eye-movements, which usually occur unconsciously and automatically toward areas of interest, are used as interface controls, a spontaneous eye movement not intended as a system command can easily be mistaken for a deliberate one. In Greek mythology, anything touched by King Midas turned to gold, a blessing soon revealed as the curse it really was. Similarly, the advantages of being able to control an interface without the use of one's hands can soon be outweighed by the drawbacks of unintended commands. A speech recognizer has the problem of not having access to any information about what the user is talking about, and whether the user's current speech is even addressed at it (not to mention whether the current auditory input is speech at all, rather than background noise), thus

making it vulnerable and prone to misinterpretations.

Both the 'context-unawareness' of speech recognizers and the Midas touch problem might be mitigated if the two types of system were combined. The speech recognizer would have access to information about whether it was being addressed and/or about what, and the eye-controlled interface would not react until spoken to.

The pursuit of these possibilities requires more dyadic eye-tracking research on people's use of different types of referring expression during different natural tasks. If the eye movement patterns of users are to be of use in the applied domain, it is of particular importance to systematically investigate the eye movement patterns of different individuals in relation to different types of referring expression. Interfaces utilizing eye movements are obviously going to interact with one user at a time. From an applied point of view, individual difference studies are thus high on the agenda for future dyadic eye-tracking research.

Chapter 8

Conclusion

The contributions of this thesis are partly theoretical, partly methodological. On the theoretical side, a series of empirical studies supported a new view of referential givenness, i.e. the status of referents in the minds of listeners on which speakers presumably base their choice of referring expressions. The new view of givenness suggests that the dynamic referential features of accessibility and identifiability, which constitute two fundamental dimensions of givenness, are essentially free to vary independently of each other rather than forming a one-dimensional hierarchy of cognitive statuses or a taxonomy of partly independent cognitive statuses. The new model of givenness inherits from earlier accounts the assumption that the accessibility level of referents is prototypically signalled through lexical explicitness with lexically lighter forms such as pronouns signalling higher accessibility and heavier forms such as full noun phrases signalling lower accessibility. It likewise endorses the wide-spread assumption that identifiability is prototypically signalled through definiteness marking with indefinite marking signalling non-unique identifiability and definite marking signalling unique identifiability.

A small corpus study of spoken Danish showed no differences in indicators of referent accessibility in indefinite and definite pronominal forms, once the grammatical feature of accenting was controlled for. This quite strongly supports the notion that pronominal forms signal the same level

of accessibility whether they are indefinite or definite, and in this respect confirms the predictions of the new feature-based view of givenness. Furthermore, the identifiability of referents of definite forms clearly tended to differ from the identifiability of referents of indefinite forms, as predicted by the feature-based view.

An experimental eye-tracking study then presented evidence for the rapid activation of referents of four types of anaphoric referring expression: indefinite and definite full noun phrases and indefinite and definite accented pronouns. All expression types were anaphoric in the sense that an entity of the type denoted by the expression had been mentioned in a previous sentence. This study provided evidence that there is no difference in the timecourse of the initiation of anaphoric reference resolution processes between expressions differing in definiteness marking and lexical explicitness. It was also shown, however, that the referential commitment of pronouns—both indefinite and definite—lagged behind that of full noun phrases. This finding provides further support for the feature-based view of givenness proposed in this thesis, since the pronominal forms behaved identically irrespective of their definiteness marking.

Finally, an explorative dyadic eye-tracking study presented remarkable pilot data showing close coordination of the eye movement patterns of speakers and listeners associated with the use of indefinite referring expressions of three degrees of explicitness in an unscripted, task-oriented dialogue. These data strongly suggested that the fine-grained, moment-by-moment activation of referent types in both speaker and listener vary as a function of lexical explicitness in natural discourse, even in indefinite forms. This pattern resembles what one would expect from numerous studies in the literature of the accessibility marking of definite expressions, and is thus consistent with the assumption of the feature-based view of givenness that accessibility marking through lexical explicitness generalizes to indefinite forms.

On the methodological side, the dyadic eye-tracking methodology eventually arrived at in this thesis proves that it is possible to study language processing in unscripted, relatively natural dialogue in both speaker and

listener simultaneously, and that interesting results can be obtained that are well worth the effort.

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