

Accessibility, Discourse Anaphora, and Descriptive Content

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Abstract

The concept of accessibility plays an important role in the relation between antecedent and anaphoric term. The anaphoric term refers to an accessible entity that was introduced or activated by the antecedent. Several factors determine the accessibility structure of a discourse. In this paper, I investigate the aspect of accessibility that depends on the descriptive content of the expressions used in a discourse. I argue that accessibility is a function that assigns one element to the set of elements that fit the description by which a new discourse item is introduced. E.g., the referent of the antecedent becomes the most-accessible object such that the anaphoric expression refers to this referent due to the definition of accessibility. In the mini-discourse “The old man looked at a waiter. The waiter came”, the indefinite NP “a waiter” becomes the most-accessible individual in the set of waiters. Thus, the anaphoric NP “the waiter” refers to the same individual since it is the most-accessible one in the given set.

or “Salience”, which form the center part of any of those

1. Introduction

In the late 70 increasing interest in discourse analysis led to a new generation of semantics that investigated discourses rather than isolated sentences. The research was initiated from as different disciplines as philosophy (Stalnaker 1978), logics (Lewis 1979), semantics (Heim 1982; Kamp 1981), the structuralism of the Prague School (Sgall & Hajičová et al. 1973; 1986), discourse pragmatics (Chafe 1976; Prince 1981) and artificial intelligence (Webber 1979). All these approaches are mainly interested in the way the coherence of texts or discourses is linguistically established. Anaphoric and definite expressions are in the center of interest since they are the main means to create coherence between sentences. Thus, discourse anaphora reflect the interaction between the discourse structure and the interpretation of a particular linguistic expression. On the one hand, the interpretation depends on the aspect of discourse structure that is covered by the term accessibility, and on the other hand, the interpretation of descriptive content of the linguistic expression changes or “updates” the given discourse structure to a new one:

Discourse context affects the interpretation of individual phrases and clauses within a single utterance. The meaning of pronouns and definite descriptions is quite obviously influenced by the context in which they are used, among the most widely studied problems in discourse processing are those concerning the influences of context on the processes of generating and interpreting such phrases. (Grosz et al. 1990, 445)

Approaches differ with respect to the nature of the objects under investigation: mental objects, discourse entities, semantic objects etc. This difference is also reflected in notions such as “Activation”, “Focusing”, “Centering”

theories. Moreover, depending on the nature of the objects, concepts like definiteness, familiarity, coreferentiality, identifiability etc. can or cannot be applied in those theories. The general question can be formulated in the following way:

A number of important questions arise. What general principles constrain possible interpretations of referring expressions in a given language and in human language in general? What aspect of form are relevant and how are they relevant? What properties of the referents themselves determine the form that will be used? Does the choice of a particular form have more general discourse function that are independent of identification of the intended referent?
(Fretheim et al. 1996, 7)

In the remainder of the paper, I will investigate the following three central concepts: accessibility, discourse anaphora, and descriptive content.

In section 2, I discuss the different aspects of the central concept of accessibility. I show that in previous research there has been different ways of understanding and representing accessibility: However, there has been no detailed semantic investigation into the mechanism of activation. In section 3, I present two analyses of discourse anaphora, one in Discourse Representation Theory and the other in Centering Theory. In section 4, I present a new approach to integrate the role of the descriptive content of linguistic expressions into a theory of discourse anaphora. In section 5, I discuss a fragment of a novel, which illustrates the complex interaction of descriptive content, accessibility, and discourse anaphora. Section 6 provides a short summary

2. Accessibility

The notion of accessibility plays a crucial role in the discussion of discourse structure and referential behavior of linguistic expressions. However, there are several aspects of accessibility that are not clearly enough distinguished. Figure 1 tries to illustrate five different aspects of accessibility: the *accessibility status* or the *activation*, the *accessibility relation*, the *accessibility hierarchy*, the *accessibility structure*, and the *accessibility* or *salience* of the objects. A linguistic expression is associated with a mental object or a discourse item, which receives a certain accessibility status or activation according to the grammatical properties of the expression. In some theories, this item is additionally linked to an object in the “world” or in a model representing the world. Reference is generally understood as the relation between a linguistic expression and an object in the “world”. However, most discourse semantics assume a mediated reference relation as illustrated in figure 1 in order to account for anaphoric reference. A subsequent referring or anaphoric expression can be linked to a discourse item by the accessibility relation, which depends on parameters like distance and structure. This relation interacts with the

information expressed in the anaphoric expressions, which can be ranked in a accessibility hierarchy. The different accessibility statuses of the discourse items or cognitive elements account for the accessibility structure of the whole discourse. Finally, the object of the world exhibits an accessibility or salience with respect to other objects of the same kind. In the following, the five aspects are discussed in detail.

2.1 Accessibility status or activation

A referring expression introduces, activates or evokes a mental object (or discourse item). This entity is assigned a certain accessibility status or activation due to the syntactic position and the lexical properties of the associated expression. For instance, an entity associated

with a subject receives a higher accessibility than one associated with an object. A definite NP or a proper name activates its associated referent in a different way than an indefinite NP. Sometimes inherent properties of the objects referred to are also included in this activation.

However, few attention is paid to the role of the descriptive content with respect to the activation. It will be claimed that the descriptive content restricts the class of elements to which the activation applies. The mirror of this is discussed below in section 2.5 under the heading "salience".

2.2 Accessibility relation

The accessibility relation holds between an already activated or established element in the discourse and another referring expression that is associated with it, the discourse anapher. This anaphoric expression "accesses" the discourse entity. The access is determined among

other factors by the distance and the syntactic structure between the anaphoric expression and the antecedent that has activated or introduced the entity. Furthermore, contextual and encyclopedic as well as inferential knowledge may constrain the relation. This relation can be understood as an instantiation of the more general reference relation. If the reference relation holds between a linguistic expression and an object in the immediate context or situation, we call it deictic reference. If the expression refers to an object that is available in our encyclopedic knowledge, we call it encyclopedic reference. Only if the relation hold between an expression and an entity that was introduced by the preceding discourse, accessibility relation is adequate. Furthermore, reference to discourse items has two different incarnations: activating or accessing. If the expression refers for the first time to an entity, it evokes or activates it, while a reference to an already accessible or activated entity is described by accessing this entity.

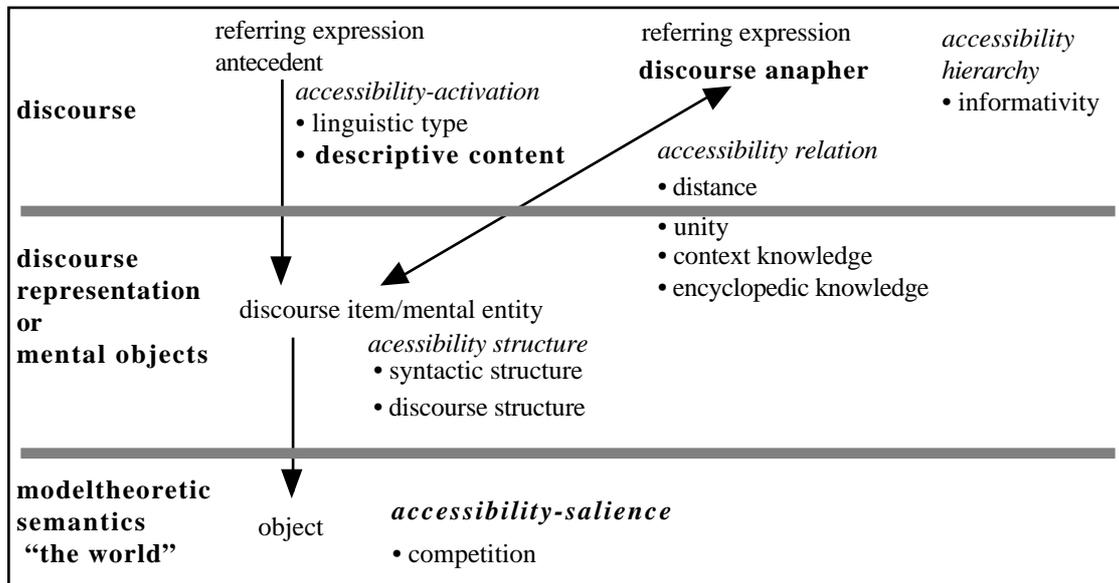


Figure 1: Five aspects of accessibility

2.3 Accessibility hierarchies

The accessibility hierarchy is reflected in the choice of the anaphoric expression. If the intended entity is easily accessible the anaphoric expression need not be very informative (e.g. a pro-form or an unstressed pronoun), while less accessible entities need more information in the anaphoric expression (full NPs, full names). This reflex of the anaphoric expression with respect to the status of the intended referent is described in Ariel's (1990) Accessibility Marking Scale and in the Givenness Hierarchy of Gundel et al. (1993). One interesting question with respect to these hierarchies is whether the accessibility hierarchies only reflect the degree of accessibility of the associated entity or whether it also shows the degree of activation for a newly activated entity. In other words: does the hierarchy express only the degree of context dependency of the referring expression or does it also express the potential of changing the context.

2.4 Accessibility structure

The accessibility relation depends on a variety of factors, one of which is the structure of the discourse. Thus, we can assign to a discourse domain, discourse segment or discourse structure a (ordered) set of accessible entities. A discourse consists of discourse elements that are ranked with respect to their accessibility or their activation. The accessibility structure can be understood as a property of a discourse that yields a (ordered) set of accessible items (with respect to a certain structural position). This notion is predominant in the discussion of Centering Theory and Discourse Representation Theory.

2.5 Accessibility and properties: salience

The description of an accessibility structure of an discourse captures important grammatical parameters, however, it misses to account for one of the most important semantic contribution to accessibility: the descriptive material that introduces an entity. The NP *the black cat* refers to the most accessible, or more general to the most salient black cat in the current context. Accessibility in this sense is an instantiation of the more general principle of salience. Salience is a property of a set associated with descriptive material expressed in a referring expression. The accessibility structure of a discourse is formed by listing the salient items of each set mentioned in that discourse. This different view on accessibility can mainly be illustrated on the behavior of definite and indefinite NPs since they exhibit a considerable descriptive material. Pronouns or proper name do not so, and form therefore an unlikely testing field for this view. Nevertheless, most theories focus on the use of pronouns and their antecedents.

3. Discourse Anaphora

In this section, I discuss two approaches that assumes that accessibility is a structural property of discourse segments or domains: Discourse Representation Theory (DRT) and Centering Theory. I compare these two approaches and present a complementary proposal in section 3. The two approaches differ in whether accessibility is a gradable or non-gradable notion and

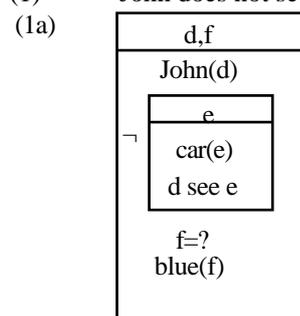
whether it is applied to discourse domains or discourse segments. A discourse domain contains all expressions that have an equal relation to discourse domain creating operators like negation, modals or verbs of attitudes. Discourse domains are nested and represented as DRSs or boxes in DRT. Discourse segments, on the other hand, are suprasentential units of two or more connected sentences. They determine a local domain in which certain rules for pronominal reference are defined.

3.1 Accessibility in DRT

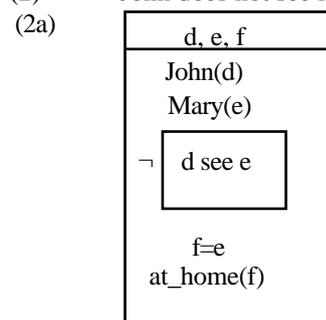
In DRT of Kamp & Reyle (1993), both indefinite and definite expressions introduce new discourse referents. The discourse referent of a definite or anaphoric expression must be identified with an already established discourse referent to meet the familiarity condition. Hence, the anaphoric relation is represented as an identification of the new discourse referent with an accessible one. There are structural restrictions on the accessibility of discourse referents, which are encoded in the construction rules for DRSs. For instance, a discourse referent can only be linked to another one that is represented in the same discourse domain or box.

In (1), the discourse referent *f*, which represents the pronoun *it*, cannot be identified with the discourse referent *e*, which represents the indefinite NP *a car*, expressing the ill-formedness of the example. In contrast, the proper name *Mary* in (2) introduces a discourse referent into the main domain, which is accessible for the pronoun *she*, explaining the possible link between the pronoun and the proper name. In example (3), the discourse referent *f* for the first anaphoric pronoun *him* can "access" the discourse referent *d* for *a man* since it occurs inside the domain (or box) in which the discourse referent *d* for *a man* was introduced. However, the discourse referent *g* for the second anaphoric pronoun cannot access *d* because it occurs in the main domain, whereas *d* was introduced in the subdomain governed by the first negation

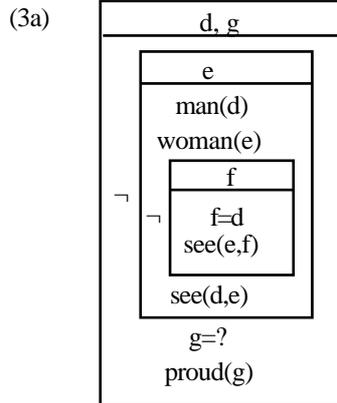
(1) John does not see a car. *It is blue.



(2) John does not see Mary. She is at home.



- (3) A man does not see a woman that does not see him. *She is proud.



The discourse referents form a set of accessible antecedents with respect to a discourse domain. We will confine the discussion on accessible referents to those in the main discourse domain (or the main box). Accessibility in DRT is a non-gradable notion and a property of a discourse domain. The problem is that there is no additional “fine-tuning” between different accessible discourse referents in the same domain, a fact already noted by Bosch (1988, 207):

Although a limitation of the search to discourse domains is certainly a step in the right direction, and although the assumption of discourse domains seems useful also for a number of other purposes, they are still too large to serve as search spaces for reference resolution. It is highly implausible, for instance, that a personal pronoun like *she* should be interpretable unambiguously only in a discourse where precisely one woman has occurred.

A more promising alternative is the notion of temporary salience of particular discourse referents and a corresponding dynamic salience structure or focus structure, which may or may not be superimposed on discourse domains.

3.2 Accessibility in Centering Theory

In Centering Theory, an alternative family of approaches to the representation of discourses (cf. Grosz et al. 1995), the discourse structure has three components: linguistic structure, intentional structure and attentional state. The attentional state represents the availability of discourse referents at any given point in the discourse. According to Centering, each utterance U_i in a coherent local sequence of utterances (a discourse segment) $U_1 \dots U_m$ affects the structure of the discourse model in two ways. First, each utterance activates a set of discourse entities called Forward-looking centers, or $\{Cf\}$. The elements of this set are ordered according to factors such as grammatical roles in the sentence. Second, the set contains a marked element called the Backward-looking

center, or Cb . The Cb connects the current utterance with the previous discourse. Centering Theory formulates constraints on the relation between the Cf and Cb expressing the local coherence between adjacent sentences. For instance, a lower-ranked element of Cf cannot be pronominalized unless the higher-ranked one is. This constraint is illustrated by the following example, where (4c) and (4d) are potential continuations of (4a) and (4b) (Gordon et al. 1993, 313):

- (4a) Susan gave Betsy a pet hamster
 $Cf = \{Susan > Betsy > hamster_1\}$
- (4b) She reminded her such hamsters were quite shy.
 $Cb = Susan;$
 $Cf = \{Susan > Betsy > hamster_1\}$
- (4c) She asked Betsy whether she liked the gift.
 $Cb = Susan;$
 $Cf = \{Susan > Betsy > gift = hamster_1\}$
- (4d) Susan asked her whether she liked the gift.
 $Cb = Susan;$
 $Cf = \{Susan > Betsy > gift = hamster_1\}$

The sentence (4a) creates the ordered set of accessible discourse items $\{Susan > Betsy > hamster_1\}$ according to the grammatical roles they occupy. In (4b) and (4c) the actual antecedent of the pronoun *she* is linked to the first element of the ordered set. In (4d) the most prominent item is realized by the proper name *Susan*, whereas the second prominent item is realized by the pronoun *she*. This violates the mentioned constraint that lower ranked elements can only be represented as pronouns if the higher one is a pronoun. This constraint accounts for the awkwardness of continuation of sentences (4a) and (4b) with sentence (4d). Centering Theory assumes a fine-tuning among accessible discourse items, which is mirrored in the lexical choice of the anaphoric expression. The more accessible the referent is the less marked is the anaphoric expression. This approach on the local coherence of discourse segments provides strategies for finding antecedents for anaphoric pronouns. However, it does not account for the antecedent of a definite NP, which depends on a global accessibility. Centering Theory distinguishes between local and global accessibility or focusing, but describe only the local interaction with pronouns:

Two kinds of focusing were distinguished: global focusing and immediate focusing. It was claimed that global focusing affected the production and interpretation of definite descriptions, whereas immediate focusing affected the production and interpretation of pronouns. (Gordon et al. 1993, 312).

Summarizing, DRT perceives accessibility as a function of the structure of a discourse domain (box) that yields a set of discourse referents. The structure is defined by the construction rules of DRSs. Expressions like negation or modals create subdomains and referring expressions like proper names and indefinites differ in whether they introduce their discourse referents in the current domain or in the main domain, reflecting the traditional concept of scope interaction. The set of

accessible discourse referents constantly increases in a progressive discourse. However, there is no “competition” or ranking between different discourse referents in the same domain. Centering theory, on the other hand, assumes that accessibility is a function of a discourse segment that yields an ordered set of discourse items. Linguistic expressions introduce discourse items into the set and rank them. Subsequent expressions not only introduce new elements but also change the ranking. However, there are only constraints on pronominalization in local domains, and no rules for accessibility of anaphoric expression in general. Both approaches assume one set of accessible items for each discourse, which they describe in structural terms: DRT on scope interaction and Centering Theory on grammatical roles. However, they neglect the role of the descriptive content of the expression by which the discourse item is introduced.

4. Descriptive content and salience

In this section I concentrate on the analysis of anaphoric NPs with descriptive material, i.e. definite NPs, and argue that accessibility is not a function of a discourse that yields a unique set of accessible elements; it is rather a function of the discourse that is applied to a set of elements representing a property or a kind yielding an element. In order to distinguish this notion of accessibility from the gradable and non-gradable one, I call the accessible referent of a kind the “most-accessible” or the “uniquely accessible”. The phenomena which are captured by this notion are illustrated by the discourse in (5) which has the schematic structure (5a) and the representation (5b). Two discourse referents d_n and d_k are introduced by two occurrences of the indefinite NP *a student*. The two discourse referents for the two occurrences of the anaphoric NP *the student* are unambiguously related to one of the two already introduced referents. However, in DRT there is no formal tool to decide why to identify the discourse referent d_l for the second definite NP *the student* with the discourse referent d_k standing for the second indefinite NP and not with d_m representing the first indefinite NP. In Centering Theory, there is no principle to relate definite NPs to their indefinite counterparts.

- (5) The dean is very busy these days: This morning, *a student* complained about his exam. The dean had to talk to *the student* for more than two hours. Then *a student* came to talk about his neighbors, who play the trumpet every night. The dean moved *the student* to a different place.
- (5a) $P_1(a\ student) \dots P_2(the\ student)\dots P_3(a\ student)\dots P_4(the\ student)$
- (5b) $\{\dots, d_n, \dots, d_m, \dots, d_k, \dots, d_l\dots\} \dots$
 $P_1(d_n) \dots P_2(d_m) \ \& \ d_n = d_m \dots P_3(d_k) \dots$
 $P_4(d_l) \ \& \ d_k = d_l \dots \}$

4.1 Salience

Salience is a concept that was applied in order to account for a theory of definiteness. The salience theory of definiteness has three historical sources: first, Lewis (1979) criticizes Russell’s Theory of Descriptions and sketches an alternative theory using a salience ranking

instead of Russell’s uniqueness condition. Second, the investigation of the Prague School (cf. Sgall et al. 1973; Hajičová et al. 1995) developed an information structure of a sentence the pragmatic background of which is a hierarchy of “activated” referents. Third, research in artificial intelligence showed that discourse models need a structure or hierarchy of referents that is very similar to Lewis’ concept of salience (cf. Grosz et al. 1995). In the following, we start with some of the observations of Lewis (1979).

4.2 Definite NPs and salience

According to Lewis (1979), a definite NP refers to the most salient object in the discourse that fits the descriptive content. And he notes further that the salience ranking depends on the context, i.e. it is not global in the sense that each expression gets its referent for global constraints since once established it can keep its ranking during the whole discourse if there is no other salience changing expression. This property of changing the salience may be exemplified by the following example given by Lewis (1979, 179):

Imagine yourself with me as I write these words. In the room is a cat, Bruce, who has been making himself very salient by dashing madly about. He is the only cat in the room, or in sight, or in earshot. I start to speak to you:

- (6) The cat is in the carton. The cat will never meet our other cat, because our other cat lives in New Zealand. Our New Zealand cat lives with the Cresswells. And there he’ll stay, because Miriam would be sad if the cat went away.

In terms of discourse representation theory, where the salience shifting potential cannot be encoded, the representation would look as follows: The first sentence in (6) introduces a discourse referent that must be linked to an already introduced one. The second sentence refers to this referent by the expression *the cat* and introduces a new discourse referent with the same property of being a cat and the further relation that belongs to the speaker (and the presupposition that the first cat belongs to the speaker, as well). The third sentence refers to the second introduced cat by the expression *our New Zealand cat*. And the fourth sentence is anaphorically linked to that cat by the expression *he* and *the cat*. However, in a discourse representation of the type given in DRT, there would be no difference in the accessibility of the discourse referents. Therefore, the theory must rely on further information.

4.3 Indefinite NPs and salience change

If we modify the theory and let the indefinite NP not introduce a discourse referent but let it give the highest salience ranking to an individual that fits the description, a definite NP would then refer to the object that fits the description and that has the highest salience rank:

Thus although indefinite descriptions -- that is, idioms of existential quantification -- are not themselves referring expressions, they may raise the salience of particular individuals in such a way as to pace the way for referring expressions that follow. (Lewis 1979, 180).

The first sentence introduces a new cat, lets say Bruce, into the discourse and raises him to the most salient cat, such that the definite NP *the cat* in the next two sentence can refer to this salient cat Bruce. The third sentence refers to this cat and introduces a second cat Albert, that gets a lower rank. Therefore, in the following two sentences we have to refer to Albert by an unambiguous description (*our other cat* and *our New Zealand cat*). Since in sentences (iv) and (v) only we talk only about Albert, he gains it the first rank of the salience hierarchy such that in the last sentences we can refer to Albert by the pronoun *he* and by the definite NP *the cat*.

(7)	Discourse	Ranking
(i)	In the room is a cat	Bruce
(ii)	The cat is in the carton.	Bruce
(iii)	The cat will never meet our other cat	Bruce > Albert
(iv)	because our other cat lives in New Zealand.	Albert, Bruce
(v)	Our New Zealand cat lives with the Cresswells.	Albert, Bruce
(vi)	And there he'll stay, because Miriam would	Albert > Bruce
(vii)	be sad if the cat went away.	Albert > Bruce

The concept of salience was never formally reconstructed although it was often regarded as an essential part for fixing the referent of definite expressions. Based on ideas of Egli & von Heusinger (1995), I have given a formal account in terms of choice functions (see von Heusinger 1997) and implemented into a dynamic semantics (von Heusinger 2000, Peregrin & von Heusinger 2000). In the following, I will present the basic ideas in an informal way.

Salience is understood as the contextual property that determines for each set in a discourse one element out of this set. This contextual property can be changed during the discourse, in particular by the interpretation of indefinite NPs (but also by definite expressions as shown in (7) and section 5 below). This view of salience differs from other reconstructions of salience in that it assumes a salience structure for each set given in a discourse. This can be illustrated by the informal analysis of the small discourse (5) in (8).

4.4 Discourse dynamics

In the view defended here, the first indefinite NP *a student* changes the accessibility structure of the discourse, which is reconstructed as a choice function . A choice function is defined as a function that assigns to a set one of its elements. E.g, the salience structure of the embedding context for the small discourse (5) can be

described as in (8i), i.e. it assigns the individual *l* to the set of deans, while it does not assign any element to the set of students. This reflects our intuitions that the definite NP *the dean* refers to an individual due to contextual knowledge. The interpretation (iii) of the first two sentences of the discourse in (ii) gives us the referent *l* for the definite NP *the dean*, while it introduces a new referent *a* for the interpretation of the indefinite *a student*. This new referent becomes the most-accessible student, or it is the element that is assigned to the set of students: Thus, in (iv) we update the given choice function to a new one such that the assignment to the set of students is changed. We can now interpret the sentence in (v) according to the new salience structure such that the interpretation for *the students* yield the referent *a*. Since there is no indefinite expression in (v) there is no update of the choice function in (vii). Sentence (viii), however, introduces a new referent *b* by the indefinite NP *a student*. This referent becomes the most-accessible element of the set of students, as encoded in the updated choice function in (x). The second definite NP *the student* is interpreted according to this newly modified accessibility and refers to the object that was introduced by the second indefinite.

- (8)
- (i) = {<||dean||, l>, <||student||, Ø>, ...}
- (ii) The dean is very busy these days: This morning, a student complained about his exam.
- (iii) ||the dean|| = l; ||a student|| = a
- (vi) update zu ' = {<||dean||, l>, <||student||, a>, ...}
- (v) The dean had to talk to the student for more than two hours.
- (vii) update ' zu " mit ' = "
- (viii) Then a student came to talk (...)
- (ix) ||the dean|| = l; ||a student|| = b
- (x) update " zu "" = {<||dean||, l>, <||student||, b>, ...}
- (xi) ""(||dean||)= l, ""(||student||)=b

5. Salience spreading

The formalism given in the last section must be modified in order to catch the salience-change potential of definite expressions, as well. In the last section, it was assumed that definite NPs do not exhibit a salience-change potential since they would raise to salience an object that was already salient. However, the following example from Hemingway's *A Clean, Well-Lighted Place* clearly shows that definite expressions can change the actual accessibility of a discourse. The definite *the younger waiter* refers to one of the two mentioned waiters. The subsequent definite *the waiter* refers to the same one. We can explain this by assuming that an expression not only changes the most-accessible element of the set introduced, but also that of some relevant supersets of this set – a behavior that I have termed “salience spreading”. The definite *the younger waiter* changes the most-accessible element of the set of younger waiters and that of the set of waiters to the same element. Therefore, we can refer back to this referent by the expression *the waiter*.

A clean, well-lighted place

It was late and everyone had left the café except an old man who sat in the shadow the leaves of the tree made against the electric light. [...]

The two waiters inside the café knew that the old man was a little drunk [...].

“Last week he tried to commit suicide,” **one waiter** said. “Why?” [...]

The younger waiter went over to him. [...]

The old man looked at **him**. **The waiter** went away. [...]

The waiter who was in hurry came over. “Finished,” **he** said [...]. “Another”, said the old man. “No, finished.” **The waiter** wiped the edge of the table with a towel and shook his head. The old man stood up [...]. “Why didn't you let him stay and drink?” **the unhurried waiter** asked.

6. Summary

I have discussed three basic notions of discourse semantics: accessibility, discourse anaphora, and descriptive content. Accessibility is the aspect of the context that determines to which referent an anaphoric expression can refer. It was argued that the impact of the descriptive material of the terms involved are not taken into account. Therefore, a different approach was presented: Accessibility is analyzed as property of a discourse structure with respect to a set defined by the descriptive content of the given NPs. Definite NPs refer to the most accessible or most salient element of the given set, while indefinite NPs introduce new elements. This structure can formally represented by choice functions, and the interpretation of the terms involved updates this structure. This extended formalism yields not only a more adequate representation of discourse, but also solves the problem of how to establish anaphoric links to definite NPs, and supplies a uniform representation of definite and indefinite expressions with respect to their potential to change the accessibility structure of the discourse.

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