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## SALIENCE AND ANAPHORIC DEFINITE NOUN PHRASES

by

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### **Abstract**

*This paper presents an original view of salience as semantically related sets of ordered discourse referents and illustrates it on the particular semantics of anaphoric definite noun phrases. Salience is one of the main aspects of discourse structure. Indefinite as well as definite noun phrases dynamically update this salience structure, which in turn determines the anaphoric relations between antecedents and anaphoric terms. Salience is modeled by interrelated sets of ordered discourse referents. Each predicate that is associated with a discourse referent has its own (local) salience structure, while the global salience structure of a discourse consists of all the local structures and semantic relations between the given predicates. Referring expressions dynamically update the local salience structures of such related predicates. The main factors that determine the update-process are the descriptive content of the referring expression, and additionally, the semantic relations between the predicates.*

### **1 Introduction\***

Research in discourse semantics investigates the linguistic means by which the coherence of discourse is established. In particular, anaphoric expressions, like pronouns or anaphoric definite noun phrases, are at the center of interest. There are different parameters that determine the reference and anaphoric reference of these expressions in a discourse. This paper investigates the role of *salience* in this process. The term *salience* has various uses, closely connected with the concepts of

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activation, competition, accessibility, etc. In the literature, salience is often understood as describing the different prominence statuses of discourse referents with respect to one another. In such a picture, referring expressions introduce discourse referents into a discourse domain, and these referents are ranked in a single set according to their prominence, activation or salience. Subsequent anaphoric pronouns refer back to salient referents in that set. This general description of salience can be found in the works of the Prague School (e.g. Hajicová & Sgall 1987), Centering Theory (Grosz et al. 1995), in approaches to accessibility hierarchies of Ariel (1990) or Gundel et al. (1993). Poesio (2003) uses it for a computational approach to definite noun phrases.

In this paper, I will develop a more elaborate view of salience and illustrate it by the behavior of anaphoric definite noun phrases. Informally, I maintain that salience is one aspect of the discourse structure that is dynamically updated by the referring expressions in that discourse. The salience structure of a discourse consists of various sets of ranked discourse referents, rather than of one unique set of such ranked elements. Each predicate that is associated with a discourse referent has its own (local) salience structure, while the global salience structure of a discourse consists of all the local structures and the relations between the given predicates. Referring expressions, such as noun phrases, can dynamically update the salience structure of different predicates at the same time. The main factors that determine the update-process are the descriptive content of the referring expression and the distance between antecedent and anaphoric expression, i.e. the recency of the anaphoric expression. Other parameters for salience, such as topicality, subjecthood, animacy, etc., are also important for the resolution of anaphoric pronouns, but play only a minor role in the resolution of anaphoric definite noun phrases. Therefore, I will focus on the descriptive content and the recency of the relevant expressions. This model of salience should be primarily illustrated by the behavior of anaphoric definite noun phrases. I will focus on three well-known observations and then show how they can be explained by the model of a dynamic salience structure. Observation A: One definite NP refers to different referents. Observation B: Distribution of pronouns and definite NPs in anaphoric chains. Observation C: Relations between two NPs in an anaphoric chain.

*Observation A: One definite NP refers to different referents*

Different occurrences of the same definite noun phrase can refer to distinct objects or discourse referents, as illustrated in (1). The noun phrase *the two waiters* introduces two discourse referents. One is picked up by *the younger waiter* and subsequently referred to by means of *him* and *the waiter*. The other is picked up

by *the waiter who was in a hurry*, and then referred to by *he* and *the waiter*. The reference is changed back to the first-mentioned waiter by using *the unhurried waiter*, as summarized in (1b):

- (1) a. 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**<sub>1⊕2</sub> inside the café knew that the old man was a little drunk [...]. “Last week he tried to commit suicide,” **one waiter**<sub>1</sub> said. “Why?” [...] **The younger waiter**<sub>1</sub> went over to him. [...] The old man looked at **him**<sub>1</sub>. The **waiter**<sub>1</sub> went away. [...] **The waiter who was in a hurry**<sub>2</sub> came over. “Finished,” **he**<sub>2</sub> said [...]. “Another,” said the old man. “No. Finished.” **The waiter**<sub>2</sub> wiped the edge of the table with a towel and shook **his**<sub>2</sub> head. The old man stood up [...]. “Why didn’t you let him stay and drink?” **the unhurried waiter**<sub>1</sub> asked. (Hemingway [1925] 1966: 380; *A clean, well-lighted place*).
- b. Structure: *The younger waiter*<sub>1</sub> ... *him*<sub>1</sub> ... *the waiter*<sub>1</sub> ... *The waiter who was in a hurry*<sub>2</sub> ... *he*<sub>2</sub> ... *the waiter*<sub>2</sub> ... *his*<sub>2</sub> ... *the unhurried waiter*<sub>1</sub>

The question that is raised by this structure is: What mechanism allows the writer to refer with different occurrences of the same definite noun phrase to different referents? This question is important since most semantic theories, including dynamic semantics, assume that definite noun phrases uniquely refer to the one element that fulfils the descriptive content of the noun phrase. Such theories do not allow for more than one referent with the same descriptive content (in the same context).

*Observation B: Distribution of pronouns and definite NPs in anaphoric chains*

The indefinite noun phrase *a small bird* introduces a new discourse item that is subsequently picked up by the anaphoric pronoun *he* or the anaphoric definite noun phrase *the bird*. The distribution of these two alternatives is not well understood.

- (2) a. **A small bird** came toward the skiff from the north. **He** was a warbler and flying very low over the water. The old man could see that **he** was very tired. **The bird** made the stern of the boat and rested there. Then **he** flew around the old man’s head and rested on the line where **he** was more comfortable. (Hemingway 1962: 28; *The old man and the sea*)
- b. Structure: *A small bird* ... *he* ... *he* ... *the bird* ... *he* ... *he*

In this example, it seems that the full definite noun phrase is necessary in order to bring the discourse item back into the topic function. However, a general observation is that we often find anaphoric chains such that a full noun phrase introduces an item which is subsequently picked up by pronouns. But after two or three pronouns, another full noun phrase seems necessary for keeping the activation level of the item high. So we generally find anaphoric chains of the following type: *(in)definite noun phrase<sub>1</sub>, pronoun<sub>2</sub>, pronoun<sub>3</sub>, (. . . pronoun<sub>n</sub>), definite noun phrase<sub>n+1</sub>, pronoun<sub>n+2</sub>* etc. with *n* not much greater than 3. The question that is raised by this structure is: Why do we need to use the second definite NP in this chain (instead of a pronoun)?

*Observation C: Relations between two NPs in an anaphoric chain*

The prototypical anaphoric relation consists of an antecedent and an anaphoric expression where the anaphoric expression contains less information than the antecedent one, such as *a bird . . . he*, or *a small bird . . . the bird* in (3a). This corresponds to the function of an anaphoric expression, namely to establish a link to the already introduced discourse item. The semantic relation of hyponymy between two such expressions can extensionally be described as a “superset”-relation, i.e. the descriptive content of the anaphoric term is associated with a superset of the set that is associated with the antecedent term’s descriptive content, as in (3a). Anaphoric pronouns do not contain content except for gender and number information; so they are associated with sets of all (male, female, inanimate) objects. However, it is also possible to pick up a discourse item with the same expression as it was introduced, as in (3b). This seems to be a marked option, but it can be appropriate in certain contexts. Here the anaphoric relation corresponds to the semantic relation of synonymy, i.e. as identity between the sets denoted by the descriptive content of the two expressions involved. These two types of anaphoric relations, i.e. (3a) and (3b), are also known as semantic anaphora, since their relations are encoded in the lexical relations between the corresponding descriptive contents.

(3) Types of anaphoric links and corresponding semantic relations

	anaphoric link	semantic relation
a.	<i>a bird . . . he, a small bird . . . the bird</i>	superset
b.	<i>a bird . . . the bird</i>	identical sets
c.	<i>a small bird . . . the beautiful animal</i>	intersection
d.	<i>a bird . . . the small bird</i>	subset

However, we also find anaphoric relations like (3c) and (3d), which are known as pragmatic anaphora, since additional knowledge is necessary to establish the anaphoric link. In (3c), the anaphoric term expresses additional content and can therefore be linked only to the antecedent if there is either no competitor in the context, or the reference is established by other means. The corresponding semantic relation is an intersection (which might be – in extreme cases – empty). Similarly in (3d), where the link is only possible if additional knowledge is supplied, the semantic relation corresponds to the subset-relation. Such pragmatic anaphora is used to introduce background information by forcing the hearer to accommodate the new information into the background. It is often used in newspapers, where it seems necessary to integrate much (background) information into little text. The questions raised by this structure are: What are semantic relations and what are pragmatic ones? What are the ranges of further (pragmatic?) relations and what determines the relations?

The structure of this paper is as follows: In section 2, I show that different usages of definite noun phrases can be best explained by the (static) notion of salience. A definite noun phrase refers to the (most) salient object of the type described by the descriptive content. The salience analysis of definiteness covers the other usages as well. In section 3, we extend this static view to a dynamic one that allows us to account for anaphoric reference. In the model we can show that salience plays a double role for anaphoric definite NPs. First, the antecedent expression raises its referent to the most salient element of the kind expressed by the descriptive material of the antecedent. This is the salience change potential of NPs. Second, the anaphoric definite NPs is interpreted according to the actual salience structure of the discourse. Thus, salience structure is the context aspect which is necessary for the interpretation of anaphoric and definite expressions. It will be shown that the two roles of salience in the interpretation of anaphoric reference are two sides of the same coin. However, this only becomes clear when we introduce the principle of salience spreading in section 4. Salience spreading means that an expression not only changes the (local) salience structure of the predicate associated with the expression, but it also changes the salience structure of other predicates that stand in some semantic relation to the directly associated predicate. In section 5, we account for the three observations with respect to our model of dynamic salience structure and summarize the findings in section 6.

## 2 Definiteness and Salience

Definite noun phrases can take different functions in a discourse, illustrated with example (4) and listed in (5), which is from the beginning of Umberto Eco's novel *The name of the rose* (1994: 21). The definite noun phrases *the steep path* and *the mountain* indicate the situational salience of that path and that mountain. Since the abbey was already mentioned in the text, the two occurrences here are used anaphorically, like the second occurrence of *the mountain* in the last sentence. The definite noun phrases *the walls that girded it* and *the plateau of the abbey* are functionally dependent on their explicit arguments *it* and *the abbey*, respectively. Finally, we also find definite noun phrases that express unique entities, referred to by proper names, as *the Aedificium*, *the City of God*, or expressions that resemble proper names, like *the Christian world*. With uniques the function of the definite article does not play any role since they always refer to the one referent. However, with definite noun phrases based on sortal concepts, it is crucial whether the expression is used with a definite or indefinite article.

(4) While we toiled up **the steep path** that wound around **the mountain**, I saw **the abbey**. I was amazed, not by **the walls that girded it on every side**, similar to others to be seen in all **the Christian world**, but by **the bulk** of what I later learned was **the Aedificium**. This was an octagonal construction that from a distance seemed a tetragon (a perfect form, which expresses **the sturdiness** and impregnability of **the City of God**), whose southern sides stood on **the plateau of the abbey**, while **the northern ones** seemed to grow from **the steep side of the mountain**, a sheer drop, to which they were bound.

(5) Functions of definite noun phrases

- |                              |   |
|------------------------------|---|
| (i) uniques and proper names | <i>the Christian world, the City of God</i>                         |
| (ii) functional dependency   | <i>the walls that girded it,</i><br><i>the plateau of the abbey</i> |
| (iii) situational salience   | <i>the steep path, the mountain</i>                                 |
| (iv) anaphoric relation      | <i>the abbey, the mountain</i>                                      |

In the following we will discuss four theories of definiteness (see Christophersen 1939; Lyons 1999; Abbott 2004 and others, for a more detailed presentation). It will become obvious that each of them is closely related to one function of definite noun phrases, listed in (5i–iv), in some cases the name of the particular theory is

similar to the function: (i) The Russellian account of uniqueness, (ii) the functional dependency-account, (iii) the situational salience account, and (iv) the anaphoric account, which will be presented in section 3.

(i) *The Russellian interpretation of definite noun phrases*

Russell takes the uniques as the prototype of definite noun phrases. His uniques are generally functional concepts, i.e. expressions that need a further argument to refer unambiguously to an object, like *the center of (the solar system)*, or *the father (of Bertrand Russell)*. He does account for context dependencies, which do not play any role in mathematics and logic. Russell (1905) represents the definite article with the “iota operator” as in (6a), which is contextually defined as a complex quantifier phrase consisting of the uniqueness condition, the existential condition and the matrix predication, as spelled out in (6c).

- (6) a. The father of Bertrand Russell was English.  
 b.  $\text{English}(\iota x \text{Father\_of}(b, x))$   
 c.  $\exists x [\text{Father\_of}(b, x)] \ \& \ \forall y [(\text{Father\_of}(b, y)) \rightarrow x = y] \ \& \ \text{English}(x)$

There seem to be unsolvable problems with Russell’s theory that concern the uniqueness condition: it is too strong for natural language descriptions, since it assumes that a definite noun phrase asserts the uniqueness of the referent. However, we can use the phrase *the son of Bertrand Russell* to refer to one of his sons in a particular context without asserting that there is only one. An additional problem is that the difference between the definite and the indefinite article lies only in the uniqueness condition. Finally, in this analysis definite NPs do not belong to the class of referring terms like proper names and pronouns, but to the class of denoting phrases like quantifiers.

There is a very long debate on the status of uniqueness for definite noun phrases (see e.g. the contributions in Bezuidenhout & Reimer 2004). Recently, Szabó (2000) opened the discussion on whether uniqueness is a semantic condition, a conventional implicature or a conversational implicature – see Abbott (2003); Szabó (2003) and Horn (2005, 2006). I cannot do justice to this discussion, and since I will argue that it is not uniqueness but salience that determines the definiteness of a noun phrase, it is not crucial whether uniqueness is understood as a semantic or pragmatic property of definite noun phrases.

(ii) *The functional interpretation of definites (Löbner 1985; Fraurud 1990)*

Löbner differs from the Russellian approach. According to Löbner the definite article is not a part of the lexical meaning of the expression, but indicates the way that



reference is to be assigned, namely that the expression refers non-ambiguously. This function was already defined by Christophersen. “I agree with Christophersen that the crucial feature of definiteness is non-ambiguity of reference” (Löbner 1985: 291). It means that a definite NP cannot be represented by a quantifier phrase, but must be reconstructed by a term, such as proper names and pronouns. The Russellian case, where the definite NP refers through its descriptive material which uniquely denotes an object, comes out as a special case of unambiguous reference.

Expressions like *weather*, *prime minister*, *post office*, etc. are inherently functional since they need a further argument to refer unambiguously to an object. This argument can be implicitly expressed by a given situation or just by the location of utterance. This is what Christophersen (1939) has called the larger situational use of the definite article. The argument can also be explicitly expressed by an overt object argument like *father of\_*, *capital of\_*. The argument slot need not be filled by another definite expression. It can also be filled by an indefinite expression, as in (7) and (8):

(7) He was the son of a poor farmer.

(8) The mayor of a small town in Wales

Examples like these suggest that definiteness has to be considered not as a property of (global) reference, but as a local property of the link between the head and its argument. (8) means that there is a definite relation between the town (whatever it is) and its mayor.

Pragmatic definites consist in anaphoric and deictic uses of definites. Löbner explains their use in terms of functional concepts. A pragmatic definite is a function from an established situation to a(n) (unique) object. He develops a discourse network to show that definite relations exist in local domains. However, Löbner does not give any formal definition of what a discourse consists of and which parts influence the definite NPs. Since he focuses on the local effect of definiteness he cannot account for the discourse phenomena of definite NPs. Therefore, he regards anaphora only as epiphenomena and not as the central use of definite NPs. The functional approach of Löbner is further developed for “first-mentioned” noun phrases (see Fraurud 1990; Poesio & Vieira 1998) and indirect anaphoric definite noun phrases (Schwarz 2000; Consten 2004).

*(iii) Situational salience*

The concept of salience was first discussed in the semantics of definite noun phrases in the seventies. The notion of salience itself seems to be influenced by the analysis of demonstrative expressions. A demonstrative like *this man* refers to the most prominent object in the physical environment of the speaker and hearer. Salience, however, does not depend only on the physical circumstances, or any other single cause. Rather it is a bundle of different linguistic and extra-linguistic factors, as noted by Lewis (1970: 63): “An object may be prominent because it is nearby, or pointed at, or mentioned; but none of these is a necessary condition of contextual prominence. So perhaps we need a prominent-objects coordinate, a new contextual coordinate independent of the other.”

McCawley (1979: ex. 21) had already observed that the mentioning of one definite noun phrase, as *the dog*, in (9), does not exclude another entity of the same kind:

- (9) Yesterday **the dog** got into a fight with **a dog**. **The dogs** were snarling and snapping at each other for half an hour. I’ll have to see to it that **the dog** doesn’t get near **that dog** again. (McCawley 1979: ex. 21)

Therefore, Lewis (1979: 178) concludes that “The proper treatment of description must be more like this: ‘the F’ denotes x if and only if x is the most salient F in the domain of discourse, according to some contextually determined salience ranking.”

This short discussion can be summarized by the following points: the uniqueness condition, i.e. the claim that the descriptive content may only be true for one individual, is a useful property, but it is too strong a condition for definite noun phrases. Functional expressions naturally follow these conditions, but so-called incomplete descriptions, i.e. noun phrases with sortal concepts, need a more flexible semantics. This semantics is given by the principle of salience, according to which the definite noun phrase picks out the first or most salient object of the set described by the descriptive content. The concept of salience is further elaborated in Egli & von Heusinger (1995); von Heusinger (2004), and formalized in Peregrin & von Heusinger (2004) as context-dependent choice functions. Informally, a definite noun phrase refers to the first element of a set associated with the descriptive content. This set need not be a singleton – the unique identification is warranted by the principle of choice: the definite noun phrase selects the first element of the set, as in (10), where  $\Phi_c$  is a contextually determined choice function that selects the first element of a set. In this view, the definite noun phrase does not assert the uniqueness of the set.

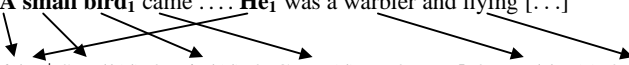
- (10) the dog: the first element of the set  $\{d_1 > d_{12} > d_7 > \dots\}$   
 $\Phi_c(\{d_1 > d_{12} > d_7 > \dots\}) = d_1$

A reviewer correctly noticed that for modeling pronouns and anaphoric definite noun phrases, a fully ordered set is not needed and computationally too costly. It suffices to keep track of the first element of the set. However, if we want to account for expressions like *the other*, *the second* etc. a fully ordered set is more appropriate (see Egli & von Heusinger 1995).

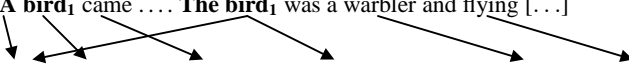
### 3 Dynamic semantics and salience structure

In Discourse Representation Theory (= 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 the identification of a new discourse referent with an accessible one.

In (11), the indefinite noun phrase *a small bird* introduces the discourse referent *d*, which is the argument of the predicates *small*, *bird* and *came*. The pronoun *he* in the next sentence is represented by the discourse referent *e*, which is identified with the already established discourse referent *d* expressing the anaphoric link.

- (11) a. **A small bird<sub>1</sub>** came . . . . **He<sub>1</sub>** was a warbler and flying [ . . . ]  
  
 b.  $\{d, e \mid \text{Small}(d) \ \& \ \text{Bird}(d) \ \& \ \text{Came}(d) \ \dots \ \& \ e = d \ \& \ \text{Warbler}(e) \ \& \ \text{Fly}(e) \ \dots \}$

If we slightly modify our example to (12a), we have to account for the anaphoric definite noun phrase *the bird* in the second sentence. DRT would represent this noun phrase as introducing a new discourse referent and then identify the new discourse referent with the already established one, as in (12b).

- (12) a. **A bird<sub>1</sub>** came . . . . **The bird<sub>1</sub>** was a warbler and flying [ . . . ]  
  
 b.  $\{d, e \mid \text{Bird}(d) \ \& \ \text{Came}(d) \ \dots \ \& \ \text{Bird}(e) \ \& \ e = d \ \& \ \text{Warbler}(e) \ \& \ \text{Fly}(e) \ \dots \}$

This representation is inadequate for at least two reasons: first, the anaphoric definite noun phrase in (12a) is differently represented from other kinds of definite noun phrases; and second, the discourse referents are not represented together with the predicate by which they were introduced. We can modify this view by assuming that the discourse referent is represented together with the predicate by which

it is introduced. Such a predicate is represented as an ordered list of elements that fall under that predicate. Indefinite noun phrases not only introduce a new referent, they rather change the ranking of the given set: they raise their referent to the first position of the ordered set. So we assume the following dynamic mechanism with a change of the salience structure. The indefinite noun phrase *a bird* in (13a) introduces a new discourse referent  $d$  and puts it at the top position of the set representing the predicate *bird*. The definite noun phrase *the bird* in the second sentence can now be linked to the first element of the set of birds – a semantics that we have applied in the last section for definite noun phrases in general:

- (13) a. **A bird<sub>1</sub>** came . . . . **The bird<sub>1</sub>** was a warbler and flying [. . .]
- b.  $\{d \mid \text{Bird}(d) \ \& \ [\text{bird} \rightarrow \{d \succ \dots\}] \dots \text{the first element of } \{d \succ g \dots\}$   
 $\Phi_c(\{d \succ \dots\}) = d$
- 

The discourse referent is then the first element of an ordered set – think of it as the representative of that set. We could assume that the discourse consists of predicates (ordered sets) and discourse referents assigned to them. Such a discourse referent can be understood as the (most) salient of its kind. The context change potential of a sentence is reconstructed as the change of the assignment of discourse referents to the predicates. In such a structure, we can easily interpret an anaphoric definite NP – it is interpreted as the discourse referent assigned to the property expressed by their descriptive content, or to the first element.

Dynamic approaches like Discourse Representation Theory (DRT) or Dynamic Predicate Logic (DPL) primarily investigate cross-sentential anaphoric pronouns. There is one problem with these approaches, which can be illustrated by example (14) from Lewis (1979: 179): the pronoun *he* as well as the anaphoric definite noun phrase *the cat* in line (viii) has two potential antecedents or already established discourse referents; the discourse referent for the cat Bruce and the discourse referent for the New Zealand cat Bobby. DRT cannot tell which is the more appropriate one, but must rely on additional knowledge, which is indicated by co-indexing the anaphoric term with its antecedent. However, it is the anaphoric relation that the theory should explain and not have to rely on.

- (14) “the cat”
- i. Imagine yourself with me as I write these words. In the room is **a cat<sub>1</sub>**,  
Bruce<sub>1</sub>,
  - ii. who has been making **himself<sub>1</sub>** very salient by dashing madly about.
  - iii. **He<sub>1</sub>** is the only cat in the room, or in sight, or in earshot.
  - iv. I start to speak to you:
  - v. The **cat<sub>1</sub>** is in the carton. **The cat<sub>1</sub>** will never meet **our other cat<sub>2</sub>**,
  - vi. because **our other cat<sub>2</sub>** lives in New Zealand.
  - vii. **Our New Zealand cat<sub>2</sub>** lives with the Cresswells.
  - viii. And there **he<sub>2</sub>**’ll stay, because Miriam would be sad if **the cat<sub>2</sub>** went away.

It seems very obvious from the discourse structure that the pronoun *he* can only refer to the New Zealand cat Bobby and therefore must be linked to that discourse referent. Therefore, I assume that the anaphoric link should follow from the theory and not be part of the input. This restriction of dynamic theories like DRT and DPL is described by Muskens et al. (1997: 606):

Discourse Representation Theory models the way in which anaphoric elements can pick up accessible discourse referents, it tells us which referents are accessible at any given point of discourse, but it tells us little about the question of which referent must be chosen if more than one of them is accessible. There are of course obvious linguistic clues that restrict the range of suitable antecedents for any given anaphoric element (...).

In the following we will concentrate on the information that is supplied by the descriptive material of definite and indefinite NPs, which updates the salience structure of the discourse. The problem just illustrated can also be shown in an example with more descriptive content, as in (15), involving linguistic and encyclopedic knowledge. Here the anaphoric link can only be resolved if we use the descriptive content of the two potential antecedents and additional encyclopedic knowledge about the classification of maritime animals.

- (15) It was a clash between **a killer whale<sub>1</sub>** and **a great white shark<sub>2</sub>**. **The fish<sub>i</sub>** lost.  
i = 1 or i = 2??

#### 4 Saliency spreading

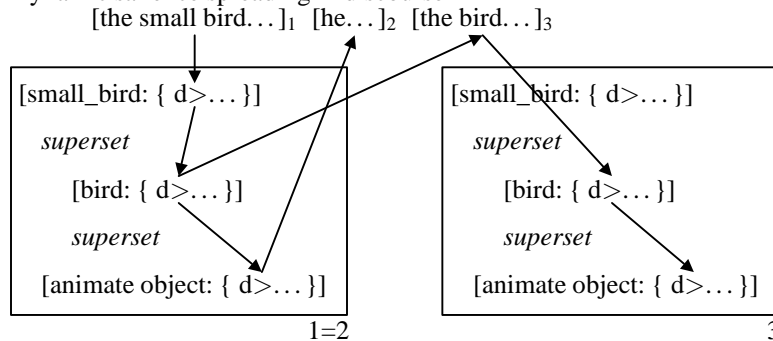
The formalism given in the last section must be modified in order also to catch the saliency-change potential of definite expressions. In the last section, it was assumed that definite noun phrases do not exhibit a saliency-change potential since they would raise to saliency an object that was already salient. However, example (16a), a slightly modified version of (2a), clearly shows that definite expressions can change the actual accessibility of a discourse referent. The definite *the small bird* refers to a small bird. The subsequent definite *the bird* 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 which I have termed “saliency spreading” (see von Heusinger 2003). The definite *the small bird* changes the most-accessible element of the set of small birds and that of the set of birds into the same element. Furthermore, the set of animate objects are also assigned the very same referent, accounting for the use of the pronoun *he*. The pronoun *he* in (16c) does not change the saliency structure. However, the definite noun phrase *the old man* changes the saliency structure for sets of old men, men, and animate objects (only the latter one represented in (16c)). Therefore, in the next sentence the definite noun phrase *the bird* is necessary to refer to *the bird* – the pronoun *he* would refer to the old man.

- (16) a. **The small bird** came toward the skiff from the north. **He** was a warbler and flying very low over the water. The old man could see that **he** was very tired. **The bird** made the stern of the boat and rested there.
- |                    |   |                                 |                             |
|--------------------|---|---------------------------------|-----------------------------|
| Saliency Structure | [bird → { ... }]  |                                 | [small bird → { ... }]      |
| b.                 | <b>The small bird<sub>1</sub></b> came ...                              | ↓                               | ↓                           |
|                    | updates to  | ↓                               | ↓                           |
|                    | Saliency Structure  | [bird → {d> ... }]              | [small bird → {d> ... }]    |
| c.                 | <b>He<sub>1</sub></b> was a warbler and flying very low over the water. |                                 | potential anaphors          |
|                    | updated Saliency Structure  | [small bird → {d> ... }]        | [[the small bird]] = d      |
|                    |   | [bird → {d> ... }]              | [[the bird]] = d            |
|                    |   | [animate → {d> ... }]           | [[he]] = d                  |
| d.                 | <b>The old man</b> could see that <b>he</b> was very tired              |                                 |                             |
|                    | updated Saliency Structure  | [small bird → {d> ... }]        | [[the small bird]] = d      |
|                    | Structure   | [bird → {d> ... }]              | [[the bird]] = d            |
|                    |   | [animate → { <b>m</b> >d ... }] | [[he]] = <b>m</b> = old man |

The example also shows that additional parameters such as grammatical relation and parallel structure must be considered for a more accurate model of salience. Centering Theory (Grosz et al. 1995) provides such rules for the resolution of anaphoric pronouns. It is primarily an approach to model the local coherence of discourse segments, rather than to account for definite noun phrases in a more global discourse structure. Thus, a combination of the proposed dynamic theory of salience and Centering Theory would give a more complete picture of anaphoric pronouns and anaphoric definite descriptions.

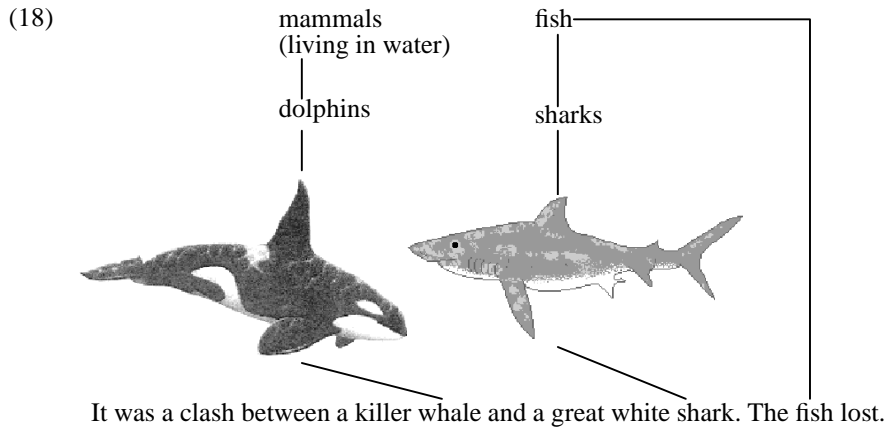
We can illustrate the salience spreading as in (17) where we have represented part of the salience structure in the boxes. The salience spreading is illustrated by the downward arrows, while the upward arrows indicate the licensing conditions for the different definite expressions: *he* refers to the small bird, since it is the most salient of the animate objects; while *the bird* refers back to the original discourse item, since it is the most salient or accessible referent, etc.

(17) Dynamic salience spreading in discourse



The box indicates a small fragment of the whole accessibility structure of the discourse. It also tries to indicate the dynamic change of the accessibility structure, which in this example is not very large. The noun phrase *the small bird* changes the most salient referent of the associated set and some supersets, the anaphoric pronoun *he* does not change the accessibility structure, however the anaphoric noun phrase *the bird* activates the referent back to the set of birds and animate objects. As long as no clear competition exists, this update does not change the most salient element, but it still seems necessary to raise the activation above a certain level.

With this semantics we can also account for example (15) as in (18):



The indefinite expression *a killer whale* not only updates the referent for the set of killer whales, but also the assigned referent for its supersets, dolphins and mammals, while the indefinite *a great white shark* updates the referent for great white sharks, sharks and fish, such that the anaphoric definite NP *the fish* can be linked to it.

(19) Context change potential of indefinite noun phrases and salience spreading

indef. NP	corresp. set	superset-1	superset-2	superset-3
<i>a killer whale</i>	<i>killer whales</i>	<i>dolphins</i>	<i>mammals</i>	<i>animals</i>
<i>a great white shark</i>	<i>great white sharks</i>	<i>sharks</i>	<i>fishes</i>	<i>animals</i>

### 5 Salience and the semantics of definite noun phrases

Once we have introduced the extended update potential for indefinite noun phrases, we can also assign it to definite noun phrases, which now not only (trivially) update the set their descriptive material denotes, but can also update the order in some supersets. With this mechanism we can account for the anaphoric relations and the shift of salience structure in (1a), repeated as (20) – Observation A:

(20) 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 a 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.

- a. Structure: *The younger waiter*<sub>1</sub> . . . *him*<sub>1</sub> . . . *the waiter*<sub>1</sub> . . . *The waiter who was in a hurry*<sub>2</sub> . . . *he*<sub>2</sub> . . . *the waiter*<sub>2</sub> . . . *his*<sub>2</sub> . . . *the unhurried waiter*<sub>1</sub>

The definite noun phrase *the younger waiter* refers to a discourse referent and raises this discourse referent to the most salient for the set of younger waiters, waiters and male humans, as listed in (21). So the subsequent expressions *he* and *the waiter* can refer (back) to the same referent. The definite noun phrase *the waiter who was in a hurry* raises its referent to the most salient for the waiters in a hurry, for waiters and for male humans, such that the subsequent definite expressions *he* and *the waiter* refer to that referent, explaining Observation A:

- (21) Context change potential of definite noun phrases and salience spreading

def. description	corresp. set	superset-1	superset-2
<i>the younger waiter</i>	<i>younger waiters</i>	<i>waiters</i>	<i>male humans</i> [he]
<i>the waiter who was in a hurry</i>	<i>waiters who were in a hurry</i>	<i>waiters</i>	<i>male humans</i> [he]

This picture also explains the distribution of anaphoric definite noun phrases and anaphoric pronouns. The latter do not have descriptive content, thus they cannot initiate a salience change nor a salience spreading. They refer to the most salient referent, but they do not change the salience structure, nor can they refer to referents that are (only) salient with respect to certain predicates, as in (22). The definite noun phrase *the bird* refers to the most salient bird, while a pronoun *he* would refer to the most salient object, which is at that point in the discourse the old man. At the same time, the anaphoric definite noun phrase *the bird* raises the salience of its referent such that the next pronoun *he* can refer to it. This is the first step to explaining Observation B.

- (22) a. **A small bird** came toward the skiff from the north. **He** was a warbler and flying very low over the water. The old man could see that **he** was very tired. **The bird** made the stern of the boat and rested there. Then **he** flew around the old man's head and rested on the line where **he** was more comfortable. (Hemingway 1962: 28; *The old man and the sea*)
- b. Structure: *A small bird ... he ... he ... the bird ... he ... he*

A more elaborated explanation must contain other cues for resolving anaphoric reference including the sentential context, selectional restriction, parallel structure etc. The full noun phrase is only necessary if other referential expressions change the salience structure. In the absence of any other referential expression one would predict very long anaphoric chains with pronouns, as this is illustrated by the following fragment from *The Name of the Rose* from Umberto Eco, p. 46:

I did not have time, however, to observe their work, because **the librarian** came to us. We already knew **he** was Malachi of Hildesheim. **His** face was trying to assume an expression of welcome, but I could not help shuddering at the sight of such a singular countenance. **He** was tall and extremely thin, with large and awkward limbs. As **he** took his great strides, cloaked in the black habit of the order, there was something upsetting about **his** appearance. The hood, which was still raised since **he** had come in from outside, cast a shadow on the pallor of **his** face and gave a certain suffering quality to **his** large melancholy eyes. In **his** physiognomy there were what seemed traces of many passions which **his** will had disciplined but which seemed to have frozen those features they had now ceased to animate. Sadness and severity predominated in the lines of **his** face, and **his** eyes were so intense that with one glance they could penetrate the heart of the person speaking to **him**, and read the secret thoughts, so it was difficult to tolerate their inquiry and one was not tempted to meet them a second time.

**The librarian** introduced us to many of the monks who were working at that moment. Of each, Malachi also told us what task he was performing [ . . . ]

Finally, the relations between the antecedent and the anaphoric expressions are licensed by lexical relations such as hyponymy or synonymy, or extensionally: a superset-relation and identity-relation. These relations are encoded in the lexicon and they do not add more information than is already given by the antecedent.

Therefore, the type (23a) and (23b) are called “semantic anaphora” since no additional information is necessary to establish the anaphoric link. This is the central case that is accounted for by the dynamic theory of salience presented above.

(23) Co-referential relations and the relations between the denoted sets

	<i>anaphoric link</i>	<i>semantic relation</i>	<i>set relation</i>
a	<i>a bird ... he, a small bird ... the bird</i>	superset	$  \text{bird}   \subseteq   \text{animals}  $ $  \text{small bird}   \subseteq   \text{bird}  $
b	<i>a bird ... the bird</i>	identical sets	$  \text{bird}   =   \text{bird}  $
c	<i>a small bird ... the beautiful animal</i>	intersection	$  \text{small bird}   \cap   \text{small animal}   \neq \emptyset$
d	<i>a bird ... the small bird</i>	subset	$  \text{bird}   \supseteq   \text{small bird}  $

The types (23c) and (23d) are said to license “pragmatic anaphora” since they need additional contextual information about the identity between the antecedent and anaphoric term. Often the contextual information is that there is no other suitable referent and therefore the anaphoric term has to be related to the antecedent. The additional descriptive content of the anaphoric expression is not asserted but added to the background. The use of such pragmatic anaphora are typical for texts in newspapers. It is still an open issue whether or not this type of anaphora should be modeled with the same dynamic mechanism of salience change as semantic anaphora<sup>1</sup>.

## 6 Summary

When we interpret a discourse, we link referential expressions to each other, thus reconstructing the coherence of the discourse. There are many aspects of the coherence structure that determine the exact conditions under which an anaphoric expression is linked to its antecedents. This paper has investigated how salience and anaphoric definite noun phrases interact. It was shown that salience is not only the general condition for definiteness, but also for anaphoricity. Additionally, it was argued that the process of salience spreading allows us to account for the

<sup>1</sup>One reviewer suggested to extend this semantically defined concept of salience to an even broader concept of salience that would also allow to include pragmatically given relations, as in (i). I agree that this would be an interesting and necessary extension of the given model in this paper. (i) My younger brother went out on a date yesterday; she was a really nice girl.

dynamic context change potential of definite noun phrases. Saliency is modeled as interrelated sets of ranked discourse referents. The relation between the sets is given by the lexical relations, but can also be extended by other contextually licensed relations. This model allows us to show the dynamic potential of definite noun phrases through the process of saliency spreading, which also accounts for the difference between anaphoric pronouns and anaphoric definite nouns.

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