

# Reference and Representation of Pronouns\*

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## 1. Introduction

Personal pronouns in the third person, such as English *he*, *she*, *it*, *they*, exhibit a great variety of referential properties for different functions in a sentence or a discourse. The difference in their referential behavior is not reflected in their lexical, morphological, or syntactic appearance and properties. This is illustrated by one of the most prominent contrasts in the referential behavior of pronouns: the contrast between their deictic and anaphoric uses. There are basically two options for the semantic representation: The first option remains close to the view that pronouns vary in their referential behavior; so they are represented in different ways. This is the assumption of most semantic theories (Geach 1962; Lasnik 1976; Evans 1980, etc.), which represent deictic pronouns as free variables, while anaphoric pronouns are copies of their antecedents, bound variables, or impoverished definite descriptions. The second option assumes that there is only one semantic representation reflecting the unity of the morphological form. The different referential properties are analyzed by using additional contextual parameters determining the interpretation; e.g., the difference between the deictic and the anaphoric use of a pronoun can be reduced to the influence of contextual parameters on the interpretation process.

In this paper, I defend the second option by a detailed analysis of cross-sentential pronouns. I assume that pronouns are interpreted as referring to the most salient element given so far: a deictic pronoun refers to an object that was raised to salience by the extra-linguistic context; an anaphoric pronoun refers to an item that was made salient by the linguistic context, e.g., by having been previously mentioned. The pronoun itself can be represented as an indexed epsilon term  $\epsilon x [P(x)]$  that is interpreted as referring to the most salient element with the property  $P$ . The argument is built on observations from the research tradition, systematic considerations, and on a close comparison with the analysis of definite NPs.

The paper is organized in the following way: Section 2 gives a very short overview of the treatment of deictic and anaphoric pronouns through history. Since classical times, deictic and anaphoric pronouns have been distinguished. The latter were regarded as copies of their antecedents, even though this view has been heavily criticized ever since it was formulated. In the last 30 years, new differences were discovered in the context of new semantic theories. Section 3 provides a systematic comparison of the properties of the mentioned groups of pronouns. Depending on the theoretical background, different classes are formed. Furthermore, there is no clear cut distinction between classes since features are shared across different classes. Starting from the three main principles for pronoun interpretations – binding, being an independent term, and salience – it will be shown that only the last principle is essential. Section 4 presents a similar situation which holds for definite NPs. There are different uses of definite NPs, similar to the uses of personal pronouns. Other than with pronouns, most semantic theories assume a uniform representation of definite NPs. Again, salience is presented as the basic principle of definiteness, and epsilon terms are introduced as the formal representation for definite NPs. They are interpreted by context dependent choice functions, which reconstruct the salience structure of the discourse. Section 5 applies this analysis to personal pronouns and shows that their different referential behavior can be explained by assuming that pronouns are represented by context dependent epsilon terms. It will be shown that the different uses of pronouns can be captured by different aspects of the salience structure of a text. Section 6 provides a short summary of the argument developed in this paper.

## 2. History of the analysis of pronouns

### 2.1 *The Greeks: deictic vs. anaphoric*

From the early investigation into linguistics and the categories of words, it became clear that personal pronouns in the third person have two quite different functions, although they have only one form. One of the earliest statements is the following of Apollonios Dyskolos of Alexandria (2nd cent. AD) in *περὶ ἀντωνυμίας* (*peri antonymias* “on pronouns”, p. 10 B, ed. J. Bekker, quoted according to Schneider 1965):<sup>1</sup>

Πᾶσα ἀντωνυμία ἢ δεϊκτικὴ ἴσται ἢ ἀναφορικὴ  
 pása antonymia ê deiktikê 'stin ê anaphorikê  
 every pronoun either deictic is or anaphoric  
 “Every pronoun is either deictic or anaphoric”

Since then several approaches have been undertaken to unify the two notions. To give only one example: Bühler (1934:385ff (§ 26 “Anaphora”)) tries to distinguish between different domains in which one and the same pronominal pointing-function (“Zeigefunktion”) operates: in one domain (the context) they result in deictic pronouns, in the other on (the symbolic field) they result in anaphoric pronouns.

## 2.2 Bloomfield: substitution

The structuralist Bloomfield (1933:251 (§ 15.4)) took pronouns – as their Latin name suggests – as standing for nouns. He describes the different functions of the pronouns *he* in chapter 15 “Substitution”, where he distinguishes between two types of substitution: anaphora and deictic use, which he calls “limitation”. He compares the deictic pronouns with definite NPs:

The meaning of the substitute *he* may be stated thus:

(...)

### B Substitution-types

1. *Anaphora*: *he* implies, in nearly all its uses, that a substantive designating a species of male personal objects has recently been uttered and that *he* means one individual of this species, say ‘recently mentioned’;

2. *Limitation*: *he* implies that the individual is identifiable from among all the individuals of the species mentioned; this element of meaning is the same as that of the syntactic category of definite nouns (§ 12.14) and can be stated, say as ‘identified’.

Following Bloomfield, American structuralism assumed a substitution function of pronouns (“pronominalization”), which was then inherited by transformational grammar as a “substitution transformation”. In this view, the pronoun replaces a copy of the syntactic expression of its antecedent. Such a pronoun is sometimes called “pronoun of laziness”.

This view works for proper names as in (1a): the pronoun *her* refers deictically to some salient female individual, while the pronoun *he* in the second sentence refers to its antecedent *John*. Both could be understood as substitutes for the full proper names as illustrated in (1b).

(1a) John met *her* for dinner. *He* had a wonderful evening.

(1b) John met *Mary* for dinner. *John* had a wonderful evening.

The substitution theory of pronouns had already been criticized by the Stoics. They illustrated this with the “nobody-paradox”. One cannot replace the pronoun *he* in (2a) by its antecedent *someone*, as in (2b) (cf. Egli 2000:19ff.):

- (2a) If *somebody* is in Athens, it is not the case that *he* is in Rhodes.  
 (2b) If *somebody* is in Athens, it is not the case that *somebody* is in Rhodes.

A second problem is illustrated by sentences with cross-reference, as in the famous Bach-Peter sentences. If we substitute the pronouns in (3a) by its antecedents, we get sentence (3b) where each substitute contains another pronoun which must be replaced the other substitute etc. By the structure of these examples, we will always end in a recursive structure which will never come to an end (cf. Bach 1970, Karttunen 1971).

- (3a) {The man who deserves [*it*]<sub>2</sub>}<sub>1</sub> will get [the price, {*he*}<sub>1</sub> desires]<sub>2</sub>.  
 (3b) {The man who deserves [the price, {*he*}<sub>1</sub> desires]<sub>2</sub>}<sub>1</sub> will get [the price, {the man who deserves [*it*]<sub>2</sub>}<sub>1</sub> desires]<sub>2</sub>.

### 2.3 Quine and quantifiers

Quine (1960:113 (§23)) criticizes the substitution method along the same line as the “nobody paradox” of the Stoics. The pronoun *it* cannot be supplanted by its antecedent if this is an indefinite term. The pronoun *it* “remains a definite singular term whether its antecedent is or not.” Quine (1960:103 (§21)) also notes that pronouns are short-handed for definite descriptions:

Often the object is so patently intended that even the general term can be omitted. Then, since ‘the’ (unlike ‘this’ and ‘that’) is never substantival, a *pro forma* substantive is supplied: thus ‘the man’, ‘the woman’, ‘the king’. These minimum descriptions are abbreviated as ‘he’, ‘she’, ‘it’. Such a pronoun may be seen thus as a short singular description, while its grammatical antecedent is another singular term referring to the same object (if any) at a time when more particulars are needed for its identification.

In § 28 “Some ambiguities of syntax”, Quine discusses another set of cases involving pronouns, as illustrated in (4a).

- (4a) Everything has a part smaller than it.

Quine calls this sentence ambiguous since the pronoun *it* can be co-referent – or “cross-referent” in Quine’s terminology – to the universal quantifier *everything* or to the indefinite *a part*. However, we cannot disambiguate the example by substituting the pronouns by its antecedent as argued before. Therefore, Quine

suggests that such pronouns are represented by variables that can be bound. So he (1960:137 (§28)) replaces the concept of *co-reference* by the principle of *binding* from of predicate logic:

Logicians happily have another terminology for talking of cross-reference, where variables are concerned: they speak of *binding*. The introductory or appositive occurrence of 'x' is said to *bind* the various recurrences of 'x', insofar as they hark back to that apposition and not to some independent use of the letter.

Generalizing Quine, the classical view assumes that all pronouns are represented as variables of predicate logic: Deictic pronouns are like unbound variables which must be given a value by contextual information as in (1c); and anaphoric pronouns are bound variables, which get the same value as their antecedent due to the formal rule of quantifier interpretation, as illustrated by the semantic representations (4b) and (5b) for the sentences (4a) and (5a). For the bound pronoun cases we additionally need co-indexing at the level of syntactic form, as in (4a') and (5a):

- (1a) John met *her* for dinner.
- (1c) Met\_for\_dinner(john, x) with x contextually determined
- (4a) Everything<sub>i</sub> has a part smaller than it<sub>i</sub>.
- (4b) x [thing(x) x [Part(y) & Smaller(y,x) & Has(x,y)]]
- (5a) Nobody<sub>i</sub> thought that he<sub>i</sub> was culprit.
- (5b)  $\neg$  x [Thought(x, (Culprit(x))]

The contrast between deictic pronouns as free variables and anaphoric pronouns as bound variables has been the classical semantic view since Montague. Anaphoric pronouns stand for the same semantic objects or referents as their antecedents, rather than for the same syntactic expression as in the structuralist and early transformational view presented in section 2.2. Note that this position does not reflect Quine's description of pronouns since for a certain class of pronouns he assumes that they are impoverished definite descriptions, rather than variables.

#### 2.4 Geach: Cross-sentential anaphoric pronouns

Geach (1962) shows that there are serious problems with the binding approach of the classical view for cross-sentential anaphoric pronouns since the scope of the binding operator is essentially defined in the limit of a sentence. This can be illustrated with examples like (6a), where the anaphoric pronoun *he* occurs in a separate sentence. In the representation (6b), the pronoun is represented as the

third occurrence of the variable  $x$ . In this position, the variable cannot be bound by the existential quantifier since it is outside of the scope of the quantifier:

- (6a) A man<sub>i</sub> walks. He<sub>i</sub> whistles  
 (6b)  $x$  [Man( $x$ ) & Walk( $x$ )] & Whistle( $x$ ) [problem of scope]

Given that the problem of binding can be solved by some way or other, there is a second problem of cross-sentential anaphoric pronouns, namely that the referent of the indefinite is determined before the anaphoric pronoun is resolved. This can lead to wrong interpretations – therefore, I call it the “problem of interpretation”. Assume a situation with two walking men: man<sub>1</sub> is not whistling and man<sub>2</sub> is. Intuitively, sentence (6a) is true in this situation since there is a man who is walking and whistling. For the interpretation of the two sentence we start with the first sentence, as illustrated in (6c). It becomes true if one man walks - let us say man<sub>1</sub>. Now we have fixed the referent for the indefinite NP, and the pronoun must get the same referent, namely man<sub>1</sub>. Since man<sub>1</sub> does not whistle, the second sentence becomes false and therefore the whole conjunct - contrary to our intuitions.

- (6c)  $\llbracket (6b) \rrbracket = 1$  iff [problem of interpretation]  
 $\llbracket x$  [Man( $x$ ) & Walk( $x$ )] = 1 &  $\llbracket$  Whistle( $x$ ) $\rrbracket = 1$   
 Situation: man<sub>1</sub>  $\llbracket$  Walk $\rrbracket$ , man<sub>2</sub>  $\llbracket$  Walk $\rrbracket$ , man<sub>2</sub>  $\llbracket$  Whistle $\rrbracket$   
 $\llbracket$  [Man( $x$ ) & Walk( $x$ )] = 1 for  $x = \text{man}_1$   
 $\llbracket$  Whistle( $x$ ) $\rrbracket = 0$  for man<sub>1</sub>; therefore  $\llbracket (6b) \rrbracket = 0$

Geach argues that we have to replace the classical existential quantifier, which is restricted to a sentence, by a textual existential quantifier. There are two steps in interpreting cross-sentential anaphoric pronouns: (i) the representation of the anaphoric link by using the same variable, and (ii) the binding of this variable at the level of a text with a new kind of existential operator  $\text{text}$ :

- (6d) (i) anaphoric resolution: Man( $x$ ) & Walk( $x$ ) & Whistle( $x$ ) ....( $x$ )...  
 (ii) binding at text-level:  $\text{text}x$  [Man( $x$ ) & Walk( $x$ ) & Whistle( $x$ ) ...]text

## 2.5 Dynamic semantics

Geach’s analysis of cross-sentential anaphoric pronouns conflicts with the principle of compositionality since Geach can only interpret the whole text, but not a particular sentence without its context. Two ways to solve this problem have been suggested: (i) dynamic semantics and (ii) E-type semantics, which I discuss in section 2.6. Dynamic semantics appears in different guises, e.g., as

File Change Semantics (Heim 1982), Discourse Representation Theory (Kamp 1981; Kamp & Reyle 1993), and Dynamic Predicate Logic (Groenendijk & Stokhof 1991). In the following, I sketch the principles of dynamic semantics by means of the example of Dynamic Predicate Logic (DPL). The basic idea of DPL is that the meaning of a sentence is not a truth value, but a contribution to change the context. The meaning can be expressed as a relation between two information states, an input and an output state. An information state can be constructed as a set of assignment functions. The basic idea is the same as in the Heim-Kamp theories, namely that an indefinite NP determines an assignment function for the variable that is introduced by the indefinite. The formalism passes this assignment function to the following text, and all subsequent occurrences of the variable receive the same value by the determined assignment function. DPL employs the traditional syntax of predicate logic, but interprets the symbols in a different way. In particular, the conjunction and the existential quantifier receive a dynamic interpretation that makes it possible to “bind” variables across the syntactic scope of the existential quantifier. Sentence (6a) is represented by the formula (6e), which is equivalent to (6f) due to the particular definition of the interpretation process, explained below.

$$\begin{aligned} (6e) \quad & \text{dyn}_x [\text{Man}(x) \ \&_{\text{dyn}} \ \text{Walk}(x)] \ \&_{\text{dyn}} \ \text{Whistle}(x) \\ (6f) \quad & \text{dyn}_x [\text{Man}(x) \ \&_{\text{dyn}} \ \text{Walk}(x) \ \&_{\text{dyn}} \ \text{Whistle}(x)] \end{aligned}$$

In the following I demonstrate the dynamic interpretation of Groenendijk & Stokhof (1991:46ff.) on the interpretation of the atomic formula (7b), of the conjunction (7c), and the existential quantifier (7d). In general, an expression is interpreted as the set of pairs of assignment functions  $g$  and  $h$ , such that  $g$  is the input assignment function and  $h$  is the output assignment function. Additional restrictions hold of these pairs – representing the information of the sentence. Thus an informative sentence reduces the set of input-output pairs. The interpretation (7b) of an atomic formula is static, i.e. the input function is the same as the output function. The interpretation only “tests” if the input function holds of the atomic sentence. The interpretation (7c) of the conjunction is dynamic: it introduces a new assignment function  $k$  that serves as output of the first conjunct and as input of the second. The interpretation (7d) of the existential quantifier is also dynamic: it changes the input function  $g$  to a new function  $k$  that maximally differs in the assignment of the variable  $x$ , written as  $k[x]g$ . In other words, the existential quantifier “updates” a given assignment function  $g$  for the value of the variable  $x$  it binds. The updated function is then the input function for the next expression (For convenience, I will suppress the index  $M$ ,  $g$  on the interpretation function  $\llbracket \cdot \rrbracket^{M,g}$ ):

- (7a)  $\llbracket \cdot \rrbracket = \{ \langle g, h \rangle \mid \text{restriction} \}$   
 (7b)  $\llbracket R(t_1, \dots, t_n) \rrbracket = \{ \langle g, h \rangle \mid h = g \ \& \ \langle \llbracket t_1 \rrbracket, \dots, \llbracket t_n \rrbracket \rangle \llbracket R \rrbracket \}$   
 (7c)  $\llbracket \cdot \ \&_{\text{dyn}} \cdot \rrbracket = \{ \langle g, h \rangle \mid k: \langle g, k \rangle \llbracket \cdot \rrbracket \ \& \ \langle k, h \rangle \llbracket \cdot \rrbracket \}$   
 (7d)  $\llbracket \text{dyn}^x \cdot \rrbracket = \{ \langle g, h \rangle \mid k: k[x]g \ \& \ \langle k, h \rangle \llbracket \cdot \rrbracket \}$

In this way the existential quantifier can “bind” across sentence boundaries, as it is illustrated for the interpretation of (6e) in (6g). First we introduce a new assignment function  $k$  that is the output of the first conjunct and the input of the second; the first conjunct updates the input function  $g$  to  $l[x]g$ , i.e.  $g$  modified for the value of  $x$ , and passes this function to the next conjunct such that the  $x$  in the second conjunct is assigned the same individual as the two occurrences of  $x$  in the first conjunct. Thus, the updated assignment function  $l[x]g$  assigns to all occurrences of  $x$  the same value or individual. Therefore, the interpretation of (6e) is equivalent to the one of (6f):

$$\begin{aligned}
 (6g) \quad \llbracket (6e) \rrbracket &= \{ \langle g, h \rangle \mid k: \langle g, k \rangle \llbracket \text{dyn}^x [\text{man}(x) \ \&_{\text{dyn}} \text{walk}(x)] \rrbracket \\
 &\ \& \ \langle k, h \rangle \llbracket \text{whistle}(x) \rrbracket \} \\
 &= \{ \langle g, h \rangle \mid k: \langle g, k \rangle \ \{ \langle g, h \rangle \mid l: l[x]g \ \& \ \langle l, h \rangle \llbracket \text{man}(x) \\
 &\ \&_{\text{dyn}} \text{walk}(x) \rrbracket \} \ \& \ \langle k, h \rangle \llbracket \text{whistle}(x) \rrbracket \} \\
 &= \{ \langle g, h \rangle \mid l[x]g \ \& \ \langle g, l \rangle \llbracket \text{man}(x) \ \&_{\text{dyn}} \text{walk}(x) \rrbracket \} \ \& \\
 &\ \langle l, h \rangle \llbracket \text{whistle}(x) \rrbracket \} \\
 &= \{ \langle g, l \rangle \mid l[x]g(x) \llbracket \text{man} \rrbracket \ \& \ l[x]g(x) \llbracket \text{walk} \rrbracket \ \& \ l[x]g(x) \\
 &\ \llbracket \text{whistle} \rrbracket \}
 \end{aligned}$$

Summarizing, dynamic semantics assume that anaphoric pronouns are variables that must be bound dynamically. Dynamic binding is reconstructed as the interaction of the context-change potential of certain expression with the interpretation of discourse items depending on the updated context.

## 2.6 Evans: E-type pronouns

Evans (1977; similar Cooper 1979, later Neale 1990 and Heim 1990) discusses another problem for Geach’s analysis and its reformulation in dynamic semantics. Evans argues that the representation of the pronoun *they* as a bound variable in (8b) does not give the correct truth conditions of the two sentences in (8a). Rather, (8b) is the representation for sentence (8c), where the quantifier is restricted by the content of the first sentence. However, in the intuitive interpretation of (8a), the quantifier phrase *few MPs* is not restricted by *came to the party* (otherwise the sentence would not make sense). The pronoun *they*

should be rephrased as *all the MPs who came to the party* as in (8d), and not represented as a bound variable.

- (8a) Few MPs came to the party, but *they* had a wonderful time.
- (8b) [Some:  $x$  MP:  $x$ ] (came to the party( $x$ ) & had a wonderful time ( $x$ ))
- (8c) Few (of the) MPs who came to the party had a wonderful time.
- (8d) Few MPs came to the party, but *all the MPs who came to the party* had a wonderful time.

The same problem arises for an analysis of sentence (9a) with a singular pronoun. Dynamic semantics represents it as (9b), where the pronoun is captured by the bound variable. However, this representation stands for sentence (9b), which intuitively expresses a different meaning than sentence (9a). Evans argues that a pronoun that is outside the syntactic scope of its antecedent quantifier – a so-called “E-type pronoun” – has to be represented by an independent term that refers to all the individuals that make the antecedent sentence true. Thus the pronoun in (9a) can be rephrased as *the man who drank champagne* in (9d). The best representation for this is a definite description as in (9e). Russell (1905) defines a definite description by the uniqueness of its descriptive material. In (9d) the pronoun *he* in (9a) is replaced by the definite description *the unique man who drank champagne*, which is represented with the corresponding iota-term  $x$  [ $Man(x)$  &  $Drank\_champagne(x)$ ]:

- (9a) Just one man drank champagne and he was ill.
- (9b)  $\exists x$  [ $Man(x)$  &  $Drank\_champagne(x)$  &  $Ill(x)$ ]
- (9c) Just one man both drank champagne and was ill.
- (9d) Just one man drank champagne and *the (unique) man who drank champagne* was ill.
- (9e)  $\exists x$  [ $Man(x)$  &  $Drank\_champagne(x)$ ] &  $Ill(\iota x$  [ $Man(x)$  &  $Drank\_champagne(x)$ ])

### 2.7 Functional pronouns

Another problem for binding approaches is the interpretation of so-called “paycheque pronouns” (cf. Karttunen 1969:114), which I will call “functional pronouns”. The pronoun *it* in (10a) does not refer to the same object as its antecedent *his paycheque*, they rather refer to different paycheques. The representation (10b) as a bound variable predicts a reading according to which we are talking about one and the same paycheque. The pronoun *it* stands for *his paycheque*, and represents a function  $f$  from men into their paycheques as in (10c); this function can be spelled out by a definite description as in (10d): “the

paycheque of  $y$ ” with  $y$  a free variable that must be either locally bound or supplied by the immediate context.<sup>2</sup>

- (10a) The man who gave his paycheque to his wife was wiser than the man who gave *it* to his mistress.
- (10b) There is an  $x$  such that  $x$  is a paycheque and it holds that the man who gave  $x$  to his wife was wiser than the man who gave  $x$  to his mistress.
- (10c) There is an  $f$  such that  $f(y)$  is a paycheque and it holds that the man<sub>1</sub> who gave  $f(\text{man}_1)$  to his wife was wiser than the man<sub>2</sub> who gave  $f(\text{man}_2)$  to his mistress.  
 $f$ : function from man into their paycheques
- (10d)  $x$  [Paycheque( $x$ ) & Owned( $x,y$ )]

Functional pronouns can be easily captured in theories that represent pronouns as definite descriptions. The difference between anaphoric pronouns and functional pronouns is that the former are represented by a definite description whose descriptive material is a one-place predicate, while for the latter, the descriptive material contains (at least) a two-place predicate, as in (10d).

To sum up, E-type approaches assume that pronouns are terms, i.e. definite description, rather than bound variables. The descriptive material of the definite description must be provided by the linguistic environment and the pragmatic context. The two main problems of E-type theories are (i) the uniqueness condition of the Russellian definite description standing for the pronoun. The representation with the Russellian description requires that there is only one such object in the relevant context. However, this is very often not the case. (ii) There is no convincing description for the mechanism of copying the descriptive material of the definite description (cf. Evans 1977, Cooper 1979, Neale 1990, Heim 1990).

### 2.8 Coreference and coindexing

Anaphoric pronouns (except for functional pronouns) are coreferential with their antecedents. This is explained either by binding the same variable (see section 2.4) or by some principle of copying the descriptive material of the antecedent into the pronoun (see section 2.6). However, in most semantic representations, coreference must already be assumed. It does not follow from the representation as such. Both families of approaches assume that the antecedent and the anaphoric expression are marked by the same index indicating coreference. Often, this is not necessary since in simple examples there are too few potential antecedents to see this problem. However, in the fragment (11) from Hemingway it becomes crucial.

- (11) A clean, well-lighted place  
 It was late and every one 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** took the brandy bottle and another saucer from the counter inside the café and marched out to **the old man’s** table. [...] **The waiter** took the bottle back inside the café. **He** sat down at the table with **his colleague** again.

The pronoun *he* in the last line could refer to any of the discourse items that are masculine: the two waiters or the old man. Neither dynamic theories nor E-type approaches can explain why the pronouns *it* refers to the last mentioned discourse item *the waiter*. For E-type theories, there is an additional problem: Once we have copied the material of *the waiter* into a definite description representing the pronoun, we get problems with the uniqueness condition since there are two waiters in the immediate context. The case clearly favors an analysis that is based on salience, which has to be constructed out of recency and other parameters. Here, we can neglect other parameters and reduce salience to recency: the last item mentioned is the most salient, and therefore picked up by the pronoun.<sup>3</sup> This idea is worked out in section 3.4.

### 3. Systematic classifications of pronouns

The historical survey has provided a great variety of ways pronouns can refer, and along with it a similar great variety of representations. For a clear classification we have to account for three main parameters: In section 3.1 I discuss cases, uses, or functions of pronouns, often illustrated by clear contrasts such as the contrast between deictic and anaphoric. In section 3.2, I describe the properties of this different uses of pronouns and assign them to the different groups. The main properties or principles according to which pronouns refer are: the principle of binding, the principle of being an independent term, and the principle of salience. In section 3.3, I show how the different uses are organized in groups or classes depending on the representational structure of the given theory. I compare dynamic approaches with E-type approaches. Finally in section 3.4, I argue that a third alternative is necessary: a theory that is based on the principle of salience.

### 3.1 Varieties of pronouns

Through the history of describing and analyzing personal pronouns, different groups of pronouns have evolved. We can summarize the groups following Evans (1980:337) except for the functional pronouns(v), which Evans would have included into group (iv).<sup>4</sup>

- (12) Different uses or groups of pronouns
  - (i) *Deictic pronouns*  
Pronouns used to make a reference to an object (or objects) present in the shared perceptual environment, or rendered salient in some other way.
  - (ii) *Pronouns of laziness*  
Pronouns intended to be understood as being coreferential with a referring expression occurring elsewhere in the sentence.
  - (iii) *Pronouns as bound variables*  
Pronouns which have quantifier expressions as antecedents, and are used in such a way as to be strictly analogous to the bound variables of the logician.
  - (iv) *E-type pronouns*  
Pronouns which have quantifier expressions as antecedents, but are standing outside of the scope of the quantifier. They are used as referring expressions.
  - (v) *Functional pronouns*  
Pronouns that do not refer to the same object as their antecedents. They “go proxy” for a functional concept with one open argument that must be filled by the immediate context.

### 3.2 Properties of pronouns

The characterization of the different groups include functional and representational contrasts. The different functions of pronouns are distinguished by various properties. In (13), I list some of the more prominent features: One of the main distinctions is the one into deictic vs. anaphoric (13a), while the distinction into coreferential pronouns vs. non-coreferential pronouns (13b) is rarely mentioned. Pronouns can receive their referent by the principle of salience as it is the case with deictic pronouns or pronouns of laziness or they (seem to) get their referent by (dynamic) binding (13c). Pronouns can also differ in the dependency from the context (13d). This feature differs from (13c) since it also includes functional pronouns (v), which need to be fed by some argument to be capable of reference. Furthermore, we can distinguish between pronouns inside or outside of the scope

of their antecedents (13e). This criterion is not applicable for deictic pronouns since they do not have a linguistic antecedent.

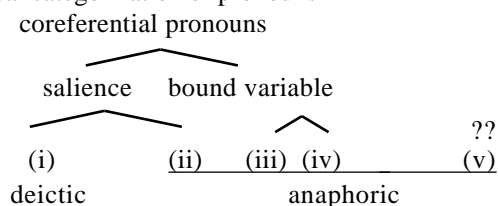
(13) The properties of pronouns

a	deixis	deictic: (i)	anaphoric: (ii)-(v)
b	coreference	coreferential with antecedent: (i)-(iv)	not coreferential with antecedent: (v)
c	salience/binding	value determined by salience: (i), (ii)	value determined by binding: (iii), (iv)
d	context/binding	depending on contextual information: (i), (ii), (v)	binding/copying material: (iii), (iv)
e	scope	in the scope of the antecedent: (ii), (iii)	outside of the scope of the antecedent (iv), (v)

3.3 Categorization of pronouns

Depending on the theory, the uses (or groups) of pronouns are categorized differently. The classical theory of pronouns (Geach 1962; Lasnik 1976; etc.) group (i) and (ii) into one category that is governed by the principle of salience, while the pronouns in groups (iii) and (iv) are represented as bound variables; group (v) was not regarded as a prominent case. The distinction into deictic vs. anaphoric cuts across this structure.

(14) Classical categorization of pronouns



Comparing the two main families of approaches to pronouns, we can summarize the characteristics in table ((15)). Deictic pronouns are represented by a free variable that must be interpreted according to a contextual parameter (which mirrors the salience structure of the context) (15a). Alternatively, in dynamic semantics, deictic pronouns can be represented by accommodation of the non-linguistic antecedent and then by binding. Coreference must be indicated by indexing in both kinds of approaches ((15b)). The main means of describing the anaphoric link is dynamic binding in dynamic semantics, and the use of definite descriptions in E-type theories ((15c)). For pronouns that are standing outside the

scope of their antecedents (and binder), dynamic binding as well as the representation by definite descriptions works well ((15d)) – it was exactly the case for which the two approaches were designed. However, as we saw in section 2.6, there are cases where the binding approach results in readings which are too strong (cf. examples (8) and (9)) ((15e)). Furthermore, dynamic semantics does not provide a representation for functional pronouns ((15f)), as discussed in section 2.7. On the other hand, E-type theories show problems with the mechanism of copying the material into the definite description (15g) and with the uniqueness condition of the Russellian definite description ((15h)).

- (15) Main characteristics of dynamic semantics and E-type theories with respect to the representation of pronouns

	<b>characteristics</b>	<b>dynamic semantics</b>	<b>E-type theories</b>
a	deictic pronouns	by a free variable	by a free variable
b	coreference	by indexing	by indexing
c	main means for describing the anaphoric relation	dynamic binding	definite descriptions
d	pronouns outside the scope of the antecedent	dynamic binding works well	definite description works well
e	restriction of the binder (cf. ex. (8) and (9))	too strong a representation	OK
f	functional pronouns	no representation	OK
g	copy of the descriptive material of the antecedent	not applicable	no clear mechanism
h	uniqueness condition	not applicable	highly problematic

### 3.4 *The salience approach*

The picture we get is that both families of approaches show serious problems: the binding approach produces representations that predict incorrect truth conditions (see the discussion of (8) and (9) above) and no representations for functional pronouns, while the question of how to copy the material for the definite description and the uniqueness condition is highly problematic for E-type theories. Therefore, a third type of semantic theory is called for: This theory is based on the third important principle of pronoun interpretation, the principle of salience. This principle is already necessary for explaining the reference of deictic pronouns and pronouns of laziness, (see (14)). And we will show that it can be extended to the other uses of pronouns as well. This view has been suggested at various times, e.g., Kripke (1991:95, n. 32):

(...) ‘he,’ ‘she,’ ‘that,’ etc. can, under various circumstances, refer to anything salient in an appropriate way. Being physically distinguished against the background is a property that may make an object salient; having been referred to by a previous speaker is another.

A similar statement was given by Bach (1994:315):

I argue (...) that anaphoric reference, the use of pronouns to refer to individuals previously mentioned, deserves no special semantic or syntactic consideration: being previously mentioned is simply one way of being salient. Unless the anaphoric reference is explicitly marked, by dedicated anaphors like reflexives and reciprocals, it is not a syntactic phenomenon.

The principle of salience is extended to the discourse: A discourse item can be salient due to the physical context or due to another linguistic expression that has been previously mentioned. However, this intuitively attractive view has never been worked out. Before such a theory is developed in section 5, I insert a short excursion to the treatment of definite NPs, which shows several analogous features. Furthermore, Bloomfield and Quine had already noted that anaphoric pronouns are a kind of “impoverished definite NP” (see sections 2.2-2.3). The treatment of anaphoric pronouns as E-type pronouns also showed the close relation between pronouns and definite NPs.

#### 4. Definite NPs and their representations

##### 4.1 Varieties of definite NPs

There are different uses or functions of definite NPs, just as there are different functions of pronouns. Among other uses, the following four are the most prominent ones – they can be paired with the uses of pronouns mentioned in (12) above

(16)	Different uses of definite NPs and uses of pronouns	
(i)	situationally salient def. NPs	deictic pronouns
(ii)	anaphoric def. NPs	anaphoric pronouns
(iii)	functional def. NPs	functional pronouns
(iv)	unique def. NPs	<i>no direct correspondence</i>

In (16i) the definite NP refers to a situationally salient object, as illustrated in sentence (17a) and (17b). Depending on the extra-linguistic context, the definite term refers to different objects. In (16ii), the definite NP is used anaphorically, i.e. it refers to an already established discourse item, as illustrated in (18a), (18b), or in the fragment (11) above. Here, the reference of the NP depends on the linguistic context and may change with the discourse, e.g., the referent of the term *the waiter* does change in the fragment (11) above. In (16iii), the definite NP is a functional expression and therefore refers to exactly one item. The reference can be determined by other contextual factors, such as time (president at what time?), but this use is less contextually dependent than the uses in (16i) and (16ii). In (16iv), the reference of the definite NP is exclusively determined by the lexical material: There is only one object that fulfills the descriptive content of the NP, as in examples (20a) and (20b):

- (17a) *The island* is beautiful.
- (17b) *The train* left two minutes ago.
- (18a) Once upon a time, there was a king, ... and *the king* ...
- (18b) ... except *an old man* who sat in the shadow the leaves [...] and...  
*the old man* was a little drunk (see (8)).
- (19a) *The father of Bertrand Russell* was a rich man.
- (19b) *The president of the US* is white.
- (20a) *The sun* is shining
- (20b) *The first man on the moon* was an American.

This very short survey of some of the most prominent uses of definite NPs illustrates that the reference of definite NPs is established by different principles: by salience, by anaphoric linkage, by functional concepts or by unique descriptions. Different families of approaches to definite NPs have been developed. Each approach takes one of the four principles as an essential principle and extends it to all other cases. In the following section I only present the classical theory of definite description developed by Russell (1905).<sup>5</sup>

#### 4.2 *The theory of definite NPs*

Russell's (1905) Theory of Descriptions is the clearest and the best understood approach to the semantics of definite NPs. It gives a clear formal representation of definite and indefinite NPs as quantifier phrases. The definite article and its indefinite counterpart are defined in the context of a sentence as quantifiers – their lexical meaning can be extracted via lambda-abstraction, as in (21). The indefinite article expresses existence, while the definite article expresses existence and

uniqueness. The complex quantifier representing the definite article can be abbreviated as the iota-operator “ $\iota$ ”:

- (21) The lexical meaning of the articles according to Russell (1905)
- $$\llbracket a \rrbracket = \exists x [Q(x) \ \& \ P(x)]$$
- $$\llbracket the \rrbracket = \exists x \ y [(Q(y) \ \& \ x = y) \ \& \ P(x)]$$
- $$= \exists x \ P[\iota x [Q(x)]] \text{ (according to a context-definition)}$$

Examples (22)-(24) illustrate how the semantics of the articles combine in a sentence with the descriptive material of the NPs. In (22a) the indefinite NP *a girl* is translated into the existential quantifier, while the definite NP *the girl* is translated into a iota-term in (22b) that includes an additional predicate *RESTR*. This predicate is necessary since there is more than one girl. Such a restriction must be explicitly or implicitly added to nearly any definite NP. The indefinite NP *a girl* in (23a) shows scope interactions with the universal quantifier in (23b) and (23c), while the definite NP *the girl with the red hair* can only receive wide scope with respect to the universal quantifier. However, the definite NP *the boy that brings her flowers* in (25a) has narrow scope with respect to the universal quantifier. In this example it is not even clear that there is a unique boy for each girl. The representations (26b) of the two definite NPs in (26a) raise additional questions: *the Queen* is a queen of some country – here indicated by the constant *c*, that must be given by the context. The definite NP *the island on Lake Constance* is not wellformed since there are at least three islands on that lake (see below for a detailed discussion):

- (22a) A girl laughs. The girl has red hair.  
 (22b)  $\exists x [Girl(x) \ \& \ Laugh(x)] \ \& \ Red\_hair(\iota x [Girl(x) \ \& \ RESTR(x)])$   
 (23a) Every boy dates a girl.  
 (23b)  $\forall x [Boy(x) \ \rightarrow \ \exists y [Girl(y) \ \& \ Date(x,y)]]$   
 (23c)  $\exists y [Girl(y) \ \rightarrow \ \forall x [Boy(x) \ \rightarrow \ Date(x,y)]]$   
 (24a) Every boy dates the girl with the red hair.  
 (24b)  $\forall x [Boy(x) \ \rightarrow \ Date(x, \iota y [Girl(y) \ \& \ Red\_hair(y)])]$   
 (25a) Every girl dates the boy that brings her flowers.  
 (25b)  $\forall x [Girl(x) \ \rightarrow \ Date(x, \iota y [Boy(y) \ \& \ Bring\_flower(y,x)])]$   
 (26a) The Queen visits the island on Lake Constance.  
 (26b)  $Visit(\iota x [Queen(x,c)], \iota y [Island\_on\_Lake\_Constance(y)])$

### 4.3 Definiteness and Saliency

Russell's Theory of Description cannot analyze all uses of definite NPs, even with the modification of adding an additional domain restriction. Therefore, a more general approach is necessary, which takes the situational use (16i) as the central one of definite NPs. The saliency approach essentially incorporates contextual information into the representation of a definite expression. The contribution of the context to the interpretation of the definite NP consists of a saliency hierarchy. It is assumed that each context can be associated with an ordering among the elements of subsets of the domain of discourse. The definite NP *the F* denotes the most salient F according to the situation *i*. This representation completes the ideas of discourse representation theories by producing a more comprehensive picture: a definite NP is not only linked to an already introduced discourse referent, rather it is linked to the most salient discourse referent of the same kind so far. The idea of a saliency hierarchy as part of contextual information can be illustrated by the following. Let us assume that there are three islands on Lake Constance: Mainau, Reichenau and Lindau. Depending on my location, the three islands are ranked differently. The definite NP *the island* always refers to the highest ranked element. E.g., located in Konstanz, I probably refer to the Mainau with the definite NP *the island*, while the same term refers to the Reichenau if uttered in Allensbach (a small village opposite to that island), etc.

(27a) The islands on Lake Constance: Mainau, Reichenau, Lindau

Location	Saliency hierarchy	reference
Constance	Mainau > Reichenau > Lindau	Mainau
Allensbach	Reichenau > Mainau > Lindau	Reichenau
Friedrichshafen	Lindau > Reichenau > Mainau	Lindau

The saliency theory of definiteness has three historical sources: first, Lewis (1979) criticizes Russell's Theory of Descriptions and sketches an alternative theory using a saliency ranking instead of Russell's uniqueness condition. Second, the investigation of the Prague School (cf. Sgall et al. 1973; Hajicová 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 saliency (cf. Grosz et al. 1995). In the following, I am referring to Lewis' basic ideas:

Lewis (1970:63) mentions the concept of saliency in the philosophical and linguistic discussion of the Russellian Theory of Descriptions:

Second, consider the sentence ‘The door is open’. This does not mean that the one and only door that now exists is open; nor does it mean that the one and only door near the place of utterance, or pointed at, or mentioned in previous discourse, is open. Rather it means that the one and only door among the objects that are somehow prominent on the occasion is open. 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. It will be determined, on a given occasion of utterance of a sentence, by mental factors such as the speaker’s expectation regarding the things he is likely to bring to the attention of his audience.

Lewis (1979:178) rejects Russell’s uniqueness condition for definites or any modified version of it: “It is not true that a definite description ‘the F’ denotes x if and only if x is the one and only F in existence. Neither is it true that ‘the F’ denotes x if and only if x is the one and only F in some contextually determined domain of discourse.” The definite NP must refer uniquely according to another and more general principle. Lewis (1979:178) names this principle *salience*:

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.

#### 4.4 *Salience, epsilon terms, and choice functions*

The concept of salience was never formally reconstructed although it was informally regarded as an essential part of fixing the referent of definite expressions. In this section, I develop a formal reconstruction of salience by means of indexed epsilon terms that are interpreted as context dependent choice functions. Choice functions have recently become a fashionable tool for representing indefinites (cf. Reinhart 1992, Winter 1997, Kratzer 1998, von Stechow 2000). We will not discuss this aspect of choice functions here, but concentrate on the application of choice functions to definite expressions. As semantic characterization for the definite article we will use the epsilon operator that was introduced into metamathematics by Hilbert & Bernays (1939).

The epsilon operator corresponds to a choice function that assigns to each nonempty set one element of this set. An empty set will be assigned an arbitrary element. Like the iota operator, the epsilon operator forms a term from a predicate. Unlike the iota operator, it does not express the uniqueness condition. The main difference may be shown by the formalization and the paraphrase of the description *the island*, as given in (28a) and (28b):

- (28a)  $x$  [island( $x$ )] the **unique**  $x$ , such that  $x$  is an island  
 (28b)  $x$  [island( $x$ )] the **selected**  $x$ , such that  $x$  is an island

Definite descriptions as epsilon terms do not require any uniqueness condition like the Russellian definite descriptions. Since the uniqueness condition has raised several problems for definite descriptions, as well as E-type pronouns, epsilon terms are the more adequate representation for definite description. However, in the representation (28b), they are not flexible enough. Depending on a physical context or a certain discourse, a definite NP can refer to different objects. Therefore, we assume different salience structures and incorporate different choice functions into our model:  $M = \langle D, I, 1, 2, 3, \dots, n \rangle$ . A choice function  $c_i$  is a function that assigns to a set  $s$  one of its elements, as in (29). On the side of the syntactic representation, we mark the particular contextually given salience structure by an index on the epsilon term. The definite NP *the F* is represented as an epsilon term which depends directly on the given context (standing for a salience hierarchy). It is interpreted as the operation of the given or actual choice function (= salience ranking) applied to the set of Fs. It yields the actual most salient F:

- (29)  $(s) \quad c_i(s) = s$  if  $s \neq \emptyset$  and  $(s) \quad c_i(s) = D$  if  $s = \emptyset$   
 (30) the F:  $\llbracket \epsilon x Fx \rrbracket^{M,g} = c_i(\llbracket F \rrbracket^{M,g})$  with  $i$  contextually determined

The salience hierarchy can also be changed by the linguistic context as assignment functions are dynamically updated (see section 2.5). An NP like *a girl* updates the current choice function  $c_i$  (representing the salience structure) by promoting the referent  $d$  of *a girl* to the most salient individual of the set of girls. This can be formalized as  $\llbracket \llbracket \text{Girl} \rrbracket, d \rrbracket$ , meaning that this function selects out of the set of girls the object  $d$ ; for all other sets it selects the same element as the original function  $c_i$ . The context – or better, salience – change potential of linguistic expression are modeled on the same lines as in dynamic semantics except for the assumption that the choice function  $c_i$  is updated, rather than the assignment function  $g$ ; see Peregrin & von Heusinger (2001) for a detailed analysis.

With this representation for definite NPs in general, we can account for the particular cases mentioned in (22)-(26) by one and the same representation: an indexed epsilon term. Here I present only the cases that are problematic for the Russellian analysis with the uniqueness condition: The anaphoric definite NP *the girl* in (22a) is represented as index epsilon term. The interpretation depends on an updated choice function  $\llbracket \llbracket \text{Girl} \rrbracket, d \rrbracket$  such that the referent for the indefinite is also the referent for the definite. Thus we do not need to insert any additional

restriction, as in (22b) above. The situational dependency of the definite NP *the island* in (26a) is also resolved by the dependency on the given context *i* in (26c).

- (22a) A girl laughs. The girl has red hair.  
 (22c)  $x$  [Girl( $x$ ) & Laugh( $x$ )] & Red\_hair(  $i$ x [Girl( $x$ ) ] )  
 (26a) The Queen visits the island on Lake Constance.  
 (26c) Visit(  $i$ x [Queen( $x$ , $c$ )],  $i$ y [Island\_on\_Lake\_Constance( $y$ )] )

In this section, I have argued that most semantic theories assume a uniform representation for definite NPs even though the same theories do not give a uniform representation for pronouns, which show a similar variety of uses. I presented the Russellian uniqueness theory and argued that it only covers a restricted set of definite NPs. Alternatively, I developed the salience theory of definiteness as formal reconstruction of definiteness. The reconstruction of the principle of salience was presented with choice functions and definite NP received a uniform representation as indexed epsilon terms. The problematic uniqueness condition was replaced by the principle of choice and the contextual influence on the interpretation of definite NPs was acknowledged by introducing the situational index on the epsilon term, indicating different possible salience structures.

## 5. Pronouns and Salience

Anaphoric pronouns in the third person singular are “impoverished” definite NPs. This claim can be traced back through the literature. Bloomfield (1933:251 (§ 15.4)) noted that “[deictic, KvH] *he* implies that the individual is identifiable from among all the individuals of the species mentioned; this element of meaning is the same as that of the syntactic category of definite nouns (...)” (see also the discussion in section 2.2). Quine (1960:103 (§21)) observes that “minimum descriptions are abbreviated as ‘he’, ‘she’, ‘it’. Such a pronoun may be seen thus as a short singular description (...)” (see the discussion in section 2.3). Finally, the discussion of E-type pronouns in section 2.6 has shown that (at least) certain pronouns are best represented as definite NPs.

In this final section, I apply to pronouns the salience semantics developed in the last section for definite NPs. In the last section, it was shown how this salience structure is reconstructed using choice functions as part of the model. There are two sides of this salience structure: on the one hand, NPs change or update a given salience structure, and on the other hand, definite NPs are interpreted according to the (updated) salience structure. In this view, the salience structure is that part of the context that is necessary to interpret definite expressions.

We can now introduce a uniform representation of pronouns as indexed epsilon terms with minimal descriptive content. E.g., in English the pronoun *he* expresses that it is the most salient object of the set of male individuals, *she* the most salient one of the set of female individuals, etc.

- (31a) he:  $\llbracket \_i x [\text{Male}(x)] \rrbracket = \_i(\llbracket \text{Male} \rrbracket)$  with  $i$  contextually determined  
 (31b) she:  $\llbracket \_i x [\text{Female}(x)] \rrbracket = \_i(\llbracket \text{Female} \rrbracket)$  with  $i$  contextually determined  
 (31c) it:  $\llbracket \_i x [\text{Neuter}(x)] \rrbracket = \_i(\llbracket \text{Neuter} \rrbracket)$  with  $i$  contextually determined<sup>6</sup>

This representation of pronouns depends on the salience structure of the context. In order to allow for anaphoric links to other expressions, the salience change potential of NPs must be modified. In our first version, an NP such as *a girl* updates the salience for the set of girls. However, for an anaphoric link with a pronoun, the NP must also change the salience structure of the set of all female individuals. So it is assumed that an NP not only updates the salience structure for the set it describes, but also for supersets. This is illustrated by the following situation (for a more detailed account, see Peregrin & von Heusinger 2001). Assume that we have three girls: Ann, Babs and Chris, and two women: Mary and Nancy. Our starting choice functions  $\_i$  selects Babs out of the set of girls (for *the girl*), Mary out of the set of women (for *the woman*), and Chris out of the set of all female individuals (for *she*), as illustrated in (32). Now we utter the sentence (22a), repeated as (33a). The salience change potential of a girl updates the salience structure for the set of girls and the set of all female individuals - for both sets the referent of *a girl*, let's say Ann, becomes the most salient one.

- (32) situation  $\llbracket \text{Girl} \rrbracket = \{\text{ann, babs, chris}\}$   
 $\llbracket \text{Woman} \rrbracket = \{\text{mary, nancy}\}$   
 $\llbracket \text{Female} \rrbracket = \{\text{ann, babs, chris, mary, nancy}\}$   
 the girl:  $\_i(\llbracket \text{Girl} \rrbracket) = \text{babs}$   
 the woman:  $\_i(\llbracket \text{Woman} \rrbracket) = \text{mary}$   
 she:  $\_i(\llbracket \_i x [\text{Female}(x)] \rrbracket) = \text{chris}$
- (33a) A girl laughs.  $\_i$  (is updated to  $\_{i+1} = \_i(\llbracket \text{Girl} \rrbracket, \text{ann})[\llbracket \text{Female} \rrbracket, \text{ann}]$ )  
 (33b) She has red hair. she:  $\_{i+1}(\llbracket \text{Female} \rrbracket) = \text{ann}$   
 (33b) The girl has red hair. she:  $\_{i+1}(\llbracket \text{Girl} \rrbracket) = \text{ann}$

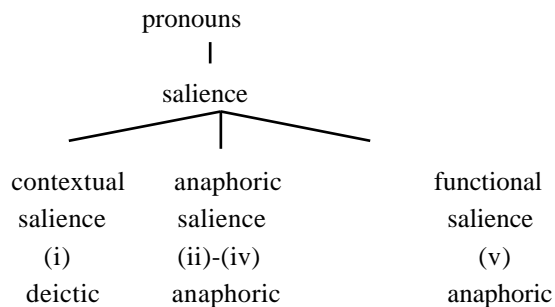
With this uniform representation for pronouns and the salience change potential of NPs, we can account for the different uses discussed in section 3.1. In the case of a deictic pronoun as in (1a), repeated as (34a), the index of the epsilon term is determined by the context, as in (34b). Thus the term refers to the most salient

female individual in the context according to the given salience structure. The pronoun of laziness *he* in the second sentence of (1a), repeated as (35a), is also represented as an indexed epsilon term. Here the index *i* is marked with “+1” indicating that the salience structure was updated by previously mentioned John: John has become the most salient man such that the pronoun refers to John. E-type pronoun case works similarly, except that here the indefinite NP *a man* has raised its referent to salience such that the updated salience structure takes it as the most salient male individual. The pronoun refers to it via its representation as epsilon term.

- (34a) John met *her* for dinner *deictic pronouns*
- (34b) Met\_for\_dinner(john,  $\epsilon_x$  [Female(x)]) the most salient female in the context
- (35a) He had a wonderful evening *pronoun of laziness*
- (35b) Have\_a\_wonderul\_evening(  $\epsilon_{i+1}$  x [Male(x)])
- (36a) A man walks. He whistles *E-type pronouns*
- (36b) ... & Whistle(  $\epsilon_{i+1}$  x [Male(x)]) i+1 the salience hierarchy updated by *a man*

With this very short sketch on how to present deictic and anaphoric pronouns with indexed epsilon terms, I conclude the argument. The overall picture of the different groups of pronouns can be given as in (30): All different uses are governed by the principle of salience, depending on contextual or discursive means. Functional pronouns take functional concepts as the domain of choice.

(37) categorization of pronouns as indexed epsilon terms



**6 Summary**

In this paper I have argued that pronouns have a uniform semantic representation, even though they show quite different referential behavior. Pronouns are understood as referring to the most salient individual in the context so far, and are represented as indexed epsilon terms that are interpreted by a choice function. The

choice function reconstructs the salience structure of the context. NPs change the salience structure by updating the choice function for the set they describe and some supersets. Interpreted by the updated choice function, the pronoun refers to the same referent as its antecedent. Thus, the semantics of pronouns in the third person is explained on the same line as the semantics of definite NPs.

### References

- Bach, Emmon 1970. Problominalization. *Linguistic Inquiry* 1, 121-122.
- Bach, Kent 1994. *Thought and Reference*. Oxford: Clarendon.
- Bloomfield, Leonard [1933] 1967. *Language*. Repr. d. Ausg. 1933. London: Allen & Unwin.
- Bosch, Peter 1983. *Agreement and Anaphora*. New York: Academic Press.
- Bühler, Karl [1934] 1982. *Sprachtheorie. Die Darstellungsfunktion von Sprache*. Mit e. Geleitw. von Friedrich Kranz. Ungekürzter Neudr. d. Ausg. Jena: Fischer 1934. Stuttgart; New York: Fischer.
- Cooper, Robin 1979. "The Interpretation of Pronouns". In: F. Heny & H. S. Schnelle (eds.). *Syntax and Semantics 10: Selections from the Third Groningen Round Table*. New York: Academic Press, 61-92.
- Egli, Urs 2000. "Anaphora from Athens to Amsterdam". In: K. von Heusinger & U. Egli (eds.). *Reference and Anaphoric Relations*. Dordrecht: Kluwer, 17-29.
- Evans, Gareth 1977 . "Pronouns, Quantifiers and Relative Clauses (I)". *Canadian Journal of Philosophy* 7, 467-536.
- Evans, Gareth 1980. Pronouns. *Linguistic Inquiry* 11, 337-362.
- Geach, Peter 1962. *Reference and Generality. An Examination of Some Medieval and Modern Theories*. Ithaca/NY: Cornell University Press.
- Groenendijk, Jeroen & Stokhof, Martin 1991. Dynamic Predicate Logic. *Linguistics and Philosophy* 14, 39-100.
- Grosz, Barbara & Joshi, Aravind & Weinstein, Scott 1995. Centering: A Framework for Modeling the Local Coherence of Discourse. *Computational Linguistics* 21, 203-225.
- Hajicová, Eva & Hoskovec, Tomáš & Sgall, Petr 1995. Discourse Modelling Based on Hierarchy of Salience. *The Prague Bulletin of Mathematical Linguistics* 64, 5-24.

- Heim, Irene 1982. *The Semantics of Definite and Indefinite Noun Phrases*. Ph.D. Dissertation. University of Massachusetts, Amherst. Ann Arbor: University Microfilms.
- Heim, Irene 1990. E-Type Pronouns and Donkey Anaphora. *Linguistics and Philosophy* 13, 137-177.
- von Heusinger, Klaus 2000. "The Reference of Indefinites". In: K. von Heusinger & U. Egli (eds.). *Reference and Anaphoric Relations*. Dordrecht: Kluwer, 247-265.
- Hilbert, David & Bernays, Paul [1939] 1970. *Grundlagen der Mathematik*. Vol. II. 2. ed. Berlin; Heidelberg; New York: Springer.
- Kamp, Hans 1981. "A Theory of Truth and Semantic Interpretation". In: J. Groenendijk & T. Janssen & M. Stokhof (eds.). *Formal Methods in the Study of Language*. Amsterdam: Amsterdam Center, 277-322.
- Kamp, Hans & Reyle, Uwe 1993. *From Discourse to Logic. Introduction to Modeltheoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory*. Dordrecht: Kluwer.
- Karttunen, Lauri 1969. Pronouns and Variables. *Papers from the Fifth Regional Meeting of the Chicago Linguistic Society*. Chicago: University of Chicago Press, 108-115.
- Karttunen, Lauri 1971. Definite Descriptions with Crossing Coreference. *Foundations of Language* 7, 157-182.
- Kratzer, Angelika 1998. "Scope or Pseudoscope? Are there Wide-Scope Indefinites". In: S. Rothstein (ed.). *Events and Grammar*. Dordrecht: Kluwer, 163-196.
- Kripke, Saul [1977] 1991. "Speaker's Reference and Semantic Reference". In: S. Davis (ed.). *Pragmatics: A Reader*. Oxford: Oxford Univ. Press, 77-96. [First published in: *Midwest Studies in Philosophy* 2, 255-276.]
- Lasnik, Howard 1976. Remarks on Coreference. *Linguistic Analysis* 2, 1-22.
- Lewis, David 1970. General Semantics. *Synthese* 22, 18-67.
- Lewis, David 1979. "Scorekeeping in a Language Game". In: R. Bäuerle & U. Egli & A. von Stechow (eds.). *Semantics from Different Points of View*. Berlin; Heidelberg; New York: Springer, 172-187.
- Löbner, Sebastian 1985. Definites. *Journal of Semantics* 4, 279-326.
- Peregrin, Jaroslav & von Heusinger, Klaus 2001. "Dynamic Semantics with Choice Functions". In: H. Kamp & B. Partee (eds.). *Context Dependence in the Analysis of Linguistic Meaning*. Amsterdam: Elsevier Science.
- Quine, Willard Van Orman 1960. *Word and Object*. Cambridge/Mass.: MIT Press.

- Reinhart, Tanya 1992. "Wh-in-situ: An Apparent Paradox". In: P. Dekker & M. Stokhof (eds.). *Proceedings of the Eighth Amsterdam Colloquium*. ILLC. University of Amsterdam, 483-491.
- Russell, Bertrand 1905. On Denoting. *Mind* 14, 479-493.
- Schneider, Richard [1878] 1965. *Apollonii Dyscoli quae supersunt. Scripta minora a Richardo Schneider edita continens*. Nachdr. d. Ausg. 1878/1902. Hildesheim: Olms. (Grammatici graeci 2,1)
- Sgall, Petr & Hajicová, Eva & Benesová, Eva 1973. *Topic, Focus and Generative Semantics*. Kronberg/Taunus: Scriptor.
- Sperber, Dan & Wilson, Deirde 1986. *Relevance*. Oxford. Blackwell.
- Winter, Yoad 1997. Choice Functions and the Scopal Semantics of Indefinites. *Linguistics and Philosophy* 20, 399-467.

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<sup>1</sup> I focus on pronouns in the third person singular. Pronouns in the first and second person do not exhibit such a rich referential behavior as they are primarily deictic expressions. Plural pronouns show additional complications of forming sets from explicitly or implicitly given discourse referents (cf. Kamp & Reyle 1993, chapt. 4). However, this process of set-formation is independent from the referential properties of the pronouns. Therefore, I on third person singular pronouns in this study.

<sup>2</sup> There is no formal account of how this free variable is instantiated - by binding or by contextually given information. However, there seems to be some restriction that derives from the antecedent expression: the *it* stands for *his paycheck* such that the missing argument must be male.

<sup>3</sup> One reviewer noted that pronouns are resolved according to different pragmatic principles like parallelism, grammatical function of the antecedent, level of embedding etc., among which salience is only one parameter. I do not assume that salience is the unique principle for resolving pronouns, but I assume that it is a semantic parameter that can be formally reconstructed, as will be shown below. Ruth Kempson made me aware of the fact that salience is not just

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"recency" and has to be computed (in some sense) in conjunction with derivability of appropriate inferential effects. See Sperber & Wilson (1986) for an informal description of this interaction. For the present study I abstract from this additional complication.

<sup>4</sup> Purely syntactic pronouns such as reflexives or reciprocals as well as non-referential pronouns are not included in this list. I do not have anything to say about non-referential pronouns (but see Bosch 1983, chapt. 4). For reflexives and reciprocals, I assume that they are treated according to class (iii) as bound variables with some additional restrictions. The focus of this investigation are the referential properties of pronouns - so I concentrate on the cross-sentential occurrence.

<sup>5</sup> Besides Russell's classical Theory of Descriptions, the most influential theories are: Heim (1982) and Kamp's (1981) Familiarity theory, and Löbner's (1985) functional approach to definite expressions. Although the theories are confronted with the multiple uses of definite NPs, they assume that there is only one underlying meaning of the definite NP that can be found in all of its uses. However, each of the theories chooses a different use of definite NPs as the primary one and gives an adequate analysis of this use. The analysis is then extended to the other uses. The three theories are successful in their primary area, but they cannot convincingly describe other uses of definite NPs. Therefore, a more general approach becomes necessary, which is presented in section 4.3.

<sup>6</sup> A reviewer noted that the use of the English pronouns *it* indicates that the referent is [- human], rather than the grammatical category *neuter*.