# Evidence for four basic noun types from a corpus-linguistic and a psycholinguistic perspective

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## Introduction*

Löbner (2011) proposes a distinction of four basic noun types corresponding to their respective concepts (sortal, relational, functional and individual concepts). A crucial claim of his theory of concept types and determination is that the different noun types are inherently predisposed to certain modes of determination. This paper surveys and discusses the findings from current research on the topic from two research methods that complement each other. First, we report two corpus-linguistic studies on the four noun types that combines an analysis of the different modes of determination with an analysis on associative anaphors in a German text collection. Second, we present a new psycholinguistic study testing reaction times to the noun types with different modes of determination. In all studies evidence was obtained to support the hypothesis that nouns are lexically specified with respect to the conceptual features uniqueness and relationality but that a relatively high proportion of their actual uses is incongruent with their lexical specification. The data are not yet conclusive as to whether or not incongruent uses affect word recognition or involve a cognitive type shift operation as assumed by Löbner (2011).

# 1   The theory of concept types and determination (CTD)

In his theory of concept types and determination, Löbner (2011) proposes a distinction of four basic noun types: sortal nouns, individual nouns, relational nouns, and functional nouns. The distinction is based on the particular values of two binary properties: inherent (non) relationality [±R][1] and inherent (non)uniqueness [±U]. The distinction between relational nouns (*leg, sister, branch, head*) and nonrelational nouns (*man, stone, snake, Peter*) has long been observed and discussed in the literature (cf. Behaghel 1923, Barker 1995, Partee 1997(1983), Vikner & Jensen 2002), the crucial difference being that relational nouns require the specification of an additional argument ("possessor argument") for reference, whereas nonrelational nouns do not. Vikner & Jensen argue that relational nouns provide an inherent relationship to their respective possessor argument whereas the interpretation of nonrelational nouns is established in the particular context of utterance and may be of various kinds ("lexical interpretation" vs. "pragmatic interpretation", Vikner & Jensen 2002: 195).

The second property ascribed to nouns in CTD is inherent (non)uniqueness. Löbner (2011) argues that nouns can be distinguished into those that are inherently unique (*father, weather, head, Peter*) and those that are nonunique (*sister, man, branch, snake*). The distinction is based on the following assumption (2011: 284): "unique nouns 'say': this is the description of the referent, in the given context of utterance there is exactly one that fits it. [−U] nouns 'say': this is the description of the referent (it need not be unique)." Löbner derives four types of nouns from the potential values of each referential property and claims that their corresponding concept types, i. e., the specific combination of the referential properties [±R] and [±U], are stored in the mental lexicon. Sortal nouns (SC; *stone, flower, car*) are [−R] and [−U], individual nouns (IC; *weather, moon, Peter*) [−R] and [+U], relational nouns (RC; *sister, branch, leg*) [+R] and [−U], and functional nouns (FC; *father, head, president*) [+R] and [+U]. In contrast to relational nouns, functional nouns provide exactly one referent if the possessor is a uniquely determined argument.

On the basis of this noun type (or concept type, respectively) distinction, Löbner (2011) develops a theory that integrates noun semantics and uses of determination. We summarize the major claims that are relevant here as follows: (1) Due to its particular combination of inherent referential properties, each noun type

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[1]   Square brackets indicate referential properties.

is predisposed to certain modes of determination in a language. (2) Many nouns are polysemous, and the different meaning variants of a noun may be of different types. (3) The different modes of determination in a language show inherent pre-dispositions to certain noun types. Löbner classifies a selection of English modes of determination with respect to their congruency with the different noun types. However, the theory explicitly accepts uses that are not in accordance with their predispositions. (4) Matching uses of noun type and mode of determination are called 'congruent', others 'incongruent'. (5) Congruent uses preserve the noun type whereas incongruent uses lead to a type shift. Table 1 lists the modes of determination and indicates whether they are congruent (✓) or incongruent (↦) with the respective noun type.

| | [–U] | inherently unique [+U] |
|---|---|---|
| [–R] | **Sortal Nouns** *stone book adjective water* ✓ indefinite, plural, quantifier, demonstrative ↦ singular definite ✓ absolute ↦ relational, possessive | **Individual Nouns** *moon weather date Maria* ↦ indefinite, plural, quantifier, demonstrative ✓ singular definite ✓ absolute ↦ relational, possessive |
| inherently relational [+R] | **Relational Nouns** *sister leg part attribute* ✓ indefinite, plural, quantifier, demonstrative ↦ singular definite ↦ absolute ✓ relational, possessive | **Functional Nouns** *father head age subject* (gramm.) ↦ indefinite, plural, quantifier, demonstrative ✓ singular definite ↦ absolute ✓ relational, possessive |

Table 1: Types of nouns and modes of determination (Löbner 2011: 307), ✓ congruent determination, ↦ incongruent determination.

For illustration, consider the following examples for congruent uses in (a) and for incongruent uses in (b):

(1)  a.  *The father of Peter is tall.*

 b.  *A father has called.*

(2)  a.  *The moon is shining.*

 b.  *A moon is shining.*

(3)    a.   *Martha is a member of the club.*

       b.   *Martha is the member.*

(4)    a.   *He found a stone.*

       b.   *He found the stone of Peter's.*

*Father* is a functional noun and it is used congruently with the definite article and in a possessive construction in (1a). The indefinite and nonpossessive use in (1b), in contrast, is incongruent and yields a type shift of the involved nominal concept. The same contrast holds for the oppositions in (2a)/(2b), (3a)/(3b), and (4a)/(4b): *moon* (individual noun) is used congruently with the definite article and nonpossessive in (2a) but incongruently with the indefinite article in (2b). The relational noun *member* congruently takes the indefinite article in a possessive construction in (3a) whereas (3b) shows an incongruent nonpossessive use with the definite article. *Stone* (sortal noun) is used nonpossessive and indefinite in (4a) but incongruently possessive and with the definite article in (4b).

The overall question that we investigate in this paper is whether the noun type distinction is reflected in language production on the one hand and language comprehension on the other. For that, we report and discuss the results of three different studies: two studies focus on language production and employ corpus-linguistic methods. The third study on language comprehension uses psycholinguistic methods. Section 2 summarizes the method and the results of a statistical analysis of the four noun types and their co-occurrences with different modes of determination in a German text collection as presented in Horn & Kimm (submitted). Section 3 provides the results of an extension of the study (based on the same text collection) to also cover associative anaphors with nominal anchors (Kimm & Horn 2011). Section 4 presents the methods and the results of a psycholinguistic study[2] investigating whether nouns combined with congruent and incongruent determination show differences in reaction times. The investigation of the noun type distinction from the different perspectives and with the different research methods provides the basis for an overall discussion of the findings in Section 5.

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[2]   The considerations as well as the experiment presented in § 4 are part of the research on psycholinguistic evidence on concept types conducted by Brenner and Indefrey as part of project C03, CRC991; cf. Brenner (in prep.).

## 2 Study I: a corpus-based analysis of the concept types and their grammatical use

### 2.1 Hypothesis and setting

The goal of the study presented in Horn & Kimm (submitted) was to investigate whether evidence for Löbner's (2011) noun type distinction can be found on the basis of a German text collection. The study tested the hypothesis that the four concept types differ with respect to their use with determination classes marking definiteness, number and possession. German is an adequate language of investigation for this task since it provides explicit modes of determination for definiteness (including a definite and an indefinite article), possession (possessive pronouns, left- and right-adjacent possessive constructions) and number (morphological alternation in most cases). The text collection consists of two short stories by anonymous authors and nine newspaper texts from websites of German newspapers. Altogether, the collection consists of 4405 word tokens subsuming 1085 noun tokens.

### 2.2 Method

The method for the investigation consisted of three major parts. The goal of the first part was to assign the respective concept type to all noun tokens in the texts. This task required several steps which were conducted by five native speakers of German:

(i) Identifying the given meaning variant in the context of utterance. This task turned out to be nontrivial and for unclear cases the Duden dictionary (1997) was consulted for disambiguation.

(ii) Excluding mass nouns (59 nouns) such as *water, rice, metal* since CTD is currently primarily concerned with count nouns. The nouns were assessed based on a combination of criteria such as divisibility, possible plural use, and whether a noun can be combined with the indefinite article without a meaning shift.

(iii) Excluding idiomatic uses (17 nouns) such as *Aus die Maus* 'over and done', lit: 'over the mouse' because they generally occur with fixed determination; here also the Duden (1997) was consulted in problematic cases.

(iv) Determining the referential properties and assignment of the concept type. The team of annotators jointly conducted the annotation of the respective concept type. First, inherent relationality was addressed and each annotator

had to decide whether the given meaning variant was [+R] or [−R] based on semantic hints such as the existence of a nonrelational counterpart (as in *mother − woman*), the inherent kind of relationship if applicable (including e. g., part-of, kinship and body-part), or the nominalization of a ditransitive verb (as in *observe − observation*). After that, each annotator decided whether the given meaning variant was inherently unique or nonunique. For a decision on this property, relational and nonrelational nouns were treated separately. For [−R] nouns the annotator was asked whether the given meaning variant was constructed as referring to only one referent, independently of what this referent may be in a given context of utterance. For [+R] nouns the question was whether the meaning variant delivers exactly one referent when its possessor argument is saturated with a uniquely determined referent. If the annotator answered the respective question with "yes" the meaning variant was assigned [+U]. For the following steps of the analysis, only those nouns were taken into account for which the annotators fully agreed with respect to the concept type (resulting in the exclusion of 60 nouns).[3] Nouns with arities greater than two (e. g., *distance* [between A and B]) were excluded (131 meaning variants) since this study concentrated on the four basic concept types. After the application of the four steps, 818 noun tokens remained for further investigation.

The goal of the second part of the investigation was to first collect the modes of determination that occurred in the investigated texts and then classify them in order to determine their inherent congruency with the different referential properties. According to CTD, the modes of determination differ semantically with respect to their preferences for certain concept types. The collected modes of determination were sorted into six determination classes which reflect their congruency with the different predispositions of the concept types, in line with Löbner's (2011) classification of modes of determination in English. [±U] concepts are considered congruent with the following $DET_U$ classes:

- $DET_{+U}$: modes of determination congruent with [+U] concept types
- $DET_0$: mode of determination prescribed for certain proper names in standard written German
- $DET_{−U}$: modes of determination congruent with [−U] concept types

[±R] concepts are considered congruent with the following $DET_R$ classes:

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[3] The aim of the pilot study was to also clarify the procedure and the relevant criteria, hence, inter-annotator agreement was not measured.

- DET$_{+R}$: modes of determination congruent with [+R] concept types
- DET$_{-R}$: modes of determination congruent with [−R] concept types

[+U][+R] concepts are considered congruent with the following class:

- DET$_{FC}$: modes of determination congruent with functional concept types

The modes of determination congruent with [+U] concept types are subsumed in the class DET$_{+U}$. In German these are the singular definite article, contractions of the definite article and a preposition, and singular possessive pronouns. Furthermore, singular left-adjacent genitive constructions belong to this class since they also exhibit a semantic predisposition for [+U] concepts.

The class DET$_0$ is motivated by certain subtypes of ICs which comprise various proper names such as certain toponyms, personal names and company names. They generally take the null article in written texts (but not necessarily in spoken language). Nouns of this kind are generally subsumed in the class of ICs in CTD and would hence be expected to occur with DET$_{+U}$ determination, contrary to the rules of standard written German. Hence, the group of ICs were split up to sharpen the results: (i) IC$_{+U}$ which are congruent with DET$_{+U}$, and (ii) IC$_0$ which are congruent with DET$_0$.

For all other combinations of definiteness marker and number, at least one component contributes a [−U] property: the indefinite article, demonstratives, numerals, quantifiers and all plurals presuppose nonuniqueness of the potential referent and are hence incongruent with [+U] but congruent with [−U]. Accordingly, these combinations were subsumed in the determination class DET$_{-U}$.

With respect to the [±R] concept type congruency, all modes of possession marking were classified as congruent with [+R] concepts into the determination class DET$_{+R}$. The absence of possession marking exhibits congruency with [−R] concepts and such constructions were hence grouped into DET$_{-R}$.

The class DET$_{FC}$ is inherently congruent only with functional concepts and the modes of determination in this class combine [+U] and [+R] concept congruency and are at the same time also members of DET$_{+U}$ or DET$_{+R}$, respectively. In German, these are singular possessive pronouns and singular left-adjacent possessive constructions; both not only indicate the relation between a possessor and a possessum but also mark the possessum as definite (cf. Barker 2004, Löbner 2011 for the definiteness of possessive pronouns in English; cf. Dobrovie-Sorin 2004 for the definiteness of left-adjacent possessive constructions).

On the basis of the annotated concept types on the one hand and the particular modes of determination on the other, a statistical analysis of their co-occurrences

in the texts was conducted (third part of the investigation). The hypothesis investigated was that the concept types occur more often with congruent determination than with incongruent determination. However, the meaning variants were not equally represented in the text collection, i. e., some meaning variants were more frequent than others. In order to avoid the bias of high frequency nouns in the statistical analysis, Horn & Kimm (submitted) took only one occurrence of each meaning variant into account. Since most meaning variants occurred only once, their only common denominator is their first occurrence. These occurrences made up 531 noun tokens.

## 2.3   Results

The results of the study can be summarized as follows.

1.  Both the [±R] and the [±U] distinction were reflected by the data. 59 % of the nouns in the texts were classified as [−R], 41 % as [+R]. 54.4 % of the nouns were assigned [−U] in comparison to 45.6 % as [+U]. The high proportion of [+U] nouns was surprising and to some extent due to differences in the text sorts. Among the newspaper texts, the proportion of ICs was four times higher than among the fictional texts. The second crucial difference between the two text sorts was that the SCs among the fictional texts outnumber those among the newspaper texts by roughly 50 %. The distribution of the concept types in both text sorts together was as follows: individual concepts 19.8 %, functional concepts 25.8 %, relational concepts 15.3 %, sortal concepts 39.2 %.

2.  The predicted relation between the concept types and the determination classes was generally confirmed by the data[4]. The semantic distinction between [+U] and [−U] concepts was reflected in the data by their use with $DET_U$. The semantic distinction between [+R] and [−R] concepts was reflected by their use with $DET_R$.

3.  The congruent and incongruent uses of the concept types were as follows: With respect to $DET_U$-congruency (cf. Figure 1), the 100 % congruent uses of the $IC_0$ was not surprising since they follow the rules of standard written German. The more interesting fact was that the proportions of congruent uses of all other concept types ranged between 59.6 % and 74.1 % (SCs 59.6 %,

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[4]  A Pearson's Chi-square test was used to analyze the data (cf. Horn & Kimm, submitted).

RCs 74.1 %, FCs 60.6 %, and IC$_{+U}$ 71.2 %). Altogether, the distribution of the data for DET$_U$ fit with the expectations depicted in CTD.

With respect to DET$_R$-congruency (cf. Figure 2), almost all SCs (93.8 %) and ICs (99.1 %) were used congruently. In contrast, the proportions of congruent DET$_{+R}$ uses dropped to only 35.8 % for functional concepts and 27.2 % for relational concepts.

■ Linguistically congruent (DETU)    ■ Linguistically incongruent (DETU)
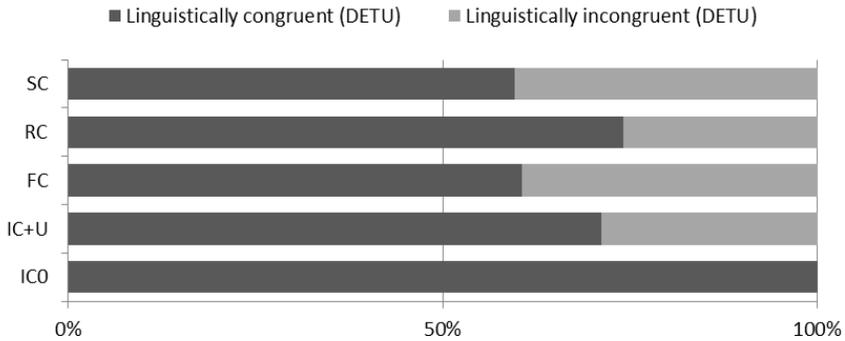
Figure 1: (In)congruent uses of the concept types w.r.t. to DET$_U$.

■ Linguistically congruent (DETR)    ■ Linguistically incongruent (DETR)
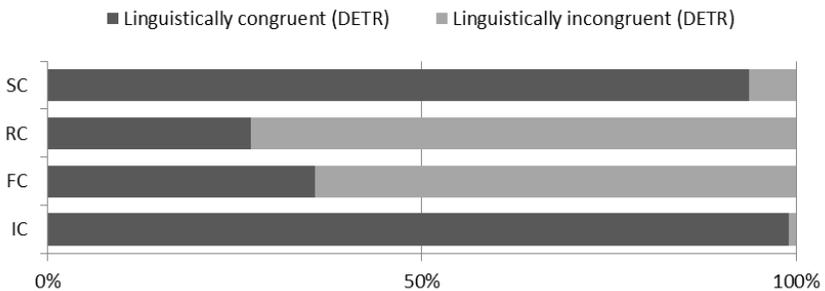
Figure 2: (In)congruent uses of concept types w.r.t. to DET$_R$.

Altogether, the results provided evidence for the assumed noun type distinction. One possible explanation for the relatively low proportion of DET$_{+R}$ uses among [+R] concepts were associative anaphors. The next section presents a follow-up study on this assumption.

## 3 Study II: a corpus-based analysis of the concept types and associative anaphoric use

### 3.1 Goal and setting

The previous section showed that two thirds of the [+R] concepts in the text corpus analyzed were used in nonpossessive constructions and hence with incongruent determination. The question arose as to how this high proportion of incongruent uses could be explained.

The kind of congruency described so far addresses the grammatical level only. Each mode of determination is either congruent or incongruent with certain concept types. Horn & Kimm (submitted) called this type of congruency 'linguistic congruency' and contrasted this with 'pragmatic congruency'. Whereas the former addresses all kinds of explicit determination, pragmatic congruency means that the referential properties of the given concept type are reflected by its particular pragmatic use. One example of such pragmatic phenomena are associative anaphors where the possessor argument is saturated by the context of utterance (cf. Löbner 1998 for an account of associative anaphors and concept types; cf. Hawkins 1978 for an account within his theory of definiteness; cf. Prince 1981 for an analysis with respect to the given-new distinction).[5] Poesio & Vieira (1998) showed that such associative anaphors constitute a frequent phenomenon among definite uses. In accordance with Grice's Maxim of Quantity (cf. Grice 1975), possessive constructions can be dropped if the hearer is able to retrieve the possessor argument from the discourse. Hence, an FC or an RC might be used linguistically incongruent (i.e., without the possessor argument overtly marked in the noun phrase) but at the same time pragmatically congruent (if it is used as an associative anaphor).

Kimm & Horn (2011) conducted a follow-up study to investigate whether the consideration of associative anaphors as one pragmatic factor would sharpen the picture for the [±R] distinction. The study focused on associative anaphors with a nominal anchor only (nominal associative anaphors, NAAs) which were defined by the following five conditions (cf. Kimm & Horn 2011: 108):

(i) The referent of the anaphoric NP is determined by associating it with a referent previously introduced in the discourse (this referent is often called the "anchor").

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[5] Associative Anaphors are also referred to as 'bridging' (cf. Clark 1975), 'indirect anaphora' (cf. Schwarz 2000), 'inferrables' (cf. Prince 1981), and 'contiguity anaphora' (cf. Greber 1993).

(ii)   The anchor is given by an NP.

(iii)  The reference to the anchor is successful.

(iv)   The anaphoric NP may be used with definite or indefinite determination.

(v)    Both the anaphoric NP and the anchor do not corefer.

We follow Hirschman (1997) in that two (or more) linguistic expressions are said to corefer if they exhibit identical reference. An example for an NAA is given in (5) where the NP *dem Display* with the FC head noun *Display* constitutes an NAA.

(5)   (Anonymous 2010)

   *Hannes hasste das Lachen mittlerweile, [. . . ] mit dem <u>sein Handy</u>ₐₙ𝒸ₕₒᵣ ihn immer gleich weckte. [. . . ] Er tastete nach **dem Display**ₙₐₐ [. . . ].*

   'Hannes began to hate the laughter [. . . ] with which <u>his mobile</u>ₐₙ𝒸ₕₒᵣ always woke him up. [. . . ] He felt around for **the display**ₙₐₐ [. . . ].' (lit.)

In (5), the possessor argument of the FC *Display* is not saturated explicitly in the NP. However, the reader retrieves it from the previous discourse, i. e., the anchor NP *sein Handy*.

   Although the literature on associative anaphors primarily addresses those with definite determination (cf. Schwarz 2000), Kimm & Horn (2011) also considered indefinite uses of nouns as potential associative anaphors (cf. Cosse 1996, Löbner 1998), as considered in condition (iv). An example is illustrated in (6).

(6)   (Abendblatt 2011)

   *[. . . ] Ausläufer des Taifuns "Muifa" auf den Philippinen haben am Dienstag auch die <u>Hauptstadt Manila</u>ₐₙ𝒸ₕₒᵣ erreicht. [. . . ] Die heftigen Regenfälle überschwemmten **viele Straßen**ₙₐₐ [. . . ].*

   '[. . . ] Offshoots of the typhoon "Muifa" in the Philippines arrived at <u>the capital Manila</u>ₐₙ𝒸ₕₒᵣ on Tuesday. [. . . ] Heavy rain flooded **a lot of streets**ₙₐₐ[. . . ].'

In (6), based on his or her knowledge of cities, the reader interprets the referent of the NP *viele Straßen* ('streets', SC) as streets that are part of the aforementioned city Manila. The annotators classified this indefinite NP as an NAA.

## 3.2   Annotation guidelines

In this second study, a preliminary annotation procedure for the annotation of NAAs was set up consisting of two parts. Part A subsumed the definition of 'markables', i. e., the string on the linguistic surface that was to be annotated.

Part B covered the annotation of NAAs and coreferences. Coreferences were annotated to separate them from NAAs (cf. condition (v)).

In part A, the annotator defined the markables using square brackets. For the purpose of the pilot study, each simple and each complex NP constituted a markable. Simple NPs only consist of a determiner and a noun whereas complex NPs might also subsume pre- and post-modification (e. g., prepositional phrases). Hence, each complex NP might also include other NPs that in turn constitute markables themselves.

Part B covered several steps that were all carried out for each markable previously defined during part A. First, the annotator had to determine whether the markable exhibited identical reference with another markable in the previous discourse. If so, the annotator linked it with the respective markable in the previous discourse. Next, the annotator checked each markable to see whether an additional possessor argument was needed and if so, whether it was provided by an NP in the previous discourse. These markables constituted the set of NAAs. Subsequently, the annotator was to identify the actual anchor for each NAA. In all other cases, the annotator assigned 'other' and proceeded with the next markable.

## 3.3   Results

The current study was based on the same texts as the one described in Section 2. The annotation of NAAs and coreferences was conducted by two native speakers of German. As pointed out above, this study focused on the first occurrences of meaning variants only in order to analyze the extent to which NAAs can account for the high amount of nonpossessive uses for [+R] concepts. All NPs that were classified as NAAs by both annotators were entered into the study, irrespectively of the anchor chosen. The results for the NAAs are shown in Table (2).

| Concept type | $DET_{+R}$ | $DET_{-R}$ | NAA (of $DET_{-R}$ uses) |
|---|---|---|---|
| FC | 51 | 101 | 47 |
| | **33.6 %** | 66.4 % | 46.5 % |
| RC | 20 | 64 | 29 |
| | **23.8 %** | 76.2 % | 45.3 % |
| IC | 1 | 108 | 13 |
| | 0.9 % | **99.1 %** | 12.0 % |
| SC | 16 | 223 | 55 |
| | 6.7 % | **93.3 %** | 24.6 % |

Table 2: Concept types and NAAs in the text collection (cf. Kimm & Horn 2011: 114)

Table 2 gives the concept types, their grammatical use regarding possessive marking, and the proportion of NAAs among those that are used with linguistically incongruent DET$_{-R}$. The proportion of NAAs among the nonpossessive uses was 46.5 % for FCs and 45.3 % for RCs. On the other hand, the proportion of NAAs among the nonpossessive uses was 12 % for ICs and 24.6 % for SCs.

The example in (5) above illustrates an FC (*Display*) being used as an NAA. An example for an NAA with an RC as the head noun is given in (7).

(7)  (Berliner Zeitung 2011)
  *Männer in* <u>*Kaufhäusern*</u>*$_{anchor}$, das geht gar nicht. [. . . ] Während Frauen mit wachem Blick zielstrebig und elegant durch* **die Abteilungen**$_{NAA}$ *schreiten, wirken ihre Begleiter gelangweilt, sie schauen mürrisch und völlig uninspiriert.*
  'Men in <u>department stores</u>$_{anchor}$, that's a no-no. [. . . ] Whereas women attentively and purposefully stroll **the departments**$_{NAA}$ in an elegant way, their male companions look bored, grumpy and completely uninspired.'

The possessor required by the RC *Abteilung* ('department') is given in the previous discourse by the NP *Kaufhäusern* ('department store'). Examples (5) and (7) show [+R] concepts used as NAAs. However, the results also illustrate that this is not a necessity for a noun, as already shown in (6), where the head noun of the NAA (*street*) is classified as an SC. In (8), the NAA exhibits an IC as the head noun.

(8)  (Frankfurter Allgemeine Zeitung 2010)
  <u>*Computerbild*</u>*$_{anchor}$ hat unter Tarnnamen elf Computer zur Reparatur geschickt. Die Redaktion hatte ein Spionageprogramm installiert, das genau aufzeichnete, was der Techniker am PC unternahm. [. . . ] Unabhängig von einer juristischen Würdigung* **dieses investigativen Journalismus**$_{NAA}$ *[. . . ].*
  '<u>Computerbild</u>$_{anchor}$ sent eleven computers for repair under assumed names. The editorial department had installed a spy program that precisely tracked what the technicians did with the computer. [. . . ] Irrespective of a legal evaluation of **this investigative journalism**$_{NAA}$ [. . . ].'

The annotators determined the reference of the NP *dieses investigativen Journalismus* ('this investigative journalism') by associating it with the NP *Computerbild* (author's note: a German computer magazine) in the previous discourse.

However, although both [+R] and [−R] concepts occur as NAAs, the results illustrate that the referential properties of a noun do in fact influence the proba-

bility of its being used as an associative anaphor. The proportion of NAAs was much higher among [+R] concepts than among [−R] concepts. Hence, FCs and RCs were more often used as associative anaphors in the text collection than their nonrelational counterparts SCs and ICs. Figure 3 illustrates the data for the overall congruency subsuming $DET_R$ uses and the use as NAAs. The integration of NAAs increased the overall congruency of [+R] concepts by almost 50 % since NAAs are considered pragmatically congruent for [+R] concepts. Hence, roughly two third of the FCs and RCs exhibit overall congruency. The decrease of the overall congruency for [−R] concepts on the other hand, was only 25 % (SCs) or 10 % (ICs), respectively. The possessor argument that is retrieved by the reader from the previous discourse in case of an NAA does not match their [−R] property. However, nine out of ten ICs and roughly two-thirds of SCs still exhibit overall congruency. In summary, it turned out that the pragmatic level contributes essentially to the overall congruency of the concept types.
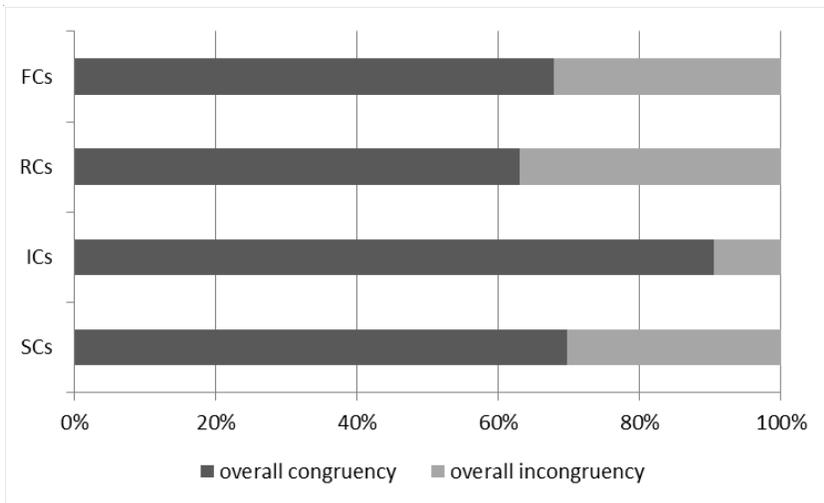


Figure 3: $DET_R$ and NAA uses of concept types combined.

Altogether, the results presented in Sections 2 and 3 provide evidence for the concept type distinction on the basis of an analysis of texts as outcomes of language production. The following section inverts this perspective to an investigation of language comprehension. We present a psycholinguistic experiment that was conducted to detect a possible concept type congruency effect in language

comprehension and thus to complement the corpus-linguistic findings from a different perspective.

## 4   Psycholinguistic investigation of CTD

As shown in the previous sections, nouns are used in the majority of the cases with the mode of determination corresponding to their lexically specified concept type as predicted by CTD. Nonetheless, the observed relatively high proportion of incongruent uses may be seen as evidence against a lexical specification of concept types (let us call this hypothesis 1). Then, however, the high proportion of congruent uses on the one hand and the semantic judgments by the annotators (i. e., the concept type annotation, cf. step (iv) in Section 2) would require a plausible explanation. The alternative hypothesis postulates that concept type information is lexically stored and allows for two possibilities: (i) nouns are flexible with respect to the mode of determination they combine with; CTD allows for such flexibility by assuming type shifts (cf. Section 1). Alternatively, (ii) more than one (or all) concept type(s) for each noun, ranked by their activation level, for example, due to different frequencies of occurrence (higher frequency of occurrence means faster and stronger activation in the mental lexicon) might be represented in the lexicon.

These accounts make different predictions with respect to potential processing costs arising for incongruent determination type and concept type combinations. If the concept types were not lexically specified at all (hypothesis 1), there would be no distinction between congruent and incongruent determination and hence no extra processing costs measurable for "incongruent" determination. On the other hand, if the concept types are stored in the mental lexicon (hypothesis 2), the cognitive processes involved may lead to a measurable congruency effect in language comprehension. Two predictions can be made. First, type shifts may require a cognitive operation that could be more time consuming than unshifted uses and lead to a measurable delay in the processing of incongruent determiner-noun combinations. Second, unshifted uses may profit from certain accelerating processes due to congruent determination which result in faster reaction times. In other words, there should be a concept type congruency effect with longer reaction times for incongruent uses as compared to congruent determination in certain standard psycholinguistic paradigms, such as lexical decision. A concept type congruency effect should also be observed in the case of lexical specification

of more than one concept type (the higher the ranking of a concept type, the faster its processing).

A first psycholinguistic experiment[6] attempted to demonstrate the presence or absence of a concept type congruency effect. The experiment used an auditory lexical decision paradigm with German noun phrases manipulating the combination of mode of determination and the four noun types to explore the influence of (in)congruency on spoken word recognition.

## 4.1 Method

**Materials and experimental set-up.** The study tested 96 native speakers of German who were mostly students at Heinrich Heine University Düsseldorf, Germany, and who were paid a small fee for their participation (mean age 24.01 years, SD 6.78; 54 women, 42 men).

A set of 80 nouns (20 nouns from each concept type (see table 3 for examples)) was chosen based on the semantic evaluation of three linguists and native speakers of German. Between the four concept type groups frequency of occurrence in CELEX database (Baayen, Piepenbrock & Gulikers 1995), the number of phonemes and number of syllables were counterbalanced. Lexical features other than *concept type* were not taken into account, as the task was not to make a semantic decision on the nouns, where other lexical features like 'animacy' or 'concreteness' might influence reaction times, but to perform a mere lexical decision, where these lexical features do not play an equally big role for the reaction times.

To balance the number of correct 'word' and 'pseudoword' lexical decision responses, the stimulus lists contained 80 additional pseudowords (nonwords following the phonotactic rules of German). Across all four lists, each noun (or pseudoword) was combined with all determiners but was presented in only one variant per participant. The following determiners were chosen to represent examples of 3 different modes of determination (cf. Section 2): the indefinite article *ein(e)* for DET$_{-U}$, the definite article *der/die/das* for DET$_{+U}$ and the 3$^{rd}$ person possessive pronoun *sein(e)* for DET$_{+R}$. For the "no" determiner control condition a 400 ms noise stimulus was used. Table 3 shows examples of the concept type and determination mode combinations that were used. Congruent combinations are marked by "✓", whereas incongruent combinations are marked by "↦".

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[6] cf. Brenner (in prep.).

|              | [–U]                          | inherently unique [+U]          |
|--------------|-------------------------------|---------------------------------|
|              | **Apfel** ('apple') – **SC**  | **Papst** ('pope') – **IC**     |
|              | ✓  *ein Apfel*                | ↪  *ein Papst*                  |
| [–R]         | ↪  *der Apfel*                | ✓  *der Papst*                  |
|              | ↪  *sein Apfel*               | ↪  *sein Papst*                 |
|              | *xxxx Apfel*                  | *xxxx Papst*                    |
|              | **Arm** ('arm') – **RC**      | **Mutter** ('mother') – **FC**  |
| inherently   | ✓  *ein Arm*                  | ↪  *eine Mutter*                |
| relational   | ↪  *der Arm*                  | ✓  *die Mutter*                 |
| [+R]         | ✓  *sein Arm*                 | ✓  *seine Mutter*               |
|              | *xxxx Arm*                    | *xxxx Mutter*                   |

Table 3: Example stimuli from auditory lexical decision task.

All items (nouns, pseudowords, and articles (except for the "neutral" determiner stimulus)) were spoken by a male German native speaker in a soundproof booth. For the recording of the stimuli, a Sennheiser ME64 microphone head and a Sennheiser K6 powering module that was linked directly to a PC were used. The stimuli were digitally recorded with a sampling rate of *44.1 kHz* and a 16-bit (mono) sample size using Audacity 1.3[7] software. The recorded files were stored on a computer hard drive for further processing. The sound files were edited into separate files for each stimulus and cut at zero crossings of onset and offset of each item under visual and auditory control using Audacity 1.3 and Adobe® Audition 3.0[8]. The neutral stimulus was constructed by using white noise with the same length as the mean length of the real determiner stimuli. All items were converted to WAV files for presentation. Determiner (or noise) and noun or pseudoword stimuli were combined by the experimental software (see below) according to the input lists.

The input for the experimental software consisted of four basic lists of determiner-noun pairs with each noun occurring only once per list, i. e., with only one of the four determiner types (indefinite, definite, possessive or neutral). The determiner types were counterbalanced across lists, concept types and all targets. Across all four lists, each noun was combined with each determination type. The same set of pseudoword stimuli was mixed into each of the four lists. The

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[7]  http://audacity.sourceforge.net/

[8]  http://www.adobe.com/de/products/audition.html

lists were pseudorandomized so that no more than three 'word' or 'pseudoword' answers followed each other. Care was also taken to ensure that no more than three trials using the same concept type or mode of determination followed each other. In total, four randomized versions of each list were created. All lists were preceded by 20 practice trials.

The experiment was run using the experimental software Presentation®[9] on a PC. The stimuli were selected and combined for each trial by the experimental software according to the selected input list. A warning (beep) sound of 260 ms marked the beginning of each trial, after 400 ms it was followed by one of the determiners. The auditory target stimulus followed 400 ms after the offset of the determiner. After the participants' button press (or after a timeout of 5000 ms if no response was made) and a 1000 ms pause the following trial began.

The participants were seated in a soundproof booth. The stimuli were presented aurally via headphones (Sennheiser HD 437, mono signal). The participants were instructed to perform a lexical decision ("word or nonword?") on the nouns as quickly and as accurately as possible by pressing assigned buttons on a response pad that was connected to Presentation® in order to record the reaction times. The reaction times were recorded from noun onset up to the participants' button press.

## 4.2 Results

Pseudowords, errors and timeouts (RT longer than 5000 ms) were excluded from all analyses (overall error and timeout rate: 1.4 %). Separate analyses of variance (ANOVA) first tested for an effect of the factor congruency (congruent determination, incongruent determination, no determination) on lexical decision times. Congruent determination was defined according to CTD (see table 1 and 3). To determine whether the observed congruency effect was due to congruency with respect to uniqueness, relationality, or both, the data were then tested for effects and interactions of the factors uniqueness (unique, nonunique) and mode of determination (indefinite, definite, none) as well as relationality (relational, nonrelational) and mode of determination (possessive, none).

As reaction time (RT) differences between concept types were irrelevant and, more importantly, the concept types were not equally distributed over conditions (cf. Table 3), a linear normalization ($RT_{norm}=RT*RT$ mean/RT mean per concept

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[9]  http://www.neurobs.com/

type) was applied to minimize mean reaction time differences between the four concept types.

**Congruency.** The reaction time data showed a significant congruency effect across participants [$F_1(94)=12.387$, p=.000] (cf. Figure 4) and across items [$F_2(78)=22,677$, p=.000]. Post-hoc comparisons (with Bonferroni's $\alpha$ -correction) showed that nouns presented with a preceding congruent determiner yielded faster responses than incongruent determiner-noun combinations (p=.000) or nouns presented with noise (i. e., no determination, p=.001). No significant difference between incongruent vs. no determination was found (p=1.0). Note that, due to the restrictive experimental setup in this experiment, only linguistic congruency (as defined in Section 2) was tested.
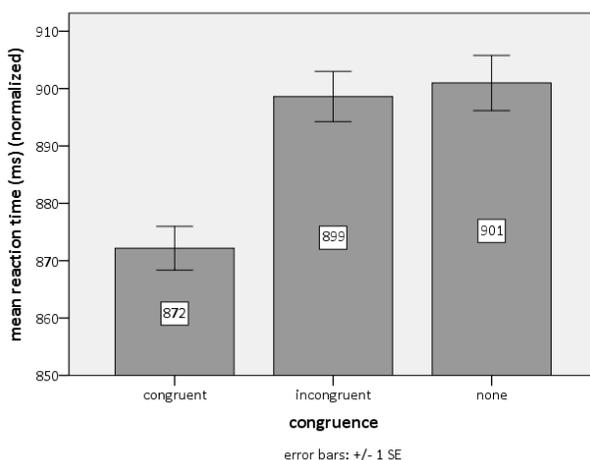


Figure 4: Mean normalized lexical decision times for congruent, incongruent and no determination across participants.

**Uniqueness and (in)definite determination.** The analysis of the combinations of the factors uniqueness and mode of determination (indefinite, definite, none) yielded a significant interaction effect across participants [$F_1(94)=9.47$, p=.000] (cf. Figure 5) and across items [$F_2(77)=6.373$, p=.003]. Separate analyses for unique (individual, functional) and nonunique (sortal, relational) nouns showed that the reaction to [+U] nouns was faster if combined with a definite article rather than with an indefinite article (p=.001) or the neutral stimulus (p=.006). No reaction time difference between [+U] nouns with a preceding indefinite article could be

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found in comparison to no determiner (p>.05). For [−U] nouns, the analysis revealed significantly faster reaction times when combined with the indefinite article rather than with no determiner (p=.014). Reaction time differences between the indefinite vs. the definite article and between the definite article and no determiner did not reach significance (p>.05).
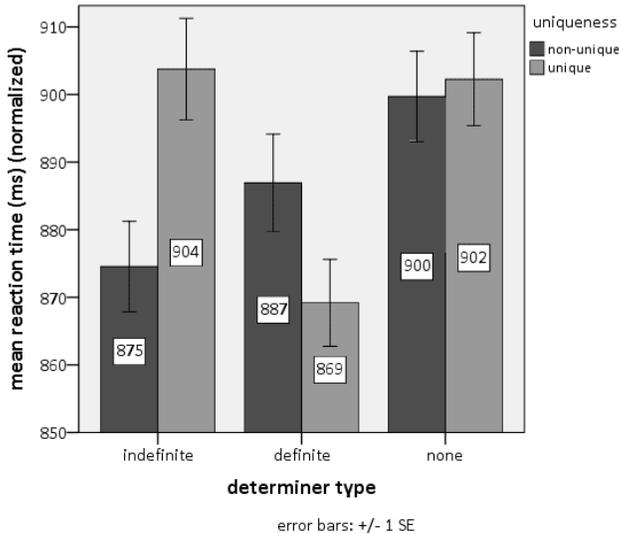


Figure 5: Mean normalized lexical decision times for unique (individual, functional) and nonunique nouns (sortal, relational) following indefinite, definite, or no determiner (across participants).

**Relationality and possessive determination.** The ANOVA for the relationality feature also yielded a significant interaction effect between determination type and relationality across participants [F1(95)=8.476, p=.004] (cf. Figure 6) and across items [F2(78)=10.741, p=.002]. As a follow-up, separate one-way repeated measures ANOVAs for relational (functional and relational) and nonrelational (sortal, individual) nouns revealed significantly faster reaction times for [+R] nouns following possessive determination in comparison to none (p=.001). For [−R] nouns no reliable difference between the use with possessive vs. no determination was found (p<.05).

**Discussion.** The lexical decision time data showed a concept type congruency effect with congruent determiner-noun combinations resulting in approximately 30 ms shorter reaction times compared to the no determiner condition. Separate analyses of the factors uniqueness and relationality showed that the congruency
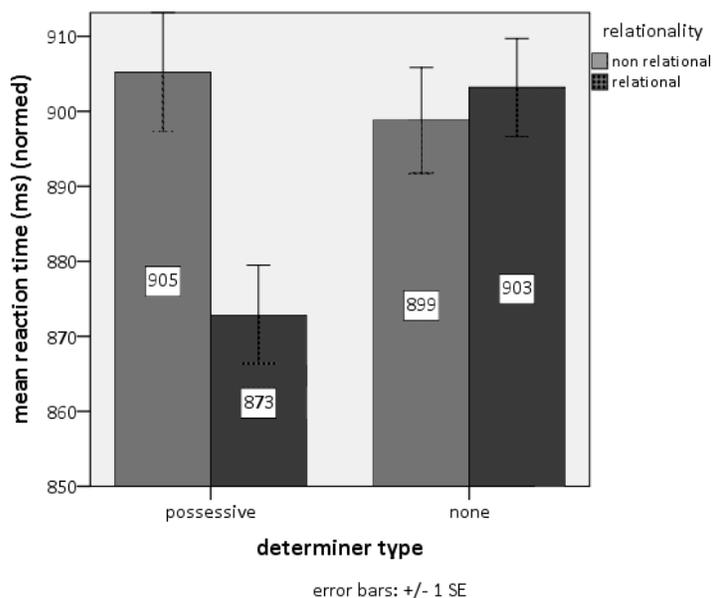
Figure 6: Mean normalized lexical decision times for relational (functional, relational) and non-relational nouns (sortal, individual) following possessive determiner or no determiner.

effect was carried by both factors. For German, at least, this result rules out the possibility that nouns might be lexically unspecified for uniqueness and relationality, as in this case they should combine equally well with all modes of determination to create noun phrases with [±R] and [±U] readings. Instead, the results favor a lexical specification of a noun's uniqueness and relationality as assumed by CTD. Based on this one experiment alone, nothing conclusive can be stated as to whether the observed congruency effect occurs due to faster lexical access to congruently used nouns (favoring ranked lexical specifications of more than one concept type per noun) or due to a delayed response to incongruent nouns undergoing a type shift operation.

Although at first glance these data seem to favor a facilitation for congruent nouns, it should be noted that the reaction times likely include a gender priming effect (Bölte & Connine 2004), because both congruent and incongruent determiners but not the control condition (no determiner) provided correct grammatical gender information. Depending on the size of the gender priming effect, the observed facilitation might be in part or fully explained by gender priming, such that the concept type congruency effect would, to a corresponding degree, be an inhibition by incongruent determination rather than facilitation by congruent

determination. Further experiments will investigate the influence of the gender effect on the concept type congruency effect. In the general discussion below, the observed congruency effect will be discussed taking into account the independent corpus-statistical evidence reported in this paper.

## 5 General discussion

In this article, two corpuslinguistic studies were reported and one new psycholinguistic study were presented to provide empirical evidence about central assumptions of CTD. The corpus-linguistic studies investigated the matter from the perspective of language production based on a German text corpus. The first study investigated whether the four concept types differ with respect to their use with congruent vs. incongruent determination. The results provided evidence for the noun type distinction based on an investigation of the respective referential features [±R] and [±U] and showed that congruent uses were more frequent for three out of four property values. However, [+R] concepts turned out to be used congruently only in roughly one-third of the cases. This finding gave rise to the second study which showed that about half of the linguistically incongruent uses of [+R] concept types were associative anaphors with NP-external nominal anchors (NAAs). These could be accounted for as being pragmatically congruent by virtue of the preceding anchor noun phrase filling the possessor argument slot. From the perspective of language comprehension, the third study used an experimental paradigm investigating lexical decision latencies for nouns preceded by congruent and incongruent determination. The results showed that congruent uses were recognized faster than incongruent determiner-noun combinations and hence provided further evidence for the noun type distinction.

The corpus-linguistic method allows for an analysis of nouns in the natural contexts they occur with. However, the use of natural language can be difficult since there might be numerous other (especially pragmatic) phenomena that might influence the use of the noun (e. g. the use of the definite article in the case of co-referential uses). The researcher cannot control the kinds of nouns she will find nor the contexts in which the nouns occur. This makes such studies also very complex: a prerequisite is to have a procedure that allows to cover all kinds of variation that may show up. From the results found, no direct link to psycholinguistic processes can be drawn: the results might indicate such mental processes but cannot exclude other explanations without any doubt. The psycholinguistic

method uses laboratory conditions and hence controls the influence of other phenomena which allows us to gain insights into cognitive processes. On the other hand, the psycholinguistic experiment presented here is limited with respect to the number of nouns tested and focuses on prototypical nouns only. Here the benefit from corpus-linguistic studies comes into play: each noun token is analyzed and thereby each noun has a direct influence on the results, irrespective of the prototypicality of the noun. Taking the advantages of both approaches together, the studies presented here complement each other not only on the basis of their results but also with respect to their method.

Our results support the distinction between "proper" relational *(sister, head)* and nonrelational *(stone, pope)* nouns which has widely been accepted in the literature (cf. Section 1). From the corpus-linguistic perspective, the distinction is supported by the distribution of the [+R] vs. [−R] concepts in the analyzed texts. From the psycholinguistic perspective, the difference in reaction times between [+R] and [−R] nouns in possessive determination contexts also strengthens this distinction. The distinction of nouns into those that are inherently unique (*head, pope*) and those that are inherently nonunique (*sister, stone*) was introduced in CTD (cf. Section 1). Again our investigation provided evidence from two perspectives: the psycholinguistic data presented here mirror this distinction in terms of differences in reaction times. These findings are in line with an electrophysiological study by Burkhardt (2008), who showed that the interpretation of inherently unique nouns in definite NPs requires less cognitive effort than the interpretation of nonunique nouns in definite NPs[10]. In the text corpus, [+U] and [−U] concepts are even more equally distributed than the [±R] concepts are. The proportion of 25.8 % functional concepts (compared to 15.3 % relational concepts) is surprisingly high and also questions their neglected status in the literature, e. g., Partee & Borschev (2012: 445) who assumes that "Among the semantic types that nouns can take on, functional types are the smallest class, and functional nouns are probably not a linguistically distinct subcategory [...]".

A question that arises from these findings is: what consequences can be drawn for theories on definiteness and reference? Several theories have been proposed including the classical approaches on uniqueness (Russell 1905) and inclusiveness (Hawkins 1978), familiarity (Christophersen 1939, Bolinger 1977, Heim 1982, Prince 1992) and identifiability (Birner & Ward 1998, Lyons 1999) and more re-

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[10] Following Löbner (1985), Burkhardt uses the terms 'semantic definites' for inherently unique nouns and 'pragmatic definites' for inherently nonunique nouns.

cent approaches with an emphasis on the cognitive status of determination (Ariel 1990, Gundel et al. 1993). All of these theories focus on the definite article (and as such on the role of definiteness marking) as the central component of definites and uniquely referring expressions and use it as the starting point of their considerations. Bolinger (1977) proposes to give up the assumption that there is one property that applies to all definite NPs in the same way. He proposes distinguishing between the grammatical marking of definiteness on the one hand and unique reference on the other. In the light of our results, we can go one step further. Our data show that the inherent uniqueness of certain nominal concepts plays a more important role than considered in the theoretical approaches mentioned and rather support the account of CTD. Since roughly half of the annotated nouns in the corpus are inherently unique, their use with definite determination is redundant from a referential perspective (but still necessary with respect to language specific marking on the uniqueness scale).[11]

Since [±R] and [±U] are seen as inherent properties of concepts, they must be stored in the mental lexicon. As a consequence, the assumption that concept type information is not lexicalized can be rejected. However, it is less clear whether exactly one or more than one concept type is lexically specified for each meaning variant of a noun. In order to clarify this point, further investigations of corresponding linguistic phenomena and psycholinguistic experiments are necessary. One additional linguistic explanation for the high proportion of $DET_{-R}$ uses of [+R] concepts (besides NAAs) may be associative anaphors with nonnominal anchors, for example, with the anchor provided by a VP as in (9) where *the door* is interpreted as the door of the house to which the aforementioned man returned from work.

(9)    *A man returned from work and opened **the door.***

A possible explanation for $DET_{+U}$ uses of [−U] concepts are coreferential cases where a referent that has already been introduced in the preceding discourse of utterance is taken up by a definite NP (*an animal$_i$... the dog$_i$...*). These and other phenomena might also account for a good proportion of incongruent uses for all kinds of nouns and hence would argue in favor of a specification of only one concept type.

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[11] cf. Gerland & Horn (2010), Löbner (2011), and Ortmann (2014) for the distinction between 'semantic uniqueness' and 'pragmatic uniqueness'. Cf. Löbner (2011) and Ortmann (2014) for considerations on the uniqueness scale.

Further psycholinguistic investigation might clarify whether the differences in reaction times that were found between congruent and incongruent cases are the result of one of the following two factors or a combination of both: (i) a facilitation of noun recognition by congruent determiners due to a higher frequency (and thus higher ranking) of one of the (possibly multiple) stored concept types or (ii) an inhibition by incongruent uses due to additional time-consuming cognitive operations – namely type shifts – to change the respective lexically specified concept type, as assumed by the CTD. So far, the results favor facilitation by congruent determination, but since we are aware of an interacting gender effect (cf. Section 4), further experiments will be conducted to distinguish the influence of gender information from that of the concept type congruency effect. Finally, in order to identify the event-related potential component(s) sensitive to concept type (in)congruency, and electrophysiological paradigms will be employed.

## 6   Conclusion

In this paper, we reported two corpus-linguistic studies and presented the results of an additionally conducted psycholinguistic experiment investigating the distinction of four basic concept types as proposed by the Theory of Concept Types and Determination. The first study investigated whether the concept types differ with respect to their use with congruent vs. incongruent determination in a collection of German texts. The second study analyzed the extent to which associative anaphors with nominal anchors can account for a large proportion of incongruent uses of functional and relation concepts that occurred in the first study. The psycholinguistic study investigated lexical decision latencies for nouns preceded by congruent and incongruent determination. The results provide evidence both for the (non)relationality distinction and for the (non)uniqueness distinction and consequently for the four basic concept types.

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