

Number words as number names

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Abstract This paper criticizes the view that number words in argument position retain the meaning they have on an adjectival or determiner use (a generalized quantifier or plural property), as argued by Hofweber (Philos Rev 114(2):179–225, 2005) and Moltmann (Philos Stud 162(3):499–534, 2013a, Abstract objects and the semantics of natural language, Oxford University Press, Oxford, 2013b). In particular the paper re-evaluates syntactic evidence from German given in Moltmann (2013a, b) to that effect.

Keywords Numbers · Number terms · Proper names · Plural reference · Mass-count

Whether numbers are objects is the subject matter of a longstanding debate in philosophy. While numbers are generally treated as abstract objects in mathematics, philosophers have also appealed to natural language in order to support the view of numbers as objects. Support from natural language for such a view means that numbers would have the status of objects in the ontology implicit in natural language, the ontology of natural language.¹

Central in the appeal to natural language for numbers as objects is Frege's (1884/1980) view that expressions such as *the number of planets* and *eight* play the syntactic role of referential terms (or referential NPs), which means they serve to stand for an object when they play that role in the context of a sentence. Thus, in the sentences below, the occurrences of *two* and *four* appear to act as referential terms:

¹ See Moltmann (2017) for the notion of the ontology implicit in language.

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- (1) a. Two and two is four.
b. Four is divisible by two.

For Frege, number words as in (1a, b) are singular terms that stand for numbers as objects. But recent work by Hofweber (2005, 2016) and myself in Moltmann (2013a, b) argue against that view of the semantics of number terms. This paper will review those arguments.

Hofweber and myself in Moltmann (2013a, b) argue that number words when they seem to act as referential terms actually retain the meaning they have as quantificational expressions (Hofweber 2005) or as adjectives (Moltmann 2013a, b), the meaning they have in the contexts below:

- (2) a. Four children came.
b. The four children came.

For Hofweber (2005, 2016), number words when they occur as nouns in argument position as in (1a, b) retain the meaning they have as quantificational determiners as in (2a), namely generalized quantifiers (sets of sets). For Moltmann (2013a, b), they retain the meaning they have as adjectives, as in (2a) and, more obviously, in (2b), namely plural properties (properties of pluralities). Number words as in (1a, b) on Hofweber's and Moltmann's view are names only syntactically, not semantically. This approach, according to which number expressions are not singular terms standing for numbers, has also been explored as the 'Adjectival Strategy' by philosophers of mathematics such as Dummett (1973) and Hodes (1984). Hofweber's arguments focus entirely on the double use of number words as in (1a, b) and in (2a). Moltmann (2013a, b) argues that there is additional semantic and syntactic evidence for the view that number words in argument position are nonreferential and retain the meaning they have when acting as adjectival noun modifiers.

The aim of the paper is to clarify how to make sense of the nonreferential view of simple number words within a compositional semantics and to present a range of important data (from English and German) that bear on the issue of the status of number words in argument position as in (1a, b). Specifically, the paper will present data that are problematic for Moltmann's (2013a, b) arguments from German in favour of number words in argument position having a nonreferential status. The data, it will be argued, bear not so much on the nonreferentiality of number words in argument position, but on the presence or absence of a sortal in names in German, including names for numbers. Yet, while those arguments for the nonreferential status of number words in argument position have to be given up, there remain good semantic reasons to retain the Adjectival Strategy for statements of the sort in (1a, b).

1 Criteria for 'referential terms' and kinds of number terms in English

The Fregean view hinges crucially on the syntactic role of an occurrence of an expression in a sentence as a referential term, and thus a clarification is needed as to what this means. While in logic, 'singular' or 'referential' terms are types of expressions that, as the logical language is designed, stand for an object, in natural

language semantics a referential term should be understood to be the occurrence of an expression in a particular semantically relevant syntactic role. It is via such a role, in a sentence of the language in question, that an expression is associated with a particular semantic role, that of standing for an object. As a syntactic role, a referential term will have to be identifiable in a purely syntactic way. What then characterizes referential terms? Philosophers, following Frege, have proposed criteria such as the ability to flank both sides of the ‘identity symbol’ (which means, in natural language, the ability to occur on either side of identity *is*) and the ability of being replaceable by a quantifier (under particular circumstances, cf. Hale 2007). The notion of a referential term (or rather referential NP) also plays a significant role in generative syntax, where it is taken to be critical that it be a determiner phrase (DP) (and thus distinguished from a predicative NP) and occur in argument position (acting as an argument of an extensional verb, noun, or preposition), rather than, say, in predicate position or as complement of an intensional transitive verb (such as *need* or *look for*). Without going into further detail of the various suggestions, the criteria appear to identify *two* and *four* in (1a, b) as referential terms, as well as *the number of planets* in (3a) and *the number four* in (3b):

- (3) a. The number of planets is greater than four.
 b. The number four is divisible by two.

This paper will focus on simple number words in argument position as in (1a, b), but a few remarks are in order first about the terms in (3a) and (3b).

Frege appealed not only to the semantic role of simple number words when arguing for numbers as objects, but also to terms of the sort *the number of planets* as in (3a), which more obviously act as referential terms in at least a range of syntactic contexts. However, there are various arguments that such terms when acting as referential terms do not stand for numbers as abstract objects, but rather for number tropes, such as the particular manifestation of the property of being eight in the plurality of the planets (or the planets reduced to just one aspect, namely how many they are) (Moltmann 2013a, b, 2016).² Therefore, they can be set aside for the discussion of this paper.

² In addition to forming number-trope terms, *number of* can also act as a numeral replacement taking the place syntactically and semantically of a numeral adjective. This is the case in the sentence below, where trope reference plays no role:

- (i) John invited a great number of people.

In Moltmann (2013a, b), I argued that this is the use involved also in (ii):

- (ii) The number of planets is eight.

Whereas Frege took (ii) to be an identity statement, with *eight* and *the number of the planets* acting as number-referring terms, Moltmann (2013a, b) argues that it is a specificational sentence just like the ones below:

- (iii) What John did was kiss Mary.

Specificational sentences in turn are taken to express question–answer pairs, with the precopula-material having the status of a concealed question and the postcopula material that of an elided answer. Crucial for the analysis of (ii) as a specificational sentence is that *number of* has the numeral replacement function

Regarding (3b), it is significant that Frege did not appeal to terms like *the number four* when arguing for numbers as objects. The reasons should be the very same as why he did not appeal to the existence of the term *the truth value true* in English when arguing for truth values being objects (and objects of reference for sentences). Terms of the sort *the number eight* and *the truth value true* are quasi-technical terms and belong to what one may call the ‘periphery of language’, not its core, a distinction that appears implicit in any appeal to natural language that philosophers have made when arguing for a particular ontological category (Moltmann 2017). Only the core reflects the ontology of natural language, not the periphery (which includes various technical and even idiolectal terms that particular philosophers may have used, see Moltmann 2017).

There is significant semantic support for the view that *the number eight* refers to a number as an object and as such may carry the various properties that mathematicians or anyone explicitly conceiving of numbers as objects ascribe to them (Moltmann 2013a, b).³ This particularity of the term *the number eight* can be attributed to its complex syntactic structure, which is that of a close apposition, of the form: definite determiner—number sortal—number word. In virtue of its syntactic structure, it acts as a reifying term, referring to an abstract object introduced, in one way or another, on the basis of the adjectival occurrence of the number word *eight* (expressing the plural property of being eight, see Moltmann 2013a, b). That is, in this structure the sortal *number* goes along with reification of a number as an object on the basis of the (adjectival) number word that follows it. Without going into further details of this view of the compositional semantics of *the number eight*, it is clear that given such an account, terms like *the number eight* can be set aside for the discussion of the role of numbers in the ontology implicit in natural language, that is, the ontology that is reflected in the core of language.

2 Semantic evidence for the Adjectival Strategy for number words in argument position

When arguing for number words in argument position retaining their meanings as quantificational determiners, Hofweber (2005, 2016) focuses entirely on the observation that the same word is used in (1a) and (1b). This, for him, is best accounted for by assigning the very same semantic value to number words used as determiners and as singular terms (that is, for him, a generalized quantifier, a set of sets). Number words as in (1b) are thus names only syntactically, not semantically. For Moltmann (2013a, b), simple number words always just express plural properties of the sort ‘being four’, and with that meaning they have the status of nonreferential terms even in argument position.

Footnote 2 continued

rather than the trope-referential function. This permits *the number of planets* to stand for the question ‘how many planets are there?’ or better ‘what number of planets are there?’, again with a numeral replacement use of *number*. *Eight* in (ii) then stands for a plural property, constituting an elliptical answer of the sort ‘there are eight planets’.

³ Hofweber (2016) maintains a different view of terms of the sort *the number eight*, not distinguishing them semantically from simple number words.

There is also specific semantic evidence for the view that number words in argument position do not behave as terms standing for numbers as abstract objects (Moltmann 2013a, b). One important semantic difference between simple number words like those in (1) and explicit number-referring terms is that only the former, but not the latter can felicitously occur in descriptions of mathematical operations, as in (1a) and in (4)–(6) below, with ‘???’ marking strong (semantic) unacceptability, ‘??’ less strong unacceptability:

- (4) a. Eight and eight is sixteen.
 b. ??? The number eight and the number eight is the number sixteen.
- (5) a. Eight plus eight is sixteen.
 b. ?? The number eight plus the number eight is the number sixteen.
- (6) a. Eight minus two is six.
 b. ?? The number eight minus the number two is the number six.

This gives considerable support for the Adjectival Strategy (Dummett 1973; Hodes 1984). According to the Adjectival Strategy, number terms in arithmetical statements are not considered referential terms standing for numbers as abstract objects, but rather are analysed in terms of quantifiers or plural properties. Thus, (7) (= (1a)) is interpreted as ‘For any two things and any other two things, these things together would be four things’:

- (7) Two and two is four.

This interpretation is formalized in (8) making use of plural logic (Yi 2005, 2006; Oliver and Smiley 2013), with ‘xx’, ‘yy’, ‘zz’ being plural variables that are able to stand for several things at once, < being the relation is/are among, and TWO and FOUR being plural predicates that are true of two things and four things (respectively) at once:

- (8) $\forall xx \forall yy (TWO(xx) \& TWO(yy) \& \neg \exists x(x < xx \& x < yy) \rightarrow \exists zz (FOUR(zz) \& xx < zz \& yy < zz))$

While both Hofweber and Moltmann make use of a version of the Adjectival Strategy, they say little about how a logical form such as (8) is obtained compositionally. Certainly on this account, *and* does not have its usual meaning; in fact it is not clear what its specific contribution to (8) would be. Also *is* in this context has a special meaning. It is not the *is* of identity since it is not symmetric:

- (9) * Four is two and two.

Rather it is what can be called ‘the *is* of calculation’ (Moltmann 2013a). As such it is synonymous with ‘the *make* of calculation’ as in (10):

(10) Two and two makes four.

The *make* of calculation is also special and clearly different from causative *make*, for example in not permitting passivization:

(11) * Four is made by two and two.

Thus *is* and *make* both are polysemous and have a special meaning in statements of mathematical operations.

What about the interpretation of *and* in (7)? Let us first note that in general, *and* does not require referential terms (*happy and satisfied*, *came and left*), and that the same holds for *is*, for example, in specificational sentences (*what John is is happy*). What does this mean for the compositional semantics of (7)? With number words as in (7), *and*, it appears, has a special meaning (and *and* has a variety of meanings anyway), applying to number properties and expressing addition as an operation on number properties in the sense of the Adjectival Strategy. But more than that, it appears that *and* and *is* in (7) act together, forming a discontinuous three-place predicate of plural properties. Given this, (7) will have the logical form below:

(12) (AND, IS) (TWO, TWO, FOUR)

This means that the predicate of plural properties (AND, IS) is true of the plural properties that TWO, TWO, and FOUR stand for just in case (8) obtains.

The Adjectival Strategy may also apply to one-place predicates such as the predicate *is divisible by two*, which can easily be defined as a property of plural properties (it is true of a plural property P just in case P is true only of pluralities that can be divided into subpluralities of equal cardinality).

Interestingly, one-place predicates like that in (1b) generally allow a replacement of a number term in subject position by a reifying number term (close apposition) (Moltmann 2013a), as in the valid inference below:

(13) a. Four is divisible by two.
The number four is divisible by two.

Let us take reified numbers ('the number two') to be entities that inherit properties from the plural properties from which they are formed (the property of being two), as in (13b):

(13) b. IS DIVISIBLE BY TWO(d) iff $\exists P$ (d = reif(P) & IS DIVISIBLE BY TWO(P))

Then this explains the possibility of substituting a simple number word in subject position by an explicit number-referring term as in (13a).

Inheritance of properties as in (13b) is not available in the case of statements of mathematical operations as in (1a)/(7), hence no substitution of number words by explicit number-referring terms is possible, as illustrated in (4), (5), and (6).

The Adjectival Strategy obviously can apply only to statements about mathematical operations and properties. It could not apply to non-mathematical predicates, and in fact with those predicates simple number words are not good (Moltmann 2013a, b):

- (14) a. The number twelve, which interests me a lot, plays an important role in religious and cultural contexts.
 b. ?? Twelve, which interests me a lot, plays an important role in religious and cultural contexts.
- (15) a. the number twelve, which I would like to write my dissertation about, ...
 b. ?? twelve, which I like to write my dissertation about, ...

There is one exception to that generalization (Moltmann 2013a, b). The sortal *number* when occurring predicate-initially makes subsequent nonmathematical predicates acceptable, in sentences with a simple number word in subject position:

- (16) a. Twelve is a number I would like to write my dissertation about.
 b. ??? I would like to write my dissertation about twelve.

That is because the function of the sortal in that position is that of introducing the same sort of abstract object as a sortal introduces when it is head of an explicit number-referring term of the type *the number eight*. That is, the predicate here has a reifying function as well.

The difference between simple number words and explicit number-referring terms with respect to non-mathematical predicates straightforwardly follows if simple number terms stand for quantifiers or plural properties and the Adjectival Strategy applies to mathematical statements. The Adjectival Strategy can apply to predicates expressing mathematical operations and properties, but not to predicates expressing nonmathematical properties.

The question then is, why are number words able to stand for adjectival meanings in argument position? Are they syntactically nonreferential in those contexts? If so, this would mean that their nonreferential status would be triggered by the embedding predicate. This is not entirely implausible since there is at least one other syntactic context in which only simple number words may appear and not explicit number-referring terms, namely as the complement of intensional *count*, specifying the result, not the object, of the counting (Moltmann 2008, 2013a, Chap. 5):

- (17) a. Every day, John has to count the visitors. Today he counted ten, yesterday he counted two, before yesterday he counted zero.
 b. ??? John counted the number zero.

Thus, number words can occur as complements of transitive intensional verbs. The question then is: do the occurrences of number words in argument position in mathematical statements have the same semantic status as complements of transitive intensional verbs? While this may not be implausible in the context of descriptions of mathematical operations, the view has little plausibility for number words in subject position as in (1b), where, as we have seen, an explicit number-referring term can appear as well, as in (13a).

3 Apparent syntactic evidence for the nonreferential status of number names

In Moltmann (2013a, b) I gave additional linguistic evidence from German for the non-referential status of number words in argument position and thus for number words in that position retaining the meanings they have as adjectives or determiners. This evidence concerned the choice of relative pronouns and the support of plural anaphora.

German has two sorts of relative pronouns, which go along with different quantifiers and count NPs:

- [1] *w-pronouns*, which consist in the neutral pronoun *was*, as in *alles, was; nichts, was; vieles, was* ‘everything that’, ‘nothing that’, ‘many things that’
- [2] *d-pronouns*, which consist in gender-marked pronouns *der, die, das*, as in *der Mann, der* ‘the man who’, *die Frau, die* ‘the woman who’, *das Kind, das* ‘the child that’, *das Ding, das / alle Dinge, die* ‘the thing / all things that’.

Given the distribution of the two sorts of relative pronouns illustrated above, the generalization appears to be that *w-pronouns* go with sortal-free NPs, whereas *d-pronouns* go with NPs with a sortal head noun.

However, *w-pronouns* and *d-pronouns* also appear to distinguish between referential and non-referential expressions or occurrences of expressions. Thus *w-pronouns* but not *d-pronouns* go with predicative complements and complements of intensional transitive verbs, as seen below, where ‘*’ marks ungrammaticality:

- (18) a. Hans wurde Musiker, was / * das Maria auch wurde.
‘John became a musician, which / who Mary became too.’
- b. Hans braucht eine sehr gute Sekretäerin, was / ??? die ja nicht einfach zu finden ist.
‘John needs a very good secretary, which / who is not easy to find.’

Moreover, *that*-clauses have been considered nonreferential expressions by a number of researchers (even though the more standard, Fregean view considers them referential terms standing for propositions).⁴ In fact, *that*-clauses take *w-pronouns* rather than *d-pronouns*:

- (19) a. Hans glaubt, dass Schnee weiss ist, was / * das ich nicht glaube.
‘John believes that snow is white, which I hope too.’
- b. Hans bemerkte, dass es regnet, was / * das ich auch bemerkte.
‘John noticed that it is raining, which I also noticed.’

That-clauses differ in that respect from explicit proposition- and fact-referring NPs, that is, the corresponding close appositions with a sortal *proposition* or *fact*:

⁴ See Moltmann (2013b, Chap. 4) and reference therein for discussion of the nonreferential status of clausal complements.

- (20) a. Hans glaubt die Proposition, dass Schnee weiss ist, die ja wahr ist.
 ‘John believes the proposition that snow is white, which is true.’
 b. Hans bemerkte die Tatsache, dass es regnet, die ich auch bemerkte.
 ‘John noticed the fact that it is raining, which I noticed too.’

This was taken as evidence that the choice of w-pronouns is in fact an indication of non-referentiality (Moltmann 2013a, b).

The observation then is that also simple number words in argument position take w-pronouns rather than d-pronouns, as in (21a), as opposed to explicit number-referring terms, which take d-pronouns, as seen in (21b):

- (21) a. zwölf, was / * das/* die durch zwei teilbar ist, ...
 ‘twelve, which divisible by two, ...’
 b. die Zahl zwölf, die / * was durch zwei teilbar ist, ...
 ‘the number twelve, which divisible by two, ...’

This was interpreted as showing the non-referential status of simple number words in argument position. Number words would then have a nonreferential status not only as complements of intensional transitive verbs like *count*, but as arguments of any predicate.

Going along with the choice of relative pronouns is another linguistic phenomenon, namely support of plural anaphora with conjoined antecedents. The generalization is that (occurrences of) expressions that select w-pronouns do not support plural anaphora when conjoined. Thus, nonreferential (occurrences of) expressions do not support plural anaphora:

- (22) a. Maria wurde eine gute Geigenspielerin und eine ausgezeichnete
 Kuenstlerin. Anna wurde das / * sie auch.
 ‘Mary became a good violinist and an excellent artist. Mary became that
 / * them too.’
 b. Hans braucht eine Sekretaerin und einen Assistenten. Maria braucht das
 / * sie auch.
 ‘John needs a secretary and an assistant. Mary needs that / * them too.’
 c. Hans fuerchtet, dass es regnen wird und dass kaum jemand kommt. Maria
 fuerchtet das / * sie auch.
 ‘John fears that it will rain and that hardly anyone will show up. Mary
 fears that / * them too.’

Note that this holds for both German and English, as the English translations make clear.

In German the same holds for number words in argument position. Conjunctions of simple number words in argument position do not support plural pronouns as

anaphora, as opposed to NPs with a number sortal as head noun (Moltmann 2013a, b)⁵:

- (23) a. Hans addierte zehn und zwanzig.
 ‘John added ten and twenty.’
 b. ??? Maria addierte sie auch.
 ‘Mary added them too.’
 c. Maria addierte diese Zahlen auch.
 ‘Mary added those numbers too.’
- (24) a. Hans addierte die Zahlen zehn und zwanzig.
 ‘John added the numbers ten and twenty.’
 b. Maria addierte sie auch.
 ‘Mary added them too.’
- (25) a. Hans notierte zehn und zwanzig.
 ‘John wrote down ten and twenty.’
 b. ?? Maria notierte sie auch.
 ‘Mary wrote them down too.’
 c. Maria notierte diese Zahlen auch.
 ‘Mary wrote those numbers down too.’
- (26) a. Hans notierte die Zahlen zehn und zwanzig.
 ‘John wrote down the numbers ten and twenty.’
 b. Maria notierte sie auch.
 ‘Mary wrote them down too.’
- (27) a. Drei und fuenf sind nicht durch zwei teilbar.
 ‘Three and five are not divisible by two.’
 b. Das sind beides / ??? Sie sind beide Primzahlen.
 ‘That are both / They are both prime numbers.’

There are two fundamental problems with this apparent support for the nonreferentiality of simple number words in argument position. One problem is that conjoined simple number words in English do support plural anaphora, as the translations in (23)–(27) make clear. This difference between German and English can hardly be due to simple number words in argument position being referential in English but not in German for this would mean that all the predicates that can apply to simple number words are intensional in German, but extensional in English.

Another problem for the apparent evidence from German for the nonreferentiality of simple number words in argument position is that certain types of names in German also take w-pronouns and resist d-pronouns and when conjoined those names also fail to support plural anaphora, just like simple number words in

⁵ This also holds for a conjoined subject with the *is* and *make* of calculation discussed earlier. Plural anaphora support is equally impossible here:

- (i) a. ??? Two and two are four. They are not ten.
 b. ??? Two and two make four. They do not make ten.

argument position. These are names for particular types of entities and include (at least in relevant dialects in German) all names for locations, such as cities, countries, and continents⁶:

- (28) a. Berlin, was / ??? das mir besser gefaellt als München
 ‘Berlin which pleases me more than Munich’
 b. Deutschland, was / ??? das ich gut kenne
 ‘Germany, which I know well’
 c. Afrika, was / ??? das ich gerne sehen wuerde
 ‘Africa, which I would like to see’

Conjunctions of simple names for locations also fail to support plural anaphora, unlike conjunctions of simple names for persons:

- (29) Hans mag Susanne und Maria. Bill mag sie auch.
 ‘John likes Susanne and Mary. Bill likes them too.’
- (30) a. Ich habe Berlin und München besucht. Maria hat ??? sie / diese Städte auch besucht.
 ‘I have visited Berlin and Munich. Mary has visited them / those cities too.’
 b. Ich mag Frankreich und Italien. Marie mag ?? sie / ok diese Länder auch.
 ‘I like France and Italy. Mary likes them / those countries too.’
 c. Ich moechte Australien und Afrika sehen. Maria moechte ??? sie / ok diese Kontinente auch sehen.
 ‘I would like to see Australia and Africa. Mary would like to visit them too.’

Close appositions with location sortals (explicit location-referring NPs) behave differently, accepting d-pronouns, as in (31a). Moreover, plural close appositions support plural anaphora, as in (31b)⁷:

⁶ A referee has pointed out that in the constructions below, *der*, *die*, *das* appear with names for locations:

- (i) a. Berlin, die Stadt meiner Träume...
 ‘Berlin, the city of my dreams’
 b. Australien, das Land mit den meisten Kängurus...
 ‘Australia, the land with the most kangaroos’
 c. 2004, das Jahr der schlechten Apfelernte...
 ‘2004, the year of the bad apple harvest’

However, this is a different construction, involving not a relative clause modifying the location name, but an appositive in which the determiner matches the sortal noun that follows it.

⁷ A referee has pointed out that conjunctions of close appositions of location names do not seem to support plural anaphora:

- (i) ??? Ich habe die Stadt Berlin und die Stadt München besucht. Maria hat sie auch besucht.
 ‘I know the cities of Berlin and Munich. Mary has visited them too.’

This indicates that plural pronouns in German require antecedents with plural head nouns and cannot just do with conjunctions.

- (31) a. die Stadt Berlin, die / * was mir gut gefaellt
 ‘the city Berlin, which pleases me’
 b. Ich habe die Städte Berlin und München besucht. Maria hat sie auch
 besucht.
 ‘I have visited the cities of Berlin and Munich. Mary has visited them too.’

As in the case of number words, the behavior of location names in German contrasts remarkably with the behavior of location names in English, which allows conjunctions of names for different locations to support plural pronouns as anaphora, as the translation of (31a, b) make clear.

Also names for times select w-pronouns and differ with respect to plural anaphora support in German and English:

- (32) a. 1960, was / * das interessanter ist als 1970, ...
 ‘1960, which is more interesting than 1970, ...’
 b. Montag, was / * der mir besser passt als Dienstag, ist ein Feiertag.
 ‘Monday, which suits me better than Tuesday, is a holiday.’
- (33) das Jahr 1960, das / * was interessanter ist als 1970, ...
 ‘the year 1960, which is more interesting than 1970, ...’
- (34) a. Hans erinnerte sich an 1960 und 1963. Maria erinnerte sich an sie / ???
 diese Jahre auch.
 ‘John remembers 1960 and 1963. Mary remembers them / those years too.’
 b. Anna schlug Montag und Dienstag vor. Maria schlug diese Tage / sie
 auch vor.
 ‘Ann proposed Monday and Tuesday. Mary proposed those days / them too.’

Furthermore, bare mass nouns in German when used as kind terms behave the same way, selecting w-pronouns and not supporting plural anaphora when conjoined:

- (35) a. Magnesium, was / ??? das lebenswichtig is, ...
 ‘magnesium, which is of vital importance, ...’
 b. Wasser, was / ??? das gesünder ist als Bier, ...
 ‘water, which is healthier than beer, ...’
- (36) a. Gold und Silber werden zum Schmuckherstellen verwendet. ??? Sie
 glänzen.
 ‘Gold and silver are used to make jewelry. They are shiny.’
 b. Magnesium und Eisen sind lebenswichtig. Jeder braucht das (beides)
 / ??? sie.
 ‘John needs magnesium and iron. Everyone needs them / that (both).’
 c. Hans trank Wasser und Wein. ??? Maria trank sie auch.
 ‘John drank water and wine. Mary drank them too.’

But conjunctions of kind terms again support plural anaphora in English, as the acceptability of the English translations makes clear.

Pure quotations are another example of names where German and English differ. Pure quotations in German take w-pronouns and when conjoined do not support plural pronouns as anaphora, but only anaphoric full NPs:

- (37) a. ‘Hans’, was / * das der Name des Lehrers ist
 ‘John, which is the name of the teacher’
 b. ‘Hans’ und ‘Karl’ sind einsilbig. ??? Sie / ok Diese Namen sind nicht
 zweisilbig.
 ‘John and ‘Charles’ are monosyllabic. They / Those names are not
 disyllabic.’

Again the acceptability of the English translation on (37b) illustrates that conjunctions of pure quotations in English do support plural anaphora.

Though the discussion of names in German and English is by far not exhaustive, the generalization suggests itself that conjunctions of names in English in general support plural anaphora, but that conjunctions of only certain types of names in German do, exactly those that select d-pronouns.

Clearly with names it cannot be referentiality that determines the choice of w-pronouns and support of plural anaphora. English and German names for locations, times, kinds, and expression types certainly are equally referential, referring to the very same entities.

For the choice of relative pronouns for names in German, it makes more sense to go back to the initial observation that w-pronouns go with sortal-free NPs (*alles*, *etwas*, *nichts*, and *das*), whereas d-pronouns go with NPs with a sortal head noun (*jeder Mann*, *jede Frau*, and *das Kind*). Given this generalization, German simple names that go with w-pronouns would be sortal-free, whereas those that go with d-pronouns would involve, in some way, an implicit sortal. German simple proper names thus would be associated with a sortal, say ‘person’, but German simple names for locations, times, kinds, and expression types would not be associated with a sortal, and neither would simple names for numbers, formed from numeral adjectives.

The sortal-nonsortal distinction in fact also applies to the case of nonreferential complements. Predicative, intensional, and clausal complements lack a sortal that relates to their (intensional) semantic value, as opposed to close appositions with a sortal head noun.

However, this still raises important linguistic questions that this paper cannot further address. First, how should the choice of w-pronouns be related to the lack of plural anaphora support in German if w-pronouns are those that resist sortals? Second, how is the difference between plural anaphora support in German and in English to be accounted for? These questions require detailed syntactic research that goes far beyond the aim of this paper, whose main aim was a reassessment of the arguments for a non-referential status of simple number words in argument position. The conclusion to draw is that there is no syntactic evidence for the nonreferential

status of number terms in argument position in German. There is only semantic support for the Adjectival Strategy, given the substitution data and the generalizations about mathematical and nonmathematical predicates.

Does this mean that Fregean view about number terms standing for objects should be given up, while considering number words syntactically referential terms? In view of the generalizations made, this now does not seem the right move. English plural anaphora require pluralities of individuals, and they will include numbers for conjoined simple number words as antecedents. This would motivate a different version of the Adjectival Strategy, namely on which number terms do stand for surrogate objects, representing adjectival meanings, a view that has been pursued by Hodes (1984). There are then two different number objects to be distinguished: surrogates of number properties for number words in argument position, and numbers introduced by explicit number-referring terms. The two sorts of number objects differ in the kinds of properties they may carry: the former may carry just those properties that go along with the Adjectival Strategy, the latter may carry all sorts of non-mathematical properties.

4 Conclusion

This paper has reviewed recent challenges to the Fregean view of number words in argument position acting as names for objects, namely views that explored the Adjectival Strategy for such number word occurrences. The picture that emerged was that while there is significant semantic support for the Adjectival Strategy being involved in the semantics of number words, there was no linguistic support for simple number words in argument position having a nonreferential status, of the sort of complements of intensional transitive verbs. The evidence for that which I gave in Moltmann (2013a, b), the paper has argued, is seriously flawed. Instead of supporting the non-referential status of number words in argument position, the relevant data might rather indicate the presence of an implicit sortal with certain simple names but not others in German. The empirical generalizations that I gave in Moltmann (2013a, b) are of interest for an in-depth linguistic analysis of number words across languages, as part of the greater class of proper names. But they do not specifically support simple number words having a nonreferential status in argument position.

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