

Number Words as Number Names

Friederike Moltmann

CNRS-IHPST and NYU

Version November 2016

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 such a view. Support from natural language for numbers as objects means that numbers would have the status of objects in the ontology implicit in natural language. Most important 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 roles of referential terms, which means they serve to stand for an object when they play that role in the context of a sentence. Thus, below the occurrences of *two* and *four* appear to act as referential terms:

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

The connection between the syntactic role of an expression in a sentence and its contribution to the meaning of the sentence makes up Fregean Context Principle, according to which expressions have a meaning only in the context of a sentence (Frege's 1884/1980). The Context Principle is the basis for Frege's (1884/1980) criterion for objecthood according to which an object is what a referential NP may stand for. This criterion is adopted widely both in philosophy and linguistic semantics, not just by philosophers working in the Fregean tradition (Wright, 1983, Hale 1987).

This paper will review a recent account of number terms as in (1a, b) that goes against the Fregean view of reference to numbers as objects, namely that of Hofweber (2005) and Moltmann (2013a, b). Hofweber and Moltmann argue that number words when they seem to act as referential actually retain the meaning they have as quantificational expressions

(Hofweber 2005) or as adjectives (Moltmann 2013a, b), the meaning they have in contexts as below:

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

For Hofweber (2005) number words when they occur as nouns in argument position as in (1a, b) retain the meaning they have as quantificational determiners, namely generalized quantifiers (sets of sets). For Moltmann (2013a, b), they retain the meaning they have as adjectives, namely plural properties (properties of pluralities). Number words as in (1a, b) on that view are names only syntactically, not semantically. This matches the Adjectival Strategy explored in the philosophy of mathematics in order to avoid natural numbers acting as objects (Dummet 1973, Hodes 1984). Whereas Hofweber's arguments for the view focus entirely on the double use of number words as in (1a, b) and in (2), Moltmann (2013a, b) argues that there is additional semantic and syntactic evidence for it.

The aim of the paper is to clarify a range of important data (from English and German) and put forward a number of linguistic considerations that bear on the issue of the status of number in argument position as in (1a, b). The goal thus is not so much to present a definitive analysis of number terms in natural language, but to put forward a range of empirical and theoretical linguistic issues that bear on the philosophical debate. 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, data that are indicative of a mass-count distinction among names, 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, the notion of a referential term in the context of natural language must be understood as a semantically relevant syntactic role of occurrences of expressions in a sentence. It is a syntactic role that is associated with a particular semantic contribution of an expression in a sentence, 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 such criteria such as the ability to flank both sides of the ‘identity symbol’ (which means, of course, the ability to occur on either side of identity *is*) and the ability of being replaceable by a quantifier (under particular circumstances, cf. Hale 1987). 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 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, say in predicate position or as complement of an intensional transitive verb (such as *need*). 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 eight* 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 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 functional terms of the sort *the number of planets* as in (3a), which more obviously function as referential terms in at least a range of syntactic contexts. However, there are a range of arguments that such terms when acting as referential terms do not stand for numbers as abstract objects, but rather for number tropes, 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).¹ Therefore, they can be set aside for the discussion of this paper.

¹ 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, 2013b), it is argued that this is the use involved also in (ii):

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, to appear). Only the core reflects the ontology of natural language, not its periphery (which includes various technical and even idiolectal terms that particular philosophers may have used) (Moltmann, to appear). Clearly, *the number eight* refers to a number as an object and as such it may carry the various properties that mathematicians or anyone explicitly conceiving of numbers as objects ascribe to them. Why is this so? It has to do with the complex syntactic structure of the term (a close apposition), consisting of definite determiner – number sortal and number word. As such, it is 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) (Moltmann 2013a, b). 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.

3. Number words in argument position and the Adjectival Strategy

When arguing for number words in argument position retaining their meanings as quantificational determiners, Hofweber (2005) focuses entirely on the observation 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

(ii) The number of planets is eight.

Whereas Frege took (ii) expresses 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 I 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 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’

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.

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 and explicit number-referring terms is that only the former, but not the latter can felicitously occur in descriptions of mathematical operations, as 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, (7a) is interpreted as ‘For any two things and another two things, these things together would be four things’. In (7b), this interpretation is formalized making use of plural logic (Yi 2005 2006, Oliver/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 plural predicates that are true of two things and four things (respectively) at once:

(7) a. Two and two is two is four.

b. $\forall xx \forall yy (TWO(xx) \& TWO(yy) \& \neg \exists xx (x < xx \vee x < yy) \rightarrow$

$\exists zz (FOUR(zz) (xx < zz \& yy < zz))$

While both Howeber and Moltmann make use of a version of the Adjectival Strategy, they say little about how a logical form such as (7b) 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 (7c) would be. Also *is* in this context has a special meaning. It is not the *is* of identity since it is not symmetric:

(8) # Eight is two and six.

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 (9):

(9) Two and six makes eight.

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

(10) * Eight is made by two and six.

Note also that the conjoined subject with *is* and *make* in mathematical statements does not support plural anaphora, which appears indicative of the special, non-referential status of the subject in such sentences:

(11) a. ??? They are not ten.

b. ??? They do not make ten.

Thus *is* and *make* both are polysemous and have a special meaning in statements of mathematical operations. In general *and* does not require referential terms (*happy and satisfied, came and left*). The same holds for *is* in specificational sentences (*what John is is happy*). What does this mean for the compositional semantics of (7a)? With number words as in (7a), *and* obviously has a special meaning (and *and* has a variety of meanings anyway), applying to number properties as addition in the sense of the Adjectival Strategy. But more than that, it appears that *and* and *is* in (7a) act together, forming a discontinuous three-place predicate among plural properties as below, which gives as its output the logical form of (7a) in (7c):

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

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). If reified numbers inherit properties from the plural properties from which they are formed as in (13a), this explains the possibility of a simple number word in subject by an explicit number-referring term as in (13b):

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

b. Four is divisible by two.

The number four is divisible by two.

Inheritance of properties as in (13a) is not available in the case of statements of mathematical operations as in (1a), hence no substitution of number words by explicit number-referring terms is possible.

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, is an important number in religious and cultural contexts.

b. ?? Twelve, which interests me a lot, is an important number in religious and cultural contexts.

(15) a. the number twelve, which I 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* predicate-initially can make nonmathematical predicates acceptable with simple number words in subject position:

(16) a. Twelve is a number I like to write my dissertation about.

b. # I 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 sort *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? This means their nonreferential status would be triggered by the embedding predicate. This is not entirely implausible since there is at least one context in which only simple number words may appear and no explicit number-referring terms, namely as 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 word in subject position as in (1b), where an explicit number-referring term can appear as well.

3.2. Apparent syntactic evidence for the nonreferential status of number names

In Moltmann (2013a, b) additional linguistic evidence was given 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 that / ‘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 Sekretaerin, was / ??? die ja nicht einfach zu finden ist.

‘John is looking for a 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).² 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*:

(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.’

²See Moltmann (2013b, Chap. 4) and reference therein for discussion of the nonreferential status of clausal complements.

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. zwoelf, was / * das / * die durch zwei teilbar ist, ...

‘twelve, which divisible by two, ...’

b. die Zahl zwoelf, 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, 2013b):

- (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 ncht durch zwei teilbar.
 ‘Three and five are not divisible by two.’
 b. ?? Sie sind / ok Das sind beides Primzahlen.
 ‘They are both prime numbers.’

There are two fundamental problems with this apparent support for the nonreferentiality of number words in argument position. One problem is that conjoined 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 number words in argument position being

referential in English but not in German since it would mean that all the predicates that can apply to 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 they also fail to support plural anaphora, just like number words in 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 continents:

- (28) a. Berlin, was / # das mir besser gefaellt als Muenchen
 ‘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’

Names for locations also fail to support plural anaphora when they are conjoined, unlike 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 Muenchen besucht. Maria hat ??? sie / diese Staedte 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 Laender 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 w-pronouns and supporting plural anaphora when conjoined, just like explicit number-referring terms:

(31) a. die Stadt Berlin, die / * was mir gut gefaellt

‘the city Berlin, which pleases me’

b. Ich habe die Stadt Berlin und die Stadt Muenchen besucht. Maria hat sie auch besucht.

‘I know the city of Berlin and the city of 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 in (31a, b, c) 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 holyday.’

(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. Mar remembers them / ok those years too.

b. Anna schlug Montag und Dienstag vor. Maria schlug * sie /ok diese Tage auch vor.

‘Ann proposed Monday and Tuesday. Mary proposed them / those days 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 gesuender ist als Bier

‘water, which is healthier than beer’

(36) a. Gold und Silber werden zum Schmuckherstellen verwendet. ??? Sie glaenzen.

‘Gold and silver are used to make jewelry. They are shiny.’

b. Magnesium und Eisen sind lebenswichtig. Jeder braucht ??? sie / ok das (beides).

‘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 w-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 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 proper names thus would be associated with a sortal, say ‘person’, but German 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.

If the presence of sortals matters for the choice of w-pronouns in German, then plural anaphora in German would require conjoined antecedents involving a sortal. But then how is the difference with respect to plural anaphora in English to be accounted for? There are two options.

First, plural anaphora in English when taking conjunctions also require those conjunctions to have sortal content, and all proper names in English, unlike in German, are associated with a sortal. There is a serious problem with this option, though, and that is cases where a conjoined antecedent of a plural anaphor in English could not involve a sortal. Whereas conjunctions of definite mass NPs in German do not support plural anaphora, in English they do, as the translations of the German sentences below make clear:

(41) a. Hans trank das Wasser und das Bier. Er trank das / ?? sie schnell.

‘John drank the water and the wine. He drank that / ok them quickly.’

b. Hans ass den Truthahn und das Fleisch. Er ass das / ??? sie allein

‘John ate the turkey and the meat. He ate that / ok them alone.’

Definite mass NP certainly are syntactically mass and they involve no sortal,

(41a, b) indicates rather that this second option is at state regarding the difference between plural anaphora in German and English: In German plural anaphora require an antecedent that is syntactically plural, whereas in English plural anaphora require an antecedent that is semantically, but perhaps not syntactically plural. What matters for plural anaphora in English is that the antecedent stands for a plurality of individuals, that is, entities presented as having a boundary or more generally being integrated wholes, in the sense of Moltmann (1997). One way of being presented as an integrated whole is by being described by a singular count noun; another way is by being specified as a maximal entity in the context that consists in entities that share a property, such as being water or being beer in (41a, b). Semantic plurality rather syntactic plurality is also involved in the semantic selectional requirements of predicates like *compare* and the internal reading of *same/different* (Moltmann 1997):

(42) a. John compared the wine and the beer / the two drinks / ??? the liquid.

b. The wine and the beer / The two drinks / ??? The liquid is are in the same location.

If plural anaphora in English require semantic plurality and in German syntactic plurality, then for German it implies a correlation of NPs involving an implicit sortal with the count category. Conjunctions of names involving an implicit sortal count as syntactically plural and thus the names as count, whereas conjunctions of names not involving an implicit sortal will not count as syntactically plural and thus the names won't be count, but rather classify as mass or number-neutral. There is in fact a view about the mass-count distinction that ties the category count to the presence of a (silent) sortal NPs, namely Borer's (2005) structural account of the mass-count distinction. This view is also able to make sense of a mass-count distinction among names, linking it to the presence or absence of an implicit sortal.

On Borer's view, count NPs in languages that display the mass-count distinction involve the very same syntactic structure as NPs with a sortal classifier in classifier languages. Thus, *three cats* has the underlying structure in (43a), with the most general implicit sortal classifier *ind* (for 'individual'):

(43) a. [[the]_D [[three]_Q [<e> [[ind]_{Cl} [[cat]_N]_{NP}]_{CIP}]_{QP}]_{DP}

This is parallel to the overt classifier NP *three pieces of cattle*, which has, simplified, the structure in (43b):

(43) b. [[e]_D [[three]_Q [[pieces]_{Cl} of [[cattle]_N]_{NP}]_{CIP}]_{QP}]_{DP}

The sortal classifier with count common nouns will be pronounced as either singular count or plural morphology.

Syntactically, this account can be carried to names straightforwardly, allowing a distinction between names that are mass and names that are count. Names classify as count if they contain a sortal classifier, and they classify as mass if they don't. Thus, names for persons in German will involve a specific classifier *pers* for persons as in (44a), whereas names for locations in German will involve no classifier, but display the simple structure in (44b):³

(44) a. The structure of German person names

³ I will leave it open whether the name subsequently raises to the D-position, as argued by Longobardi (1994).

[[e]_D[[pers]_{CI}[[Hans]_N]_{NP}]_{CIP}]_{DP}

b. The structure of German names for locations

[[e]_D[[Berlin]_N]_{NP}]_{DP}

Similarly, number names in German will involve no classifier, as below:

(44) c. The structure of number names in German

[[e]_D[[eight]_N]_{NP}]_{DP}

On this view, it is the presence of a sortal classifier that categorizes an NP as count, whatever type of entity the NP may stand for and whatever conceptual content it may have. Such a structural approach to the mass-count distinction has the advantage of being applicable to names, unlike those that associate a conceptual or ontological content with ‘mass’ and ‘count’. But it raises an important issue, namely how to interpret the structure of count NPs as opposed to mass NP. Borer’s (2005) own mereological account is no longer applicable since it was tailored to common nouns, not proper names. A more promising approach to pursue may instead be in terms of reference to something as ‘one’ (count NPs) as opposed to something as neither ‘one’ nor ‘many’, but just as ‘something’ (mass NPs), along the lines sketched in McKay (2016) and Laycock (2006). This means that a German (simple) name for a location, a kind, an expression type or a number will involve reference to something not as ‘one’, but just as ‘something’. Of course this idea has to be further developed and the question needs to be addressed how it relates to generalizations about the mass-count distinction among common nouns, for example the mereological properties of entities or noun extensions. However, in the present context a mere suggestion will have to suffice.

The way the selection of relative pronouns relates to the mass-count distinction in German is actually more complex than presented so far. First let us note that the conjunctions of w-pronouns selecting w-pronouns (*das*) do not support plural pronouns, which is what is expected:

(45) Bill traegt das, was Hans gehoert und das, was Maria gehoert. Anna kann das / ??? sie nicht tragen.

‘Bill carries that which belongs to John and that which belongs to Mary. Ann cannot carry that / them.’

But with full mass NPs, though, the data are less straightforward. Full mass NPs that are neutral in gender take *w*-pronouns with certain quantifiers, namely *alles*, *kein*, *das meiste*, but not with definite determiners, *few*, and *little*:

- (46) a. *alles / das meiste / kein Material, was / ?? das ich gefunden habe*
 ‘all / most / no material that I have found’
 b. *das / viel / wenig Wasser, das / ??? was ich gefunden habe*
 ‘much / little material that I have found’

Apparently, with full NPs, *was* bears a special connection to the universal determiners *alles*, which licences it. Moreover, only neutral mass NPs allow for *was*, masculine or feminine mass Ns don’t:

- (47) a. *aller Sand / Wein / Unfug, der / * was*
 ‘all (the) sand (masc) / Wine (masc) / nonsense (masc), that’
 b. *alle Farbe / Flussigkeit / Schoenheit /, die / * was*
 ‘all (the) color / liquid / beauty that’

Thus the selection of *w*-pronouns as opposed to *d*-pronouns with full NPs does not directly reflect to the mass-count distinction, but only conditionally so. When the NP is neutral and comes with a particular type of determiner, the choice of *w*-pronouns is indicative of its mass status or the absence of a sortal.

How would, on that view of the mass-count distinction, the selection of *w*-pronouns with nonreferential complements be explained? Certainly, there is no position available for a silent classifier for CPs (*that*-clauses) or the category of predicative complements (NPs as opposed to DPs). Complements of intensional transitive verb may be DPs, but if they contain a sortal, it would no longer be indicative for the semantic value of the complement (an intension) and the relative clause relates to that semantic value.

Given the mass-count distinction among names in German, the question arises, should a mass-count distinction also be applied to names in English? Given that plural anaphora in English cares about semantic, not syntactic plurality, the data are compatible with English names all coming either with a sortal or without a sortal. In English, plural anaphora just care about pluralities of individuals (which means that there is just one constraint, namely that the antecedent cannot consist in nonreferential complements).

We can conclude then 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 number words as antecedents. This then motivates a version of the Adjectival Strategy on which number terms do stand for surrogate objects, representing adjectival meanings, a view that in fact 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 sorts 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.

5. 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 number words in argument position having a nonreferential status, of the sort of complements of intensional transitive verbs. The evidence for that given 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 indicate the presence of a sortal with some names but not others in German and thus a (structural) mass-count distinction among names. The empirical generalizations thus 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.

References

- Boolos, G. (1984): 'To be is to be Value of a Variable (or to be the Values of Some Variables).' *Journal of Philosophy* 81, 430-449.
- Borer, H. (2005): *Structuring Sense. Volume I. In Name only*. Oxford UP, Oxford.
- Carrara, M. / A. Arapinis / F. Moltmann (eds.) (2016): *Unity and Plurality. Logic, Philosophy, and Semantics*. Oxford University Press, Oxford.
- Dummett, M. (1973). *Frege: Philosophy of Language*. Harvard University Press, Cambridge, MA..
- Frege, G. (1884/1980): *The Foundations of Arithmetic*. Trans. J. L. Austin. Second Revised Edition. Northwestern University Press, Evanston, Illinois.
- Hale, B. (2007): *Abstract Objects*. Blackwell, New York
- Hodes, H. (1984): 'The Ontological Commitment of Arithmetics', *Journal of Philosophy* 81, 123-49
- Hofweber, T. (2005): 'Number Determiners, Numbers, and Arithmetics'. *Philosophical Review* 114.2., 179-225.
- Laycock, H. (2006): *Words without Objects: Semantics, Ontology, and Logic for Non-Singularity*. Oxford University Press.
- Longobardi, P. (1994): 'Proper Names and the Theory of N-Movement in Syntax and Logical Form'. *Linguistic Inquiry* 25, 609-665.
- McKay, T. (2016): 'From Mass to Plural'. In Carrara et al. (eds.).
- Moltmann, F. (1997): *Parts and Wholes in Semantics*. Oxford UP, Oxford.
- (2008): 'Intensional Verbs and their Intentional Objects'. *Natural Language Semantics* 16.3., 257-281.
- (2013a): 'Reference to Numbers in Natural Language'. *Philosophical Studies* 162.3., pp. 499-534.
- (2013b): *Abstract Objects and the Semantics of Natural Language*. Oxford UP, Oxford.
- (2016): 'The Number of Planets: A Number-Referring Term?'. In M. Rossberg and P. Ebert (eds.): *Abstractionism*, Oxford UP, Oxford, pp. 109-133.
- (to appear): 'Natural Language Ontology'. To appear in the *Oxford Encyclopedia of Linguistics*, Oxford UP, Oxford.
- Oliver, A. / T. Smiley (2013): *Plural Logic*. Oxford UP, Oxford.
- Wright, C. (1983): *Frege's Conception of Numbers as Objects*. Aberdeen UP, Aberdeen.
- Yi, B.-Y. (2005): 'The Logic and Meaning of Plurals. Part I'. *Journal of Philosophical*

Logic 34, 459-506.

----- (2006): 'The Logic and Meaning of Plurals. Part II'. *Journal of Philosophical Logic* 35,