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Garlic and ginger are not like apples and oranges. Effects of mass/count information on the production of noun phrases in English.

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Abstract

In the research presented here a picture-word interference paradigm was used to investigate how grammatical mass/count (countability) information is processed during noun phrase production in English. Levelt, Roelofs and Meyer's (1999) theory distinguishes between two different types of lexical-syntactic information: variable extrinsic lexical-syntactic features such as number (singular, plural) and fixed intrinsic lexical-syntactic properties such as grammatical gender (e.g., masculine, feminine). Previous research using the picture-word interference paradigm has found effects of distractor lexical-syntactic congruency for grammatical gender but no congruency effects for number. We used this phenomenon to investigate whether mass/count information is processed in a similar way to grammatical gender. In two picture-word interference experiments, participants named pictures of mass or count objects using determiner noun phrases (e.g., Experiment 1 with mass nouns and plural count nouns: 'not much$_{mass}$ rice$_{mass}$', 'not many$_{count}$ pegs$_{count}$'; Experiment 2 with mass nouns and singular count nouns: 'some rice$_{mass}$', 'a peg$_{count}$'), while ignoring superimposed distractors which were countability congruent or incongruent nouns. The results revealed a countability congruency effect for mass and plural count nouns in Experiment 1 and for singular count nouns, but not mass nouns in Experiment 2. This is similar to grammatical gender suggesting that countability processing is predominantly driven by a noun's lexical-syntactic information. The results can be best explained with competition between mass/count-specific determiners.

Introduction

Nouns have a number of characteristics which can affect the form of grammatical units such as noun phrases. For example, lexical-syntactic information is required in order to select the appropriate determiner and/or the appropriate suffix. In German, for instance, each noun has a grammatical gender (feminine, masculine or neuter). The noun's specific gender determines the form of the definite or indefinite determiner in the same noun phrase (e.g., **der**$_{masc}$ schlaue Fuchs (the sly fox) versus **die**$_{fem}$ schwarze Katze (the black cat)). Similarly, number also influences the form of determiners and adjectives to generate agreement between words in a phrase (e.g., **die**$_{plural}$ schlau**en**$_{plural}$ F**ü**chs**e**$_{plural}$ (the sly foxes)).

Levelt, Roelofs and Meyer's (1999) theory is one of the most prominent theories of language production and includes detailed hypotheses regarding the representation of lexical-syntactic information (e.g., number, grammatical gender, word category). According to Levelt et al., lexical syntax is represented at an abstract grammatical level (lemma level) which is part of the lexicon. The theory distinguishes between three major levels: a level of lexical concepts (conceptual-semantic level), a lexical-syntactic (lemma) level and a word form level. The lemma level mediates between the level of lexical concepts and the word form level. Each lexical item is represented by an empty lemma node which is linked to the word's specific lexical-syntactic characteristics such as word category, grammatical gender and number information (e.g., the lemma node for the German word 'Katze' (cat) points to the features: noun, feminine, singular). Lexical-syntactic features can be further connected to the lemmas of agreement targets[1] (e.g., the syntactic feature [feminine] is linked to the determiners 'die$_{fem}$' (the) and 'eine$_{fem}$' (a)). Activation flows from the noun's lemma to its lexical-syntactic features. Although lexical-syntactic features always receive activation when a noun, phrase or sentence is produced, Levelt et al. propose that selection of the features is bound to their grammatical necessity, such as when agreement is required within a noun

[1] Agreement targets are words which have to agree in specific features (e.g., gender, number) with another word in the phrase or sentence, thus they are syntactically dependent. In our example, adjectives or determiners are the agreement targets and depend on the lexical-syntactic features of the noun in a noun phrase.

phrase using gender-specific determiners. For example, in order to form agreement in the German noun phrase 'die$_{fem}$ Katze' (the cat), the lexical-syntactic feature [feminine] has to be selected to then activate and select the appropriate gender-specific determiner 'die'. Following activation of a lemma cohort, the most active lemma is selected and only this node activates its corresponding word form.

Even though number and grammatical gender both represent lexical-syntactic information, the nature of this information is different. Grammatical gender represents an unchanging characteristic of a specific noun (e.g., the German word 'Katze' (cat) is a noun which always retains the grammatical gender 'feminine'). It is a purely grammatical property whose form is not influenced by conceptual-semantic information[2], hence, in Levelt et al.'s theory, a noun's grammatical gender and gender-specific determiner can only be accessed and selected through the noun's lemma node. Features such as grammatical gender are referred to as 'intrinsic features' (Caramazza, 1997) or 'lexical-syntactic properties' (Levelt et al., 1999; Roelofs, 1992; Schriefers & Jescheniak, 1999).

Number, in contrast, is not fixed and its value depends on the speaker's intention. For example, whether the word 'Katze' (cat) is produced in singular or plural depends on the speaker's intention to talk about one or more than one cat (single versus multiple). Hence, the lexical-syntactic feature number is selected through conceptual-semantic information. Features such as number are referred to as 'extrinsic features' (Caramazza, 1997) or 'syntactic features' (Levelt et al., 1999; Roelofs, 1992; Schriefers & Jescheniak, 1999). For clarity, we will use the most explicit terminology: 'fixed intrinsic lexical-syntactic property' to refer to lexical-syntactic properties such as grammatical gender; 'variable extrinsic lexical-syntactic feature' to refer to a lexical-syntactic feature like number, and 'lexical-syntactic attributes' to refer to both kinds of lexical-syntactic information.

For the majority of nouns the relationship between conceptual-semantic number (e.g., SINGLE vs. MULTIPLE) and grammatical number information is transparent. For example, in

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[2] Even though grammatical gender is a grammatically derived and hence a fixed lexical-syntactic property, in some rare cases its selection can be influenced by conceptual-semantic information. For example, Schiller, Münte, Horemans & Jansma (2003) found that participants made faster gender decisions for words which have biological sex (e.g., die$_{fem}$ Frau$_{fem}$ – the woman) and are congruent

English, singular nouns are grammatically unmarked and plural nouns are grammatically marked for plural with a plural morpheme, such as /s/, /z/ or /ɪz/. However, there are some classes of nouns which are exceptions in that conceptual-semantic number information does not map directly onto the noun's grammatical number. For example, pluralia tantum nouns (e.g., scissors, trousers, goggles) can refer to single and multiple noun concepts while the nouns remain grammatically plural. When referring to one or two pairs of scissors, "scissors" remains grammatically plural (for discussion see Nickels et al., 2015). Mass nouns (e.g., garlic, rice, milk) are another group of nouns where conceptual-semantic and grammatical number information may mismatch. In contrast to pluralia tantum nouns, mass nouns remain grammatically singular (or unmarked for number) independent of their reference to single or multiple mass noun entities (e.g., one or two bulbs of garlic). However, their grammar is not singular specific: mass nouns can be combined with determiners that are used for both singular and plural count nouns (e.g., 'this$_{singular}$ garlic' vs. 'some$_{plural}$ garlic') irrespective of the mass noun's reference to one or multiple mass noun entities (whether one or two bulbs of garlic) and hence its semantic number information. As there is no transparency in the mapping of conceptual-semantic number and grammatical number for pluralia tantum and mass nouns, this information must be stored at the lexical-syntactic level and accessed by activation from the noun lemma node. This activation is required to prevent the production of grammatically incorrect noun phrases (e.g., '*some garlics' for multiple bulbs of garlic, '*this scissors' for one pair of scissors) (for further discussion see Nickels et al., 2015).

As motivated above, the mass/count status of nouns (also known as countability) is regarded as another lexical-syntactic attribute of nouns, alongside grammatical gender and number. Many languages (e.g., English, German, and Russian) distinguish grammatically between mass nouns (e.g., garlic, milk, rice) and count nouns (e.g., apple, house, table). The mass/count status of a word can influence the grammatical form of adjacent constituents in phrases and sentences. For example, count nouns can be specified by a preceding numeral (e.g., **two** tables), quantifiers that denumerate (e.g., **many** tables, **few** tables), and the definite or the indefinite article (e.g., **the** table, **a** table). Mass nouns in comparison are

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regarding their grammatical and biological gender compared to words with no biological sex (e.g., der$_{masc}$ Tisch$_{masc}$ – the table) (see also Nickels, Biedermann, Fieder & Schiller, 2015).

mostly restricted to a combination with the definite article (e.g., **the** milk, not *a milk) and quantifiers that do not denumerate (e.g., **much** milk, not *many milk; **little** rice, not *few rice).

Unlike grammatical gender and number, the nature of mass/count information is less clear with the origin of the grammatical distinction between mass and count nouns still debated (see e.g., Middleton, 2008). Originally, grammatical differences between mass and count nouns were proposed to reflect conceptual-semantic differences in their representation, with mass nouns representing substances (e.g., milk, honey) and aggregates (e.g., confetti, rice) which have no definite boundaries, and count nouns representing entities with clear boundaries (e.g., house, table) (Cheng, 1973; Grandy, 1973). Another conceptual-semantic, yet less perceptual and more abstract, approach comes from the cognitive individuation hypothesis (Middleton, Wisniewski, Trindel & Imai, 2004; Wierzbicka, 1988; Wisniewski, Lamb & Middleton, 2003). In the cognitive individuation hypothesis, the grammatical distinction between mass and count nouns arises from how people perceive and interact with mass and count objects. For example, depending on whether objects can be perceived as individual/individuated entities (e.g., individuated: a cat with white fur and a black tail; non-individuated: a white grain of rice) and therefore easily distinguished from other exemplars of that category (e.g., individuated: other cats with different coloured fur and/or tail; non-individuated: other grains of rice with the same shape and colour), and whether people interact more with a single individual element (individuated: pet one cat) instead of with multiple elements (non-individuated: cook 100 grams of rice which equals 5000 grains of rice) determines the use of count syntax instead of mass syntax. For this reason, count nouns are also referred to as individuated entities and mass nouns as non-individuated entities[3].Support for the view that mass/count status might be influenced by the conceptualisation of an entity as more or less individuated comes from a number of 'dual nouns': nouns which can be used both as a mass noun and as a count noun depending on the context. For example, the noun 'coffee' is generally used as a mass noun: 'Can I have some coffee?' but can also be used as a count noun: 'Can I have a coffee'; similarly the noun

[3] Middleton et al. (2004) introduced the term 'non-individuated entity' which is more abstract than the term substance and comprises more kinds of mass entities. For example, in addition to substances it refers also to cognitive events (e.g., sadness), physical events (e.g., sleep) and sounds (e.g., thunder).

‘dog’ is usually a count noun: ‘I saw a dog.’ but can be a mass noun: ‘There is dog in that curry.’ Wisniewski et al. (2003) argue that speakers can to some extent flexibly choose whether they refer to nouns as mass or count nouns depending on which conceptual/perceptual characteristic they want to refer to. For example, if people want to refer to or stress the spatial dimension of a count noun, they can refer to it as a mass noun: ‘There is not enough table for everyone to sit at’ (Allan, 1980). Similarly, if people want to refer to a type or kind of a mass noun, they can refer to it as a count noun: ‘a fine wine’ (Langacker, 1987).

Hence, it would seem plausible that the selection of lexical-syntactic mass/count information for a noun might, at least to some extent, be influenced by conceptual-semantic information, namely whether the speaker refers to an object/individuated entity or a substance/non-individuated entity. However, compared to grammatical number, grammatical mass/count information cannot be purely derived from conceptual-semantic information due to the lack of transparency. For example, some nouns which refer to distinct, individuated objects (e.g., broccoli, bread, bacon) are still grammatically mass nouns and some nouns which represent non-individuated entities (e.g., lentils, peas, pearls) are count nouns. Further support against a conceptually driven mass/count distinction can be found in nouns which are virtual synonyms but one is mass and the other count (e.g., $\text{pebbles}_{\text{count}}$ vs. $\text{gravel}_{\text{mass}}$, $\text{garments}_{\text{count}}$ vs. $\text{clothing}_{\text{mass}}$). Finally, a conceptual distinction underlying countability becomes even harder to maintain looking cross-linguistically at cases of language-specific mass/count categorization. For example, some nouns which are mass nouns in English, are countable in other languages such as ‘furniture’ and ‘information’ which are count nouns in French (meuble, information) and ‘spinach’ and ‘spaghetti’ which are count nouns in Italian (spinaci, spaghetti) (Middleton et al., 2004; Middleton, 2008).

The lack of conceptual-semantic transparency between mass and count noun referents and their grammatical mass/count status, plus the lack of semantic number transparency for mass nouns makes it necessary for mass/count information to be predominantly accessed via the lexical-syntactic level (e.g., Garrard, Carroll, Vinson & Vigliocco, 2004; Middleton, 2008; Shapiro, Zurif, Carey & Grossman, 1989; Vigliocco, Vinson, Martin & Garrett, 1999). Within this theory, each noun is specified for countability at the lexical-syntactic level in form of a lexical-syntactic attribute: either [mass] for mass nouns or [count] for count nouns. This attribute at the lexical-syntactic level can be accessed and selected through the noun's lexical-syntactic (lemma) representation, as for grammatical gender. However unlike grammatical gender, the selection of mass/count noun attributes may be additionally influenced by conceptual-semantic mass/count information (for supporting evidence see Fieder, Nickels, Biedermann & Best, 2014, 2015; Fieder, Nickels & Biedermann, 2014). Support for a syntactically driven mass/count distinction comes from an ERP study by Steinhauer, Pancheva, Newman, Gennari and Ullman (2001) which measured brain activity during reading of grammatically plausible mass and count noun sentences. Steinhauer et al. found a frontal negativity effect which reflected syntactic processing and was different to the conceptual-semantic effect (N400) found in semantically implausible sentences.

So far, we have discussed how lexical-syntactic mass/count information is most likely to be represented and accessed within Levelt et al.'s theory (1999): in form of a hybrid lexical-syntactic attribute whose selection is predominantly determined by lexical-syntactic activation but can additionally be influenced by conceptual-semantic information. In this study we focus on the production of mass and count noun phrases using the picture-word interference paradigm to investigate lexical-syntactic processing of mass and count nouns. As we will see from the results of previous picture-word interference studies, the type of lexical-syntactic attribute (fixed intrinsic lexical-syntactic properties vs. variable extrinsic lexical-syntactic features) can have implications for lexical-syntactic processing.

One empirical approach used to investigate how words are represented and processed is the picture-word interference task (e.g., Alario, Matos & Segui, 2004; Costa, Mahon, Savova & Caramazza, 2003; La Heij, Mak, Sander & Willeboordse, 1998; Schiller & Caramazza, 2002; Schriefers, 1993; Schriefers, Jescheniak & Hantsch, 2002; Schriefers & Teruel, 2000; Spalek & Schriefers, 2005; van Berkum, 1997). In this paradigm, participants are presented with a picture which they are asked to name with either a bare noun without a determiner or using a simple noun phrase. Additionally, they are presented auditorily or visually with a distractor word which either shares characteristics with the target word or does not. Results of picture-word interference tasks have shown that picture naming latencies are affected by the type of relationship between the distractor word and target: There is interference with longer picture naming latencies when target and distractor are semantically related (e.g.,Schriefers, Meyer & Levelt, 1990) but facilitation, with shorter naming latencies, when target and distractor are phonologically related (e.g., Schriefers et al., 1990).

More recently the picture-word interference paradigm has been used to investigate lexical-syntactic representation by studying agreement within a noun phrase[4]. Schriefers (1993) was the first to extend the paradigm to study processing of grammatical gender by manipulating the grammatical relationship between target pictures and distractor words. Grammatical gender was either the same (gender congruent) or different (gender incongruent) across target and distractor items. Experiments with Dutch speakers revealed a gender congruency effect with gender incongruent distractors leading to longer latencies for noun phrase production than gender congruent distractors. Schriefers interpreted longer naming latencies in the gender incongruent condition as resulting from competition between the grammatical gender of the target noun and the grammatical gender of the distractor noun at the lexical-syntactic level. In this case the two activated gender nodes compete for selection, whereas in the gender congruent condition, only one gender node is activated for selection. Schiller and Caramazza (2003, 2006) refer to Schriefers' (1993) theory as the 'gender selection interference hypothesis'. In order to extend its scope to lexical-syntactic attributes other than gender, we will refer to this hypothesis with the more general term: 'lexical-syntactic attribute selection interference hypothesis'. The gender congruency effect was replicated in Dutch by Van Berkum (1997), La Heij et al. (1998) and Schiller and Caramazza (2003), in Croatian by Costa, Kovacic, Fedorenko, and Caramazza (2003), and in German by Schriefers and Teruel (2000), and Schiller and Caramazza (2003).

The origin of the gender congruency effect, however, was questioned (see e.g. Miozzo & Caramazza, 1999; Schiller & Caramazza, 2002, 2003) because it was only

[4] Of course, there are a number of other commonly used empirical methods to investigate lexical-syntactic processing of bare nouns, such as during Tip of the Tongue states (e.g., Biedermann, Ruh, Nickels & Coltheart, 2008; Miozzo & Caramazza, 1997, Caramazza & Miozzo, 1997; Vigliocco, Antonini & Garrett, 1997; Vigliocco et al., 1999) and lexical-syntactic processing at the sentence level using sentence completion tasks (e.g., Bock, Eberhard, Cutting, Meyer & Schriefers, 2001; Eberhard,

apparent when the subject was required to produce a noun phrase with a determiner and not when bare nouns were produced (La Heij et al., 1998; Starreveld & La Heij, 2004). In noun phrases, target and distractor in the gender incongruent condition not only differed in their grammatical gender but also with regard to their determiners (Dutch has two grammatical genders, nouns of common gender are combined with the definite determiner 'de' and nouns of neuter gender with the definite determiner 'het'). Hence, an interference effect in the gender incongruent condition could have resulted from competition between different determiners rather than between gender nodes. Miozzo and Caramazza (1999) referred to this theory as the 'determiner selection interference hypothesis'.

Schiller and Caramazza (2003) used the same paradigm to further investigate the origin of the grammatical gender effect. They made use of the fact that in German and Dutch there is form identity between the gender unmarked plural determiner (in Dutch: de; in German: die) and one of the gender-specific singular determiners (in Dutch the singular common determiner: 'de' and in German the singular feminine determiner: die). Hence, to distinguish between the attribute and determiner selection interference hypotheses, they used target-distractor pairs that differed in grammatical gender and compared those that shared the same determiners (plural targets and plural distractors) with those that differed in their determiners (singular targets and singular distractors). In the lexical-syntactic attribute interference hypothesis, the source of interference is lexical-syntactic gender, and therefore a gender congruency effect was predicted independently of whether the determiners were the same or different. In contrast, if the source of the interference was competition between determiners, then no gender congruency effect was predicted when the target-distractor pairs shared the same determiner form. The results of this study replicated the gender congruency effect (Schriefers, 1993) for singular target pictures paired with singular distractors, when the determiners differed. However, critically, no gender congruency effect was found in the plural-plural target-distractor condition where the determiner form was shared. These results supported the determiner selection interference hypothesis, which assumes that the selection of grammatical gender is an automatic non-competitive process.

Cutting, & Bock, 2005; Bock, Carreiras & Meseguer, 2012; Bock & Middleton, 2011; Meyer & Bock, 1999).

According to this theory, both target and distractor activate their grammatical gender at the lexical-syntactic level and their gender-specific determiner forms at the word form level. Competition is assumed to occur only in gender incongruent conditions when different determiners are activated and compete for selection.

The origin of the gender congruency effect is still debated on the basis of findings from studies in different languages using a similar methodology to Schiller and Caramazza (2003) that exploits conditions where gender differs but noun phrase constituents (e.g., determiners, pronouns, adjectives) can be the same or different (in Dutch: Janssen & Caramazza, 2003; Schiller & Caramazza, 2006; in German: Schriefers, Jescheniak & Hantsch, 2002, 2005; in French: Alario & Caramazza, 2002; Alario, Ayora, Costa & Melinger, 2008; in Czech: Bordag & Pechmann, 2008, 2009). Evidence and counterevidence has been found for both the lexical-syntactic attribute and the determiner selection interference hypotheses, which has led to the development of several alternative theories for the selection of grammatical gender and gender-specific constituents (e.g., 'primed unitized activation hypothesis', Alario & Caramazza (2002); 'singular-as-default hypothesis', Schriefers et al., 2002).

Even though processes and mechanisms involved in the selection of grammatical gender and gender-specific determiners are still unclear, nevertheless, a clear conclusion can be drawn about the representation of grammatical gender at the lexical-syntactic level. Namely, nouns are specified for grammatical gender in the form of a fixed intrinsic lexical-syntactic property for each gender which is activated and selected during the production of gender-specific noun phrases and enables the activation of gender congruent determiner representations.

Turning from grammatical gender to the variable extrinsic lexical-syntactic feature number, Schiller and Caramazza (2002) investigated effects of number congruency in German using the picture-word interference paradigm. Participants were asked to name target pictures using a singular or plural bare noun depending on the number of objects displayed in the picture. Each target picture was combined with a number congruent and a number incongruent written distractor noun whose comparison revealed no number congruency effect. Schiller and Caramazza (2003) found no effect of number congruency for the production of noun phrases in Dutch or German, in contrast to the effect of gender congruency in these languages. Schiller and Caramazza (2003) accounted for the absence of a number congruency effect by suggesting that the number feature could be determined extra-lexically. However, they did not further specify how this could prevent competition between determiners and/or attributes.

Based on the results of the picture-word interference literature, it seems to follow that grammatical gender and number differ in their representation and processing. The lexical-syntactic representation of number is activated by conceptual-semantic information, whereas gender is activated via a noun's lemma node. In addition, there is competition for gender but not for number.

It is clear that most of the previous research on lexical-syntax has focused on grammatical gender and number, with far less on the mass/count (countability) distinction (e.g., Barner & Snedeker, 2005, 2006; Gillon, Kehayia & Taler, 1999; Mondini, Kehayia, Gillon, Arcara & Jarema, 2009; Taler & Jarema, 2006, 2007; Vigliocco et al., 1999). Countability is a particularly interesting lexical-syntactic attribute due to the fact that there appear to be clear influences of both conceptual-semantics and lexical-syntax (Fieder et al., 2014, 2015). This study used the picture-word interference paradigm to investigate lexical-syntactic processing of mass and count nouns. Specifically, we investigated whether processing of lexical-syntactic mass/count information leads to similar congruency effects as for grammatical gender. Based on our theoretical assumptions earlier, we hypothesise that lexical-syntactic mass/count processing is predominantly (but not necessarily exclusively) driven by lexical-syntactic information. We therefore predict a clear countability congruency effect with longer naming latencies for target pictures which are paired with a countability incongruent distractor compared to a countability congruent distractor. Two experiments are reported that assess grammatical processing of countability. Experiment 1 examined naming pictures of plural count noun and mass noun targets with a noun phrase using the mass-specific or count-specific determiners 'much$_{mass}$' and 'many$_{count}$'. Experiment 2 aimed to replicate and thus test the robustness of the countability congruency effect that was found in Experiment 1 under even more tightly controlled conditions by using: (i) morphologically simple target and distractor words in form of mass and singular count nouns, and (ii) different determiners: ‘some$_{mass}$’ and ‘a$_{count}$’.

Experiment 1: Countability Congruency in Mass Nouns and Plural Count Nouns

In Experiment 1, native English speakers were required to name a set of pictures of mass nouns and plural count nouns with the grammatically appropriate noun phrase: ‘not much...’ for mass nouns and ‘not many...’ for plural count nouns. The quantifiers ‘much$_{mass}$’ and ‘many$_{count}$’ were chosen as determiners because (with ‘little$_{mass}$’ and ‘few$_{count}$’) they represent the only unambiguous mass/count-specific determiners in English. Each picture had a superimposed written distractor noun. This could be either: countability congruent (i.e., a mass noun for a mass picture, a plural count noun for a plural count picture) or countability incongruent (i.e., a plural count noun for a mass picture, a mass noun for a plural count picture). In addition, we included an identity condition (the target noun), which we expected to show facilitation of naming and thereby demonstrate that the distractor was being processed. We also included a baseline condition (a row of five Xs) as a neutral distractor condition (i.e. XXXXX) in order to identify whether any congruency effect was due to facilitation in the congruent condition or competition in the incongruent condition[5]. Both the determiner competition and lexical-syntactic attribute competition hypotheses (e.g., Schiller & Caramazza, 2003; Schriefers, 1993) predict longer naming latencies for the countability incongruent distractor condition compared to the baseline condition. Table 1 summarises the conditions in the experiment.

Method

Participants

Forty-eight participants (18-52 years) took part in this experiment, in exchange for course credits or AU$15. All participants were students at Macquarie University, Sydney

[5] It has been argued that a row of Xs is not an ideal neutral distractor condition for lexical experimental distractor conditions, as Xs are visually less complex (Bloem & La Heij, 2003), non-lexical (Alario et al., 2008) and therefore faster (Jonides & Mack, 1984) and more accurately processed compared to lexical distractors. However, a lexical neutral distractor was not possible in this study, as any noun is either mass or count and hence not lexical-syntactically neutral, consequently we had no choice but to use a row of Xs as the neutral condition.

and native speakers of English with no history of language impairment.

Materials

Sixty-four picture stimuli were used with 32 pictures representing mass nouns and 32 pictures representing plural count nouns (see Supplemental Material A). Plural count nouns and mass nouns were depicted as arrays of between two and five objects. The number of depicted objects was matched across the two conditions.

Mass noun and count noun stimuli were matched listwise for log transformed written and spoken lemma frequency from the CELEX database (Baayen, Piepenbrock & van Rijn, 1993; Baayen, Piepenbrock & Guliker, 1995), number of syllables, phonemes and graphemes using the MRC Psycholinguistic database (Coltheart, 1981), bigram and trigram frequency, phonological and orthographic neighbourhood density from the English lexicon project (Balota, Yap, Cortese, Hutchinson, Kessler, Loftis, Neely, Nelson, Simpson & Treiman, 2007), and for imageability, concept familiarity, age of acquisition, image agreement and name agreement (data collected by the authors). Ratings were obtained by the authors from 20 participants for imageability, concept familiarity and visual complexity and from 30 participants for age of acquisition and image agreement, using the instructions from Gilhooly and Hay (1977) for Age of Acquisition, Paivio, Yuille and Madigan (1968) for imageability, and Alario and Ferrand (1999) for the remaining variables (see Supplemental Material B for matching data). For name agreement, thirty participants provided objective measures of naming accuracy in a picture naming experiment. Participants were instructed to name the pictures as quickly and as accurately as possible.

We further controlled the selection of mass and count noun items using Vigliocco et al.'s (1999) technique for rating countability: 20 participants were given a list of nouns and three different pairs of sentence contexts of which one was grammatically restricted to count nouns and the other to mass nouns ((a) There is …$_{mass}$ vs. There is a …$_{count}$, (b) There won't be much…$_{mass}$ vs. There won't be many…$_{count}$, (c) There is some…$_{mass}$ vs. There are a few…$_{count}$). The participants were asked to select the appropriate choice for each noun and also to decide whether the noun could form a plural. The average number of mass noun contexts and count noun contexts were calculated for each word. Only those nouns with an average of more than 3.5 out of a possible four for the target (mass or count) context were selected as experimental stimuli.

In the picture-word interference task, each stimulus picture was paired with 4 different written distractors: (a) countability congruent distractor (target-distractor: plural count noun-plural count noun; mass noun-mass noun), (b) countability incongruent distractor (target-distractor: plural count noun-mass noun; mass noun-plural count noun), (c) identity distractor (written name of the target) and (d) neutral distractor (baseline, XXXXX) condition, (see Supplemental Material A for stimuli). Distractor words in the 2 critical distractor conditions (plural count nouns and mass nouns) were matched listwise for log transformed written and spoken lemma frequency from the CELEX database (Baayen et al., 1993; Baayen et al., 1995) and the number of syllables and graphemes using the MRC Psycholinguistic database (Coltheart, 1981)(see Supplemental Material C for details of distractor matching). Distractors were not semantically or phonologically related to their target pictures. For both target groups (count nouns and mass nouns) the same mass noun and plural count noun distractors were used, to ensure that differences between conditions did not arise due to differences in the distractors. Both plural count noun and mass noun targets were displayed as multiple objects (e.g., several heads of broccoli rather than just one). This was in order to prevent (i) possible strategic effects (mass nouns being indicated by a single visual referent, whereas count nouns by multiple); and (ii) effects of semantic number incongruency between the depicted objects and the number information of the determiners: mass and count noun objects were represented as multiple objects as both target determiners 'much' and 'many' refer to a multitude of entities or substances.

The pictures appeared as coloured photographs on a white background. The size of each picture was 10x10cm. Distractors were displayed in black characters, written in Arial 16 point font. Pictures were displayed in the centre of the screen with the distractor words appearing at slightly different positions around fixation to prevent participants from ignoring the distractor. The position of all 4 distractor words for an individual picture, however, was always the same.

Procedure

Participants were tested individually in a quiet room. The experimenter sat in the room to score errors. The items were presented on a Diamond Digital 1998E computer screen. On each trial participants saw a fixation point for 600 ms in the centre of the screen. The target picture followed with a superimposed distractor word. Participants were instructed to name each picture as fast and as accurately as possible either with the noun phrase 'not much_(plus picture name)' or 'not many_ (plus picture name)' depending on the name of the picture. Participants were further informed that there would be a word superimposed on each picture which they should try to ignore. Naming latencies were measured by means of a voice key, which was activated at the onset of the target presentation. Target and distractor remained on the screen until a vocal response was provided or until the timeout of 3000 ms. The next trial started 500 ms after the end of the previous trial. Trial sequences were controlled by DMDX (Forster & Forster, 2003).

Design

Before the beginning of the test phase, participants received a familiarisation phase followed by a practice phase. In the familiarisation phase, participants were presented with each of the target pictures without their distractors (64 pictures). Each picture remained on the screen for 2000 ms in total. Participants were instructed to study the picture. After 1000 ms the picture's name (a mass noun or plural count noun) was displayed below the picture which had to be read aloud by the participant. Participants were asked to use only the name provided when naming the pictures in the subsequent phases of the experiment.

In the practice phase, each target picture was again presented without its distractor (64 pictures). The participants were instructed to name the picture with the appropriate one of two noun phrases: 'not many_(picture name)' or 'not much_(picture name). Each trial started with a fixation point (+) for 600 ms followed by the picture. The picture remained on the screen for 3000 ms. After completion of the practice phase, participants received corrective feedback on those pictures for which they had not used the designated name (e.g., target: $\text{cotton}_{\text{mass}}$, response: '$\text{wool}_{\text{mass}}$' or '$\text{marshmallows}_{\text{count}}$'; target: $\text{vases}_{\text{count}}$, response: '$\text{glasses}_{\text{count}}$' or '$\text{crystal}_{\text{mass}}$') or the correct noun phrase (e.g., target: not $\text{much}_{\text{mass}}$

broccoli, response: ‘not many$_{count}$ broccolis’ or ‘some$_{mass}$ broccoli’; target: ‘not many$_{count}$ apples’; response: ‘not much$_{mass}$ apple’, ‘few$_{count}$ apples’, or ‘_apples’). The practice phase was adopted to make sure that participants knew the correct word and determiner for each target and to provide familiarisation with the procedure.

All participants saw the 64 target pictures in all four distractor conditions. Target-distractor conditions were distributed evenly across four blocks (32 items per word group (32 mass nouns, 32 plural count nouns)/ 4 conditions = 8 items of each distractor condition for each of the two word groups (mass nouns and count nouns per block). No target picture appeared more than once in a block. Participants received the 4 blocks with a short break between blocks. The order of the blocks was counterbalanced across the participants. Order of stimuli within each block was randomised for each participant. The experimental phase started with 14 training pictures to familiarise participants with the new requirements. The procedure was similar to the practice phase with the exception that the participants did not receive any feedback. The entire experiment lasted approximately 45 minutes.

Analysis

A series of planned comparisons was conducted to examine effects of noun distractor conditions: countability (countability congruent versus countability incongruent), identity (identity versus countability congruent, identity versus countability incongruent, identity versus baseline) and baseline (countability congruent versus baseline, countability incongruent versus baseline). The analyses of the picture naming latency data (logRT) were performed using linear mixed-effects modelling as implemented in the lme4 package (Bates, Maechler, Bolker & Walker, 2014) in the statistical software R (version 3.2.2), R Development Core Team, 2008) with four fixed effect factors (noun distractor conditions, countability, a 2x2 interaction between noun distractor condition x countability, item presentation order) for each of the noun distractor comparisons. The structure of the random factors was determined using a backward stepwise model selection procedure. Random factors were only included if they improved the model’s fit significantly resulting in random intercepts for items and participants, as well as by-participants random slopes for the effect of countability: *lmer (logRT ~ distractor condition * countability + presentation order + (1 +*

countability | participants) + (1 | targets), data = experiment 1). For the analyses of (ANOVA-like) main effects of distractor condition and countability factors were sum coded. In order to analyse simple effects and thus assess whether mass and count noun targets were influenced similarly by the different noun distractor conditions, planned contrasts were conducted separately for mass and count noun targets in the different noun distractor conditions. The p-values for the contrasts were adjusted using the Holm-Bonferroni sequential correction for multiple comparisons. The factor 'item presentation order' was included to control for longitudinal task effects such as fatigue or habituation.

The error analyses were performed using the same principles as the naming latency analyses. We applied a binomial variance assumption to the trial-level binary data using the function glmer as part of the R-package lme4 (Bates et al., 2014). We considered the overall error rate and the error rate for determiners separately. We hypothesized that countability incongruency was more likely to result in determiner errors than in noun errors. P-values were determined using the package lmerTest (Kuznetsova, Brockhoff & Christensen, 2014).

Results

All response trials were audio recorded, transcribed and checked for accuracy and timing using CheckVocal[6] (Protopapas, 2007) to ensure that the voice-trigger mechanism had correctly registered the beginning of the response. Trials which were mistriggered (e.g., through lip smacking, heavy breathing, movements or sound volume) were adjusted. Trials in which participants produced errors (452 data points, 3.7%), 'no responses' (7 data points, 0.06%) and hesitations (e.g., 'not….much broccoli', 'not many….apples') (201 data points, 1.6%) were excluded. Trials where naming latencies were faster than 300 ms and slower than 2000 ms, and those which were more than three standard deviations above or below

[6] CheckVocal is a program which aims to facilitate the manual processing of spoken responses. It determines response accuracy, and it also ensures that the voice-trigger mechanism has correctly registered the participant's naming response, because it is very likely that voice keys are triggered by non-speech sounds made by the participant prior to the response (e.g., lip smacking, coughing, and hesitation fillers), or late responses to the preceding items. Although it is possible to exclude some sources of timing errors by setting absolute thresholds (e.g., discarding response times below 100 ms or above a certain delay), it is not possible to ensure reliable response times entirely automatically (Protopapas, 2007, p. 859).

the mean of the participant (207 data points, 1.7%) were removed. The mean naming latencies and error rates are summarised in Table 1.

--Table 1 about here--

Latency Analyses

Planned comparisons: identity, baseline and countability congruency.

For a summary of the results see Table 2. Presentation order was always significant and will not be discussed further.

--Table 2 about here--

Identity: The identity condition resulted in significantly faster naming latencies compared to countability congruent noun distractors, countability incongruent noun distractors and the baseline. Countability was not significant, nor were any of the interactions between countability and distractor condition (identity and either countability congruent distractors, countability incongruent distractors, baseline distractors). We undertook planned contrasts to assess whether each of the target noun groups, mass and count nouns were influenced by the distractor conditions. The results showed a significant identity advantage for both mass and count noun targets compared to countability congruent noun distractors, countability incongruent noun distractors and the baseline.

Baseline: The baseline condition was significantly faster than the countability incongruent condition and the countability congruent noun distractor condition. Countability and the interaction between countability and distractor condition were not significant. Planned contrasts showed a significant effect of baseline condition for both, mass and count noun targets.

Countability Congruency: Most importantly, there was a significant countability congruency effect for target nouns: Target pictures were named faster with countability congruent noun distractors than with countability incongruent noun distractors. There was no significant effect of countability, nor an interaction between countability and distractor condition. Moreover, planned contrasts revealed that the countability congruency effect was significant for both mass and count nouns.

Error Analyses

Percentage of the relevant error subtypes are summarised in Table 3. As discussed in the Analysis section, we considered not only the overall error rate but also the error rate for determiners as countability incongruency is more likely to result in determiner errors than in noun errors.

--Table 3 about here--

Planned comparisons: identity, baseline and countability congruency.

The results are summarised in Table 4 & 5. Presentation order was only significant when comparing the countability congruent with the countability incongruent condition, identity with the countability congruent condition, and the baseline with the countability congruent condition.

--Table 4 & 5 about here—

All Errors (Overall Accuracy)

Identity: The identity condition resulted in significantly fewer errors compared to countability congruent noun distractors, countability incongruent noun distractors and to the baseline condition. A marginally significant interaction between countability and distractor condition was found for the identity condition compared to the countability congruent condition and compared to the baseline condition. Planned contrasts showed a significant identity advantage for mass and count noun targets with fewer errors in the identity condition (mass nouns: total of 19 errors; count nouns: total of 27 errors) compared to the countability congruent condition (mass nouns: 73 errors; count nouns: 59 errors) and to the countability incongruent condition (mass nouns: 81 errors; count nouns: 109 errors). This was not the case for the identity-baseline comparison, where only mass nouns (identity: 19 errors;

baseline: 50 errors) but not count nouns (identity: 27 errors; baseline: 37 errors) showed a significant identity advantage.

Baseline: In all baseline comparisons, there were significantly fewer errors in the baseline condition compared to the countability congruent condition and to the countability incongruent condition. A significant interaction between countability x distractor condition was found for the baseline compared to the countability incongruent distractor condition. Planned contrasts revealed a significant effect of distractor condition for mass nouns and count nouns in all of the comparisons.

Countability Congruency: Similar to the naming latency data, a significant countability congruency effect was found for naming accuracy with more errors in the countability incongruent condition compared to the countability congruent condition. However, for errors a significant interaction was found between countability x distractor condition whereby a contrast revealed only a significant effect of countability congruency for count nouns (countability congruent: 59 errors; countability incongruent: 109 errors), but not for mass nouns (countability congruent: 73 errors; countability incongruent: 81 errors).

Determiner errors

Presentation order was always significant or close to significant, except when comparing the baseline with the countability incongruent condition and the countability congruent with the countability incongruent condition.

Identity: The separate analysis of determiner errors revealed an identity effect similar to the overall error analysis with significantly fewer errors for the identity condition compared to the countability congruent condition, the countability incongruent condition and the baseline condition. There was no significant effect of countability, nor an interaction between countability x distractor condition. Contrast analyses showed a significant effect for mass and count nouns in the identity condition compared to the countability incongruent condition. The identity effect was also significant for mass nouns and marginally significant for count nouns when compared to the countability congruent condition. The comparison of the identity and baseline condition revealed only a marginally significant effect for mass nouns, but not for count nouns.

Baseline: The baseline condition resulted in fewer determiner errors. This effect was significant when compared to the countability incongruent condition, and marginally significant when compared to the countability congruent condition. There was no significant effect of countability, nor an interaction between countability x distractor condition. Contrast analyses revealed a significant effect for mass and count nouns in the baseline condition compared to the countability incongruent condition, but not in the countability congruent condition.

Congruency: Most importantly, as hypothesized, there was a main effect of countability congruency with significantly more determiner errors in the countability incongruent condition compared to the countability congruent condition. Contrast analyses showed that the countability congruency effect was significant for both, mass nouns and count nouns.

Discussion

This is the first study to use the picture-word interference paradigm to test for effects of countability congruency on noun phrase production.

First, in the identity condition, producing noun phrases using mass nouns or plural count nouns in response to pictures was significantly faster and more accurate when the written name of the target was superimposed on the picture, compared to any of the other conditions (countability congruent, countability incongruent, and baseline conditions). This identity advantage can be attributed to additional converging activation for the target word from the written noun. The presence of this identity advantage demonstrates both that the distractor words were processed and that the experiment was sensitive enough to generate distractor effects on picture naming.

Most importantly, this experiment demonstrated a countability congruency effect for mass nouns and count nouns: For pictures requiring naming with plural count noun phrases (not many_$nouns_{countpl}$), responses were significantly faster and determiners were produced significantly more accurately with a count noun distractor than a mass noun distractor. Similarly, naming pictures with mass noun phrases (not much_$noun_{mass}$) was significantly faster and determiners were produced significantly more accurately when the distractor was a mass noun rather than a count noun.

The finding of a countability congruency effect suggests that grammatical mass/count information has a psychological reality and that nouns are specified for countability. The symmetrical patterns of countability congruency found here are identical to those found in the experiments on grammatical gender (Costa et al., 2003; La Heij et al., 1998; Schiller & Caramazza, 2003; Schriefers, 1993; Schriefers & Teruel, 2000; Van Berkum, 1997). Thus, the congruency effect supports our hypothesis that countability information is processed in a similar way to grammatical gender and is therefore predominantly determined by activation via a noun’s lexical-syntactic representation.

Finally, the results of the baseline (row of Xs) condition in Experiment 1 when compared to the countability incongruent noun distractor condition are in line with our predictions that the effect was due to competition: Naming latencies were significantly longer and less accurate for pictures with countability incongruent noun distractors compared to the baseline. Participants were also significantly faster and mostly more accurate in picture naming in the baseline condition compared to the countability congruent noun distractor condition (for similar baseline effects in picture-word interference studies see Janssen, Melinger, Mahon, Finkbeiner & Caramazza, 2010; Pechmann, Garrett & Zerbst, 2004). Longer naming latencies for the countability congruent noun distractor condition compared to the baseline condition can be accounted for by an interference effect caused through competition between target and distractor nouns (but not their lexical-syntactic attributes) at the lexical-syntactic level (see Nickels et al., 2015).

Despite finding the predicted congruency effect, we cannot be certain that slower naming latencies for pictures in the countability incongruent condition compared to the countability congruent condition were caused entirely by differences in countability congruency between a target picture and its distractor words. Instead the congruency effect could have also been the result of differences in morphosyntactic complexity (markedness) between mass nouns and plural count nouns. In this experiment, mass nouns were morphologically unmarked (or simple) while count nouns were morphologically marked (or complex) through the presence of an additional plural morpheme (-s, -es). It follows, that the observed congruency effect for mass and count nouns could have been influenced by, and thus be an artifact of, morphological congruency/incongruency between the target and its distractor words. That is, mass noun targets were morphologically unmarked, hence when paired with a mass noun distractor, mass noun target and distractor words were not only countability congruent but also morphologically congruent. In contrast, mass noun targets paired with a plural count noun distractor word in the countability incongruent condition led to an incongruency in countability and morphological markedness. Similarly for plural count noun targets, in the countability congruent condition target and distractor words were countability and morphologically congruent as both were count nouns marked with plural morphology. For the incongruent condition, plural count noun target and distractor words differed with morphologically marked count noun targets and morphologically unmarked mass noun distractors.

It follows, therefore, that differences in the generation of marked (or complex) versus unmarked (or simple) morphology in the congruent compared to the incongruent condition could have resulted in the observed congruency effect. For example, shorter naming latencies in the countability and morphologically congruent condition could have been caused by facilitation in the generation of the morphological frame. For plural count noun targets, the plural count noun distractor word could have pre-activated and thus facilitated the activation of the morphological frame for the target {unmarked noun + plural morpheme}, while no such facilitation would have taken place in the countability and morphologically incongruent condition. This confound between countability congruency and morphological congruency was addressed in Experiment 2.

Another concern arising from the use of morphologically marked count nouns in Experiment 1 was that written distractor words were consequently overtly marked for mass and count in this stimulus set. Count noun distractors were always identifiable as count by the presence of a plural –s, while mass noun distractors were marked for mass through the absence of the plural –s. This could have raised the participants' awareness of the mass/count distinction and as a result influenced their grammatical processing. For example, once participants were aware of the mass/count distinction they could have paid more attention to the mass/count status and the countability congruency of target-distractor pairs leading to an increased countability congruency effect. In Experiment 2, we prevented the possible occurrence of such an effect by using singular count nouns and mass nouns and thus target and distractors that are not overtly marked for countability.

A final motivation for conducting Experiment 2 was the use of different determiners, specifically, indefinite articles ('a' and 'some') instead of quantifiers ('many' and 'much'). Articles unlike quantifiers have the advantage of comprising predominantly grammatical information and hardly any semantic information. This prevents a possible semantic influence on grammatical processing of the determiner in the target noun phrase. In contrast to articles, quantifiers contain considerable semantic information about the quantity or the amount of the object. In Experiment 1, semantic information of the quantifiers 'many' and 'much' could have influenced grammatical processing. For example, semantic information derived from the number of object depictions ('MUTIPLE') could have pre-activated a cohort of determiners that comprise the meaning MULTIPLE (e.g., many, much, several, plenty). As a result of the pre-activation of a selective determiner cohort that also includes the target determiners ('much' and 'many') grammatical processing could have been accelerated in each of the distractor conditions.

Experiment 2: Countability Congruency in Mass Nouns and Singular Count Nouns

The aim of Experiment 2 was firstly to identify the source of the congruency effect by using exclusively morphologically simple (unmarked) target and distractor words in the form of singular count nouns and mass nouns. If the congruency effect found in Experiment 1 is caused by congruency/incongruency in countability, we would expect to see the same countability congruency effect in Experiment 2. However, if the congruency effect in Experiment 1 was the result of congruency/incongruency in morphological complexity (markedness), we would expect to find no difference between the countability congruent and incongruent condition in Experiment 2. Secondly, Experiment 2 aimed to test the robustness of the countability congruency effect with a different set of determiners – the indefinite articles 'a' for singular count nouns and 'some' for mass nouns.

Similar to Experiment 1, Experiment 2 used a picture-word interference paradigm in which participants were asked to name mass and count noun pictures with a noun phrase (‘a _’ for count nouns, ‘some _’ for mass nouns). Two critical noun distractor conditions were included: a countability congruent condition (i.e., a mass noun for a mass picture, a singular count noun for a singular count picture) and a countability incongruent condition (i.e., a singular count noun for a mass picture, a mass noun for a singular count picture). As in Experiment 1, we included further an identity condition (the target noun) in order to demonstrate that the distractor was being processed and a baseline condition (i.e. XXXXX) to identify the nature of the congruency effect - facilitation in the congruent condition or competition in the incongruent condition (see Table 6).

Participants

Forty-eight participants (17-42 years) took part in this experiment in exchange for course credits or AU$15. All participants were students of Macquarie University, Sydney and native speakers of English with no history of language impairment.

Materials

The same target picture stimuli were used as in Experiment 1 except that mass and count nouns were depicted as single objects. Each target picture was paired with 4 different written distractors: (a) countability congruent distractor (target-distractor: singular count noun- singular count noun; mass noun-mass noun), (b) countability incongruent distractor (target-distractor: singular count noun-mass noun; mass noun-singular count noun), (c) identity distractor (written name of the target) and (d) neutral distractor (baseline, XXXXX) condition, (see Supplemental Material D for stimuli). Distractor words (including 50% of the distractor items from Experiment 1) in the 2 critical distractor conditions (singular count nouns and mass nouns) were matched listwise for log transformed written and spoken lemma frequency from the CELEX database (Baayen et al., 1993; Baayen et al., 1995) and the number of syllables and graphemes using the MRC Psycholinguistic database (Coltheart, 1981) (see Supplemental Material E for details of distractor matching). Target-distractor pairs were not semantically or phonologically related. The same mass noun and singular count noun distractors were used for mass and count noun targets.

Design and Procedure

The design and procedure was identical to Experiment 1 except for the determiners used with the target count noun ('a') and mass noun phrases ('some'). The entire experiment lasted approximately 45 minutes.

Analysis

As in Experiment 1, picture naming latency and error data was analysed using a linear mixed-effects model with four fixed effect factors (noun distractor conditions, countability (count, mass), a 2x2 interaction between noun distractor condition x countability, and item presentation order) and random intercepts for items and participants, as well as by-participants random slopes for countability for each of the noun distractor comparisons.

Results

As in Experiment 1 response trials were audio recorded, transcribed and checked for accuracy and timing using CheckVocal (Protopapas, 2007). Trials in which participants produced errors (201 data points, 1.6%), 'no responses' (25 data points, 0.2%) and hesitations (33 data points, 0.3%) were excluded. Trials where naming latencies were faster than 300 ms and slower than 2000 ms, and those which were more than three standard deviations above or below the mean of the participant (489 data points, 1.9%) were removed. Mean naming latencies and error rates are summarised in Table 6.

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--Table 6 about here—

Latency Analyses

Planned comparisons: identity, baseline and countability congruency.

For a summary of the results see Table 7. Presentation order was always significant and will not be reported further.

Identity: The results showed a facilitation effect in the identity distractor condition with significantly faster naming latencies for targets that were paired with identical noun distractors compared to countability congruent noun distractors, countability incongruent noun distractors, and the baseline. Countability and the interaction between countability x distractor condition were not significant in any of the comparisons, except for the baseline condition which was marginally significant. Planned contrasts revealed a significant identity effect for both mass nouns and count nouns in all of the comparisons. This indicates that the facilitation from identity distractors was similar for mass and singular count nouns in all comparisons.

Baseline: The results of the baseline comparisons showed a significant effect of distractor condition with faster naming latencies for target pictures in the baseline condition compared to the countability congruent condition and the countability incongruent condition. There was no significant effect of countability, nor an interaction between countability x distractor condition in the baseline condition compared to the countability congruent condition, but in the baseline condition compared to the countability incongruent condition. Planned contrasts revealed a significant effect of distractor condition for both mass nouns and count nouns with faster naming latencies in the baseline condition compared to the countability congruent and incongruent condition.

Countability Congruency: There was a significant main effect of countability congruency: Target pictures were named faster with countability congruent noun distractors than with countability incongruent noun distractors. However, contrast analyses revealed that this effect was only significant for count nouns and not for mass nouns. No effect of countability, nor an interaction between countability x distractor condition was found.

--Table 7 about here--

Error Analyses

Percentage of the different error subtypes are summarised in Table 8.

--Table 8 about here--

Planned comparisons: identity, baseline and countability congruency.

All Errors (Overall Accuracy)

The results are summarised in Table 9. Presentation order was only significant when comparing the identity condition with the countability incongruent condition, and marginally significant in the identity condition compared to the countability congruent condition.

--Table 9 about here--

Identity: The identity condition always resulted in the production of the least errors. The identity effect was significant when compared to countability congruent distractors and countability incongruent distractors and marginally significant when compared to the baseline condition. There was no significant effect of countability, nor a significant interaction between countability x distractor condition. Planned contrasts showed a significant advantage for mass nouns and count nouns in the identity condition compared to countability congruent and incongruent distractors, while only mass nouns, but not count nouns showed an identity effect when compared to the baseline condition.

Baseline: In all baseline comparisons, there were significantly fewer errors in the baseline condition compared to the countability congruent condition and to the countability incongruent condition. There was a marginally significant effect of countability when comparing the baseline with the countability incongruent condition with count nouns resulting in the production of fewer errors compared to mass nouns. Moreover, the interaction between countability and distractor condition was significant when comparing the baseline to the countability congruent condition and marginally significant to the countability incongruent condition. Planned contrasts for both comparisons revealed only a significant effect of distractor condition for count nouns (baseline: 12 errors; countability congruent: 37 errors; countability incongruent: 31 errors), but not for mass nouns (baseline: 35 errors; countability congruent: 38 errors; countability incongruent: 45 errors).

Countability Congruency: There were no significant main or simple effects of countability congruency, countability, nor a significant interaction between those two factors.

Determiner errors

The results are summarised in Table 10. Presentation order was not significant in any of the comparisons.

--Table 10 about here--

Identity: The separate analysis of determiner errors showed a marginally significant identity effect in the comparison with the countability incongruent distractor condition, but not with the countability congruent condition and the baseline. There was no significant effect of countability, but there was a significant interaction between countability and distractor condition when comparing the identity condition with the countability congruent and incongruent condition. Contrasts revealed an identity effect for count nouns (identity: six determiner errors; countability congruent: 17 determiner errors; countability incongruent: 19 determiner errors), but not for mass nouns (identity: 16 determiner errors; countability congruent: eleven determiner errors; countability incongruent: 15 determiner errors) which was significant when compared to the countability incongruent condition and marginally significant when compared to the countability congruent condition. No significant identity effect was found for mass and count nouns in the baseline condition.

Baseline: The results showed a significant effect of distractor condition for the baseline compared to the countability incongruent distractor condition, but not to the countability congruent distractor condition. There was no significant effect of countability. However, there was an interaction between countability and distractor condition which was significant for the baseline compared to the countability congruent condition and marginally significant for the baseline compared to the countability incongruent distractor condition. Planned contrasts revealed an effect of distractor condition for count nouns (baseline: 6 determiner errors; countability congruent: 17 determiner errors; countability incongruent: 19 determiner errors), which was significant for the countability incongruent condition and marginally significant for the countability congruent condition compared to the baseline. No significant effect of distractor condition was found for mass nouns (baseline: 14 determiner errors; countability congruent: 11 determiner errors; countability incongruent: 15 determiner errors).

Congruency: Unlike in Experiment 1, there were no significant main or simple effects of countability congruency on determiner accuracy, nor of any other factor when comparing countability incongruent with countability congruent distractors.

Discussion

As in Experiment 1, Experiment 2 revealed a clear identity effect. Picture naming with mass and singular count noun phrases was significantly faster and more accurate when the written distractor word was identical to the target compared to any of the other distractor conditions. This shows once again that the experiment was sensitive enough to generate effects.

The outcomes of Experiment 2 also demonstrated a significant countability congruency effect. However, unlike in Experiment 1, the countability congruency effect in Experiment 2 was only significant for count noun targets, but not for mass noun targets. Pictures which required naming with singular count noun phrases (a _) produced faster response times with a singular count noun distractor than with a mass noun distractor. In contrast naming pictures with mass noun phrases (some_) was equally fast when the distractor was a mass noun compared to a singular count noun.

Even though the congruency effect that was found for mass and count nouns in Experiment 1 was only replicated for count nouns in Experiment 2, we propose nevertheless that this effect has its origin in the congruency/incongruency of countability between target and distractor and thus can still be taken as evidence for nouns being specified for countability at the lexical-syntactic (lemma) level.

There was the possibility that the congruency effect in Experiment 1 was due to congruency of morphological complexity rather than countability. The congruency effect for singular count nouns in Experiment 2 confirms that this cannot be the case since singular count noun targets and mass noun distractors were both morphologically simple (unmarked) in Experiment 2. Consequently, longer naming latencies for singular count nouns paired with a mass noun distractor in the countability incongruent condition compared to the countability congruent condition could not have resulted from congruency/incongruency in morphological complexity.

Why did Experiment 1 and Experiment 2 differ in the scope of the congruency effects found (mass and count noun phrases vs count noun phrases only)? We suggest that this may have been caused by the differences in the countability status of the target determiners that were used.

Unlike the articles in Experiment 2, the quantifiers in Experiment 1 were grammatically mass-specific and count-specific: In English, the quantifier ‘many’ is exclusively used with count nouns, and the target determiner for mass noun targets, ‘much’, is exclusively used with mass nouns. The lemma representations of a target and distractor word would only activate one of the two determiners via their lexical-syntactic mass or count attributes. For example, in the countability congruent condition with target and distractor mass nouns, both target and distractor lemmas activate the lexical-syntactic attribute [mass] and hence also activate the mass noun determiner ‘much’ (see Figure 1). In the countability incongruent condition when the target is a mass noun and the distractor is a count noun, the target activates the lexical-syntactic attribute [mass] and subsequently the determiner ‘much’, while the distractor sends activation to the lexical-syntactic attribute [count] and the determiner ‘many’. Hence, in line with the lexical-syntactic attribute interference hypothesis, as well as with the determiner selection interference hypothesis activation of the competitor attribute [count] and/or determiner ‘many’ interferes with the selection of the target attribute [mass] and/or quantifier ‘much’. This interference results in longer naming latencies for the target noun phrase in the countability incongruent condition compared to the countability congruent condition (see Figure 2).

---Figure 1 & 2 about here---

In contrast to Experiment 1, in Experiment 2 only the target determiner ‘a’ was unambiguous for countability. It can be exclusively used with (singular) count nouns, while the target determiner ‘some’ is ambiguous for countability and can be used with both mass and count nouns (e.g., ‘some$_{mass}$ celery’ versus ‘some$_{count}$ cars’). It seems probable that the countability ambiguity of the determiner 'some' diminishes the countability congruency effect for mass noun targets: As before, in the countability congruent condition, both mass noun target (e.g., celery) and mass noun distractor (e.g., hockey) activate the target determiner 'some' via their lexical-syntactic attribute [mass] at the lexical-syntactic (lemma) level (see Figure 3). In the countability incongruent condition, the mass noun target also activates the lexical-syntactic [mass] attribute which then forwards activation to the target determiner 'some'. However, while the lemma node of the count noun distractor (e.g., kennel) activates the lexical-syntactic [count] attribute, this not only activates a "distractor" determiner 'a', but also activates the target determiner 'some' since both determiners 'a' and 'some' can be used with count nouns and thus are count congruent. Hence, in the countability incongruent condition for mass nouns, while the incongruent determiner is activated, the target determiner 'some' is activated both by the target and the distractor and this would facilitate the selection of the determiner 'some' and consequently would lessen the interference effect of the countability incongruent distractor 'a' (see Figure 4). We will discuss the theoretical implication of the results in more detail in the General Discussion.

---Figure 3 & 4 about here---

Looking at the baseline, naming latencies were significantly longer for pictures with either countability congruent or incongruent noun distractors compared to the baseline. This is most likely the result of an interference effect caused through competition between target and distractor nouns (see e.g., Nickels et al., 2015).

Finally, we note that naming latencies in Experiment 2 were slower than in Experiment 1. Whilst it is possible that this is simply a random difference in the participants in each pool, we should consider whether there are any other potential factors. While there were methodological differences between the experiments, such as congruency/incongruency of morphological complexity between target and distractor words, or distractors being overtly marked for countability in Experiment 1, but not in Experiment 2 it seems unlikely that these could account for apparent differences in naming latencies between the experiments. For example, congruency of morphological complexity would have enhanced any congruency effect but not affected overall response latencies. The fact that there was overt marking of countability (-s for count nouns) in Experiment 1 could have increased the participants' awareness of the countability condition and once again could have led to a larger countability congruency effect but not overall faster naming latencies.

However, it is also possible that differences in the use of quantifiers in Experiment 1 could explain these faster naming latencies. Quantifiers are a subgroup of determiners, which unlike definite (e.g., the) and indefinite determiners (a, some) do not serve primarily a grammatical function but also comprise semantic information. For example, the quantifiers 'much', 'many', 'few' and 'little' comprise information about a relatively unspecified quantity (a large or small amount) of the noun that they precede. It is possible that the semantic information of quantifiers could exert an influence on their grammatical processing. For example, in Experiment 1 semantic information about the number of depicted objects, MULTIPLE might have activated quantifiers that comprise this number information (e.g., much, many, several) leading to a pre-activated subset (cohort) of suitable quantifiers for the production of the target noun phrase. Pre-activation of a small cohort of quantifiers including the target quantifiers might have speeded processing at the lexical-syntactic level and thus resulted in shorter naming latencies in Experiment 1 compared to Experiment 2 where indefinite articles were used.

General Discussion

This is the first reported series of experiments to use the picture-word interference paradigm to investigate effects of countability congruency on noun phrase production. The aim of this study was to investigate the nature of the representation and processing of countability, a somewhat under investigated lexical-syntactic attribute. More specifically, we were interested in whether the representation and processing of lexical-syntactic countability information is similar to that of grammatical gender and therefore whether mass/count processing is predominantly driven by lexical-syntactic information. As noted in the Introduction, the representation of mass/count information is particularly interesting as its grammatical processing is influenced by both lexical-syntactic and conceptual-semantic information. This suggests that it is neither an intrinsic lexical-syntactic property (like grammatical gender) nor an extrinsic lexical-syntactic feature (like grammatical number) but rather a hybrid lexical-syntactic attribute (see Fieder et al., 2014, 2015)[7].

The picture-word interference experiments reported here mostly replicate the previous literature that has shown that noun phrase production can be influenced by the lexical-syntactic attributes of noun distractors (e.g. grammatical gender, Schriefers, 1993; Schiller & Caramazza, 2003). In Experiment 1, we found a classical congruency effect for countability with faster noun phrase naming latencies with countability congruent distractors than with countability incongruent distractors for both mass and count noun targets. In Experiment 2 using articles instead of quantifiers, the congruency effect was replicated for count nouns, but not for mass nouns. We argued that the absence of a congruency effect for mass noun targets in Experiment 2 is most likely the result of the countability ambiguity of the target determiner 'some' which can be used with both mass nouns and count nouns (e.g., 'some celery$_{mass}$' 'some cats$_{count}$'). However, the fact that countability did result in a congruency effect (like grammatical gender, and unlike grammatical number) for mass and count noun targets in Experiment 1 and for count noun targets in Experiment 2, suggests that, as hypothesised in the Introduction, mass/count information is represented and processed in a more similar way to grammatical gender. We therefore conclude that the mass/count distinction and thus processing of mass/count grammar appears to be partly driven by lexical-syntax rather than conceptual-semantic information.

In the Discussion of Experiment 2 we described how, in the context of a picture-word interference task, target pictures and noun distractors both activate their lexical-syntactic attributes [mass] or [count]. These lexical-syntactic attributes in turn activate their corresponding quantifiers and determiners (see Figure 1 & Figure 3 earlier). Hence, in the *countability congruent condition*, the lexical-syntactic attribute (e.g., [mass]) and the determiners activated by the distractor are the same as those activated by the target noun (e.g., little, much) and include the target determiner (much). Consequently, the lexical-syntactic attribute [mass] and the target determiner receive activation twice, once from the

[7] While it is true that the grammatical expression of gender can, on occasion, be influenced by conceptual semantic factors (natural gender), these effects seem more prevalent in the expression of

target noun and once from the distractor noun. In contrast, in the *countability incongruent condition*, it is the lexical-syntactic attribute [count] and corresponding determiners (e.g., few, many) which are activated by the noun distractor. These are incongruent both at the level of the lexical-syntactic attribute and the determiners activated by the target mass noun. The lexical-syntactic attribute [mass] and the target noun quantifier (much) receive activation from only the target noun and not from both target and distractor.

The results of Experiment 1 (illustrated in Figures 1 & 2) can be explained under either the hypothesis that there is competition at the level of lexical-syntactic attribute selection or competition at the level of determiner selection. In both cases, in the congruent condition, there is no competition for selection. However, in the incongruent condition, the distractor activates the [count] attribute which may compete with the [mass] attribute (or vice versa), or the count determiner may contribute with the mass determiner (or vice versa). Either level of competition would result in longer naming latencies in the incongruent than in the congruent condition.

However, unlike in Experiment 1, the pattern of results in Experiment 2 is consistent with interference through determiner competition but not with lexical-syntactic attribute interference. If there was competition at the level of lexical-syntactic attributes we would have expected to see the same congruency effects as in Experiment 1, for both count and mass targets. However, the lack of congruency effects for mass nouns can best be explained by the fact that the target determiner 'some' is both mass and (plural) count congruent, and hence competition between determiners in the incongruent condition with mass targets is reduced: As explained in the Discussion of Experiment 2, a mass noun target (e.g., celery) presented with a countability incongruent distractor noun (e.g. kennel) results in the activation of the target lemma node and the lexical-syntactic [mass] attribute through the mass noun target and the activation of the lexical-syntactic [count] attribute through the count noun distractor. Critically, the target determiner 'some' receives activation from both the mass target and the incongruent count distractor. This enhances the activation level of the target determiner 'some' relative to other (competitor) determiners. Consequently, the target determiner 'some' remains by far the most highly activated determiner thereby reducing the

countability (see Introduction for examples).

chance of an actual interference effect from other countability incongruent (competitor) determiners, such as the determiner ‘a’ (see Figure 4, earlier).

Conclusion

Our objective was to investigate how mass/count information is processed at the lexical-syntactic level. This study derived its methodology from earlier studies which found cross-linguistic effects of gender congruency but failed to find similar effects of number congruency (e.g., Schiller & Caramazza, 2002; 2003). These results exemplified differences in representation between fixed intrinsic lexical-syntactic properties, such as grammatical gender, and variable extrinsic lexical-syntactic features like number. Given the conceptual-semantic and grammatical nature and usage of mass and count nouns, we suggested that countability could be represented in form of a hybrid lexical-syntactic attribute, a fusion between a fixed intrinsic lexical-syntactic property and a variable extrinsic lexical-syntactic feature. Our experiments, using the picture-word interference paradigm with nouns as distractors, provide the first demonstrations of a countability congruency effect on noun phrase production. Our results suggest that countability information is processed more similarly to grammatical gender than grammatical number: Countability information is predominantly activated and selected through a noun’s specific lemma node rather than directly by conceptual-semantic information. This study revealed a classical countability congruency effect for mass and plural count nouns in noun phrases with quantifiers in Experiment 1 and for singular count nouns in Experiment 2 in noun phrases with indefinite articles. The absence of a congruency effect for mass nouns when used with a countability ambiguous determiner (‘some’) supports an account where congruency effects arise due to competition between determiners at the lexical-syntactic and/or word form level.

Supplemental Material

Supplemental Material A: Experimental Stimuli for Experiment 1

Supplemental Material B: Stimuli characteristics averaged by target category (plural count nouns, mass nouns) for Experiment 1.

Supplemental Material C: Noun distractor characteristics averaged by target category (plural count nouns, mass nouns) for Experiment 1.

Supplemental Material D: Experimental Stimuli for Experiment 2.

Supplemental Material E: Noun distractor characteristics averaged by target category (singular count nouns, mass nouns) for Experiment 2.

The Supplemental Material can be found at the address

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Figure Captions

Figure 1. An illustration of mass attribute/determiner selection in the picture-word interference task of Experiment 1 for mass noun target pictures, using the example $celery_{mass}$ with a countability congruent distractor word, $hockey_{mass}$.

Figure 2. An illustration of mass attribute/determiner selection in the picture-word interference task for mass noun target pictures, using the example $celery_{mass}$ with a countability incongruent distractor, the plural count noun $arrows_{count}$.

Figure 3. An illustration of mass attribute/determiner selection in the picture-word interference task of Experiment 2 for mass noun target pictures, using the example $celery_{mass}$ with a countability congruent distractor word, $hockey_{mass}$.

Figure 4. An illustration of mass attribute/determiner selection in the picture-word interference task of Experiment 2 for mass noun target pictures, using the example $celery_{mass}$ with a countability incongruent, the singular count noun distractor $kennel_{count}$.

Table 1 *Mean picture naming latencies (in ms) and standard deviations (SD), percentage errors (%) and standard deviations (SD) of the different target-distractor conditions for Experiment 1.*

	Target condition							
	Count (Plural) (axes)				Mass (garlic)			
Distractor condition	Latency (SD)	Errors (SD)	Distractor noun	Distractor noun category	Latency (SD)	Errors (SD)	Distractor noun	Distractor noun category
Countability Congruent	766 (141.8)	3.8% (1.2)	bed	plural count noun	771 (138.7)	4.8% (1.6)	dust	mass noun
Countability Incongruent	792 (146.1)	7.1% (2.0)	dust	mass noun	789 (140.8)	5.3% (1.8)	beds	plural count noun
Identity	704 (124.6)	1.8% (0.9)	axes	plural count noun	707 (117.7)	1.2% (0.7)	garlic	mass noun
Baseline	740 (133.5)	2.4% (0.8)	XXXXXX		740 (114.9)	3.3% (1.6)	XXXXXX	
Total	*752 (139.3)*	*3.8% (1.5)*	-		*753 (131.3)*	*3.6% (1.6)*	-	

Table 2 *Results of the naming latency analyses using the model: lmer (logRT ~ distractor condition * countability + presentation order + (1 + countability | participants) + (1 | targets), data = experiment 1) for each of the different distractor condition comparisons.*

Fixed effects:	Estimate	Std. Error	df	*t*-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Identity - countability congruent								
(Intercept)	2.882	0.011	51	273.405	<.001			
Main effects:								
Distractor condition: identity-countability congruent	0.036	0.002	5619	18.366	<.001	Subject (Intercept)	0.005	0.071
Countability: count-mass	-0.003	0.004	70	-0.681	.498			
Distractor condition x Countability	-0.001	0.004	5620	-0.204	.838	Target (Intercept)	0.000	0.012
Presentation order	0.000	0.000	5625	-15.435	<.001	Countability	0.000	0.013
Simple effects:						Residual	0.005	0.073
Distractor condition for mass nouns	0.018	0.001		13.118	<.001			
Distractor condition for count nouns	0.018	0.001		12.856	<.001			
Identity: Identity - countability incongruent								
(Intercept)	2.889	0.011	52	273.668	<.001			
Main effects:								
Distractor condition: identity-countability incongruent	0.047	0.002	5556	24.746	<.001	Subject (Intercept)	0.005	0.071
Countability: count-mass	-0.001	0.004	72	-0.199	.842			
Distractor condition x Countability	0.003	0.004	5557	0.774	.439	Target (Intercept)	0.000	0.013
Presentation order	0.000	0.000	5606	-16.53	<.001	Countability	0.000	0.013
Simple effects:						Residual	0.005	0.072
Distractor condition for mass nouns	0.023	0.001		17.031	<.001			
Distractor condition for count nouns	0.024	0.001		17.962	<.001			
Identity: Identity - baseline								
(Intercept)	2.875	0.010	52	281.956	<.001			
Main effects:								
Distractor condition: identity-baseline	0.021	0.002	5710	11.525	<.001	Subject (Intercept)	0.005	0.069
Countability: count-mass	-0.002	0.004	72	-0.6	.550	Target (Intercept)	0.000	0.013
Distractor	-0.001	0.004	5712	-0.162	.871			

condition x Countability								
Presentation order	0.000	0.000	5763	-16.947	<.001	Countability	0.000	0.013
Simple effects:						Residual	0.005	0.069
Distractor condition for mass nouns	0.011	0.001		8.255	<.001			
Distractor condition for count nouns	0.010	0.001		8.045	<.001			

Fixed effects:	Estimate	Std. Error	df	*t*-value	p-value	*Random effects:*	Variance	Std. Dev.
Baseline: Baseline - countability congruent								
(Intercept)	2.893	0.011	52	275.233	<.001			
Main effects:								
Distractor condition: baseline-congruent	-0.015	0.002	5554	-7.734	<.001	Subject (Intercept)	0.005	0.071
Countability: count-mass	-0.003	0.005	74	-0.655	.515			
Distractor condition x Countability	0.001	0.004	5555	0.158	.875	Target (Intercept)	0.000	0.014
Presentation order	0.000	0.000	5603	-16.097	<.001	Countability	0.000	0.014
Simple effects:						Residual	0.005	0.072
Distractor condition for mass nouns	-0.008	0.001		-5.564	<.001			
Distractor condition for count nouns	-0.007	0.001		-5.373	<.001			
Baseline: Baseline - countability incongruent								
(Intercept)	2.901	0.011	53	274.841	<.001			
Main effects:								
Distractor condition: baseline-incongruent	-0.027	0.002	5491	-14.149	<.001	Subject (Intercept)	0.005	0.071
Countability: count-mass	-0.001	0.005	74	-0.196	.845			
Distractor condition x Countability	-0.003	0.004	5491	-0.88	.379	Target (Intercept)	0.000	0.015
Presentation order	0.000	0.000	5496	-17.226	<.001	Countability	0.000	0.013
Simple effects:						Residual	0.005	0.071
Distractor condition for mass nouns	-0.013	0.001		-9.409	<.001			

Distractor condition for count nouns	-0.014	0.001		-10.598	<.001			
Countability congruency: Countability congruent - countability incongruent								
(Intercept)	2.907	0.011	53	264.834	<.001			
Main effects:								
Distractor condition: countability congruent-incongruent	-0.012	0.002	5400	-5.997	<.001	Subject (Intercept)	0.005	0.074
Countability: count-mass	-0.001	0.005	73	-0.282	.779			
Distractor condition x Countability	-0.004	0.004	5399	-0.959	.338	Target (Intercept)	0.000	0.015
Presentation order	0.000	0.000	5447	-15.414	<.001	Countability	0.000	0.014
Simple effects:						Residual	0.006	0.074
Distractor condition for mass nouns	-0.005	0.001		-3.573	.001			
Distractor condition for count nouns	-0.007	0.001		-4.904	<.001			

Table 3 *Errors of each type as a percentage of total errors in each condition (determiner substitutions include countability congruent and incongruent determiner substitutions and false starts of determiners) and other error types (e.g., noun substitutions, omissions of nouns or determiners) and error sum for each target - distractor category for Experiment 1.*

	Target condition							
	Count (Plural)				Mass			
Error types	Countability incongruent determiner substitutions[a]	Countability congruent determiner substitutions[b]	Others	Total Number of Errors	Countability incongruent determiner substitutions[a]	Countability congruent determiner substitutions[b]	Others	Total Number of Errors
Distractor condition								
Countability Congruent	55.93%	0.00%	44.07%	59	50.68%	0.00%	49.32%	73
Countability Incongruent	67.89%	0.92%	31.19%	109	77.78%	0.00%	22.22%	81
Identity	70.37%	0.00%	29.63%	27	57.89%	0.00%	42.11%	19
Baseline	67.57%	0.00%	32.43%	37	56.00%	0.00%	44.00%	50

[a] Countability incongruent substitutions refer to substitutions by a count noun determiner for target mass nouns and a mass noun determiner for target count nouns (e.g., for mass nouns: many, few; for count nouns: much, little) which lead to a grammatically incorrect noun phrase (e.g., for mass nouns: *many rice, *those rice; for count nouns: *much apples).
[b] Countability congruent substitutions refer to substitutions by a count noun determiner for count nouns and mass noun determiner for mass nouns which are not the target determiner (e.g., for mass nouns: target determiner ‘much’, response: some; for count nouns: target determiner ‘many’, response: few) but lead to a grammatically correct noun phrase (e.g., for mass nouns: some rice, for count nouns: few apples).

Table 4 *Results of the naming accuracy analyses using the model: glmer (Accuracy ~ distractor condition * countability + presentation order + (1 + countability | participants) + (1 | targets), data = experiment 1, control = lmerControl (optimizer="bobyqa")) for each of the different distractor condition comparisons.*

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Identity - countability congruent							
(Intercept)	-3.431	0.174	-19.68	<.001			
Main effects:					Subject (Intercept)	0.468	0.684
Distractor condition: identity-countability congruent	1.131	0.175	6.469	<.001			
Countability: count-mass	0.168	0.262	0.642	.521	Target (Intercept)	0.289	0.538
Distractor condition x Countability	-0.589	0.349	-1.685	.092			
Presentation order	-0.004	0.001	-6.13	<.001	Countability	0.220	0.469
Simple effects:							
Distractor condition for mass nouns	0.713	0.129	5.51	<.001			
Distractor condition for count nouns	0.418	0.118	3.558	.001			
Identity: Identity - countability incongruent							
(Intercept)	-3.687	0.189	-19.52	<.001			
Main effects:					Subject (Intercept)	0.449	0.670
Distractor condition: identity-countability incongruent	1.531	0.174	8.8	<.001			
Countability: count-mass	0.502	0.243	2.066	.039	Target (Intercept)	0.262	0.512
Distractor condition x Countability	-0.049	0.348	-0.141	.888	Countability	0.452	0.672
Presentation order	-0.001	0.001	-0.979	.327			
Simple effects:							
Distractor condition for mass nouns	0.778	0.133	5.832	<.001			
Distractor condition for count nouns	0.753	0.112	6.743	<.001			
Identity: Identity - baseline							
(Intercept)	-4.148	0.248	-16.74	<.001			
Main effects:					Subject (Intercept)	0.480	0.693
Distractor condition: Identity-baseline	0.695	0.190	3.657	<.001			
Countability: count-mass	0.293	0.334	0.878	.380	Target (Intercept)	0.507	0.712
Distractor condition x Countability	-0.686	0.380	-1.806	.071			
Presentation order	-0.002	0.001	-1.618	.106	Countability	0.605	0.778
Simple effects:							
Distractor condition for mass nouns	0.519	0.139	3.728	.001			
Distractor condition for count nouns	0.176	0.129	1.361	.142			

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Baseline: Baseline - countability congruent							
(Intercept)	-3.358	0.191	-17.536	<.001			
Main effects:							
Distractor condition: baseline-countability congruent	-0.473	0.138	-3.415	.001	Subject (Intercept)	0.488	0.698
Countability: count-mass	0.002	0.244	0.008	.994			
Distractor condition x Countability	-0.053	0.277	-0.193	.847	Target (Intercept)	0.352	0.593
Presentation order	-0.003	0.001	-2.959	.003	Countability	0.288	0.536
Simple effects:							
Distractor condition for mass nouns	-0.223	0.092	-2.43	.045			
Distractor condition for count nouns	-0.250	0.104	-2.411	.045			
Baseline: Baseline - countability incongruent							
(Intercept)	-3.428	0.185	-18.547	<.001			
Main effects:							
Distractor condition: baseline-countability incongruent	-0.862	0.131	-6.604	<.001	Subject (Intercept)	0.485	0.696
Countability: count-mass	0.286	0.244	1.171	.242			
Distractor condition x Countability	-0.610	0.261	-2.336	.020	Target (Intercept)	0.338	0.582
Presentation order	-0.001	0.001	-0.883	.377	Countability	0.509	0.714
Simple effects:							
Distractor condition for mass nouns	-0.279	0.090	-3.096	.004			
Distractor condition for count nouns	-0.584	0.095	-6.173	<.001			
Countability congruency: Countability congruent - countability incongruent							
(Intercept)	-3.022	0.172	-17.574	<.001			
Main effects:							
Distractor condition: countability congruent-incongruent	-0.389	0.115	-3.369	<.001	Subject (Intercept)	0.525	0.7246
Countability: count-mass	0.259	0.209	1.239	.215			
Distractor condition x Countability	-0.555	0.231	-2.407	.016	Target (Intercept)	0.2356	0.4854
Presentation order	-0.002	0.001	-2.175	.030	Countability	0.3253	0.5703
Simple effects:							
Distractor condition for mass nouns	-0.056	0.082	-0.681	.496			
Distractor condition for count nouns	-0.333	0.082	-4.086	<.001			

Table 5 *Results of the determiner accuracy analyses using the model: glmer (DeterminerAccuracy ~ distractor condition * countability + presentation order + (1 + countability | participants) + (1 | targets), data = experiment 1, control = lmerControl (optimizer="bobyqa")) for each of the different distractor condition comparisons.*

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Identity - countability congruent							
(Intercept)	-4.379	0.304	-14.383	<.001			
Main effects:							
Distractor condition: Identity-countability congruent	0.853	0.219	3.899	<.001	Subject (Intercept)	0.882	0.939
Countability: count-mass	0.498	0.434	1.147	.251			
Distractor condition x Countability	-0.488	0.437	-1.116	.265	Target (Intercept)	0.633	0.795
Presentation order	-0.004	0.001	-3.04	.002	Countability	0.828	0.910
Simple effects:							
Distractor condition for mass nouns	0.548	0.162	3.393	.002			
Distractor condition for count nouns	0.304	0.147	2.067	.078			
Identity: Identity - countability incongruent							
(Intercept)	-3.837	0.189	-20.265	<.001			
Main effects:							
Distractor condition: identity-countability incongruent	1.582	0.195	8.113	<.001	Subject (Intercept)	0.578	0.760
Countability: count-mass	0.366	0.295	1.241	.215			
Distractor condition x Countability	-0.107	0.390	-0.273	.785	Target (Intercept)	0.279	0.529
Presentation order	-0.002	0.001	-3.265	.011	Countability	0.536	0.732
Simple effects:							
Distractor condition for mass nouns	0.818	0.147	5.576	<.001			
Distractor condition for count nouns	0.765	0.128	5.953	<.001			
Identity: Identity - baseline							
(Intercept)	-4.580	0.285	-16.086	<.001			
Main effects:							
Distractor condition: Identity-baseline	0.528	0.229	2.304	.021	Subject (Intercept)	0.298	0.546
Countability: count-mass	0.483	0.437	1.104	.270			
Distractor condition x Countability	-0.432	0.458	-0.943	.356	Target (Intercept)	0.455	0.674
Presentation order	-0.003	0.002	-1.762	.078	Countability	2.182	1.477
Simple effects:							
Distractor condition for mass nouns	0.372	0.169	2.2	.084			
Distractor condition for count nouns	0.156	0.155	1.009	.626			

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Baseline: Baseline - countability congruent							
(Intercept)	-4.209	0.274	-15.355	<.001			
Main effects:							
Distractor condition: Baseline-countability congruent	-0.326	0.188	-1.735	.083	Subject (Intercept)	0.802	0.896
Countability: count-mass	0.277	0.368	0.754	.451	Target (Intercept)	0.518	0.720
Distractor condition x Countability	0.051	0.376	0.136	.892			
Presentation order	-0.003	0.001	-2.057	.040	Countability	0.668	0.817
Simple effects:							
Distractor condition for mass nouns	-0.176	0.130	-1.349	.532			
Distractor condition for count nouns	-0.150	0.135	-1.111	.534			
Baseline: Baseline - countability incongruent							
(Intercept)	-3.626	0.196	-18.533	<.001			
Main effects:							
Distractor condition: Baseline-countability incongruent	-1.075	0.166	-6.483	<.001	Subject (Intercept)	0.529	0.728
Countability: count-mass	0.193	0.230	0.84	.401	Target (Intercept)	0.235	0.484
Distractor condition x Countability	-0.321	0.332	-0.966	.334			
Presentation order	-0.001	0.001	-1.144	.253	Countability	0.376	0.613
Simple effects:							
Distractor condition for mass nouns	-0.458	0.117	-3.923	.001			
Distractor condition for count nouns	-0.618	0.118	-5.239	<.001			
Countability congruency: Countability congruent - countability incongruent							
(Intercept)	-3.623	0.205	-17.647	<.001			
Main effects:							
Distractor condition [countability congruent]	-0.769	0.152	-5.049	<.001	Subject (Intercept)	0.754	0.868
Countability: count-mass	0.323	0.240	1.345	.179	Target (Intercept)	0.275	0.524
Distractor condition x Countability	-0.359	0.305	-1.178	.239			
Presentation order	-0.002	0.001	-1.629	.103	Countability	0.589	0.768
Simple effects:							
Distractor condition for mass nouns	-0.295	0.108	-2.74	.012			
Distractor condition for count nouns	-0.474	0.108	-4.399	<.001			

Table 6 *Mean picture naming latencies (in ms) and standard deviations (SD), percentage errors (%) and standard deviations (SD) of the different target-distractor conditions for Experiment 2.*

	Target condition							
	Count (Singular) (car)				Mass (coal)			
Distractor condition	Latency (SD)	Errors (SD)	Distractor noun	Distractor noun category	Latency (SD)	Errors (SD)	Distractor noun	Distractor noun category
Countability Congruent	858 (123.3)	2.4% (1.1)	bell	singular count noun	853 (126.5)	2.5% (1.4)	veal	mass noun
Countability Incongruent	869 (118.6)	2.0% (0.9)	veal	mass noun	858 (128.6)	2.9% (1.5)	bell	singular count noun
Identity	734 (112.6)	0.7% (0.5)	car	singular count noun	723 (112.3)	1.1% (0.8)	coal	mass noun
Baseline	771 (97.2)	0.8% (0.5)	XXXXX		773 (109.5)	2.3% (0.9)	XXXXX	
Total	*808 (126.3)*	*1.5% (0.8)*	-		*802 (131.3)*	*2.2% (1.2)*	-	

Table 7 *Results of the naming latency analyses using the model: lmer (logRT ~ distractor condition * countability + presentation order + (1 + countability | participants) + (1 | targets), data = experiment 2) for each of the different distractor condition comparisons.*

Fixed effects:	Estimate	Std. Error	df	*t*-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Identity - countability congruent								
(Intercept)	2.910	0.009	61	326.589	<.001			
Main effects:								
Distractor condition: identity-countability congruent	0.070	0.002	5759	34.455	<.001	Subject (Intercept)	0.003	0.057
Countability: count-mass	0.004	0.006	81	0.582	.562			
Distractor condition x Countability	-0.004	0.004	5759	-1.025	.306	Target (Intercept)	0.000	0.021
Presentation order	0.000	0.000	5761	-13.428	<.001	Countability	0.000	0.019
Simple effects:						Residual	0.006	0.078
Distractor condition for mass nouns	0.036	0.001		-24.896	<.001			
Distractor condition for count nouns	0.034	0.001		-23.448	<.001			
Identity: Identity - countability incongruent								
(Intercept)	2.91	0.01	59	331.64	<.001			
Main effects:								
Distractor condition: identity-countability incongruent	0.07	0.00	5751	36.74	<.001	Subject (Intercept)	0.003	0.057
Countability: count-mass	0.01	0.01	77	1.14	.258			
Distractor condition x Countability	0.00	0.00	5751	0.39	.700	Target (Intercept)	0.000	0.019
Presentation order	0.00	0.00	5759	-14.79	<.001	Countability	0.000	0.017
Simple effects:						Residual	0.006	0.078
Distractor condition for mass nouns	0.037	0.001		25.637	<.001			
Distractor condition for count nouns	0.038	0.001		26.328	<.001			
Identity: Identity - baseline								
(Intercept)	2.889	0.009	61	333.746	<.001			
Main effects:								
Distractor condition: identity-baseline	0.027	0.002	5840	13.725	<.001	Subject (Intercept)	0.003	0.056
Countability: count-mass	0.002	0.006	84	0.355	.723	Target (Intercept)	0.000	0.020

Distractor condition x Countability	-0.007	0.004	5840	-1.866	.062			
Presentation order	0.000	0.000	5848	-14.643	<.001	Countability	0.000	0.021
<u>*Simple effects:*</u>						Residual	0.006	0.076
Distractor condition for mass nouns	0.015	0.001		10.983	<.001			
Distractor condition for count nouns	0.012	0.001		8.417	<.001			

Fixed effects:	Estimate	Std. Error	df	*t*-value	p-value	*Random effects:*	Variance	Std. Dev.
<u>*Baseline: Baseline - countability congruent*</u>								
(Intercept)	2.921	0.009	65	341.541	<.001			
<u>*Main effects:*</u>								
Distractor condition: baseline-countability congruent	-0.043	0.002	5728	-21.744	<.001	Subject (Intercept)	0.003	0.054
Countability: count-mass	0.000	0.007	78	0.012	.990			
Distractor condition x Countability	-0.003	0.004	5728	-0.805	.421	Target (Intercept)	0.001	0.024
Presentation order	0.000	0.000	5735	-12.300	<.001	Countability	0.000	0.019
<u>*Simple effects:*</u>						Residual	0.006	0.077
Distractor condition for mass nouns	-0.021	0.001		-14.776	<.001			
Distractor condition for count nouns	-0.023	0.001		-15.977	<.001			
<u>*Baseline: Baseline - countability incongruent*</u>								
(Intercept)	2.926	0.008	65	346.065	<.001			
<u>*Main effects:*</u>								
Distractor condition: baseline-countability incongruent	-0.048	0.002	5720	-24.101	<.001	Subject (Intercept)	0.003	0.053
Countability: count-mass	0.003	0.007	77	0.435	.665			
Distractor condition x Countability	-0.009	0.004	5720	-2.244	.025	Target (Intercept)	0.001	0.023
Presentation order	0.000	0.000	5724	-13.955	<.001	Countability	0.000	0.018
<u>*Simple effects:*</u>						Residual	0.006	0.076
Distractor condition for mass nouns	-0.022	0.001		-15.386	<.001			

Distractor condition for count nouns	-0.026	0.001		-18.714	<.001			
Countability congruency: Countability congruent - countability incongruent								
(Intercept)	2.946	0.009	63	332.234	<.001			
Main effects:								
Distractor condition: countability congruent-incongruent	-0.004	0.002	5639	-2.005	.045	Subject (Intercept)	0.003	0.056
Countability: count-mass	0.004	0.007	77	0.663	.509			
Distractor condition x Countability	-0.006	0.004	5638	-1.382	.167	Target (Intercept)	0.001	0.023
Presentation order	0.000	0.000	5646	-12.778	<.001	Countability	0.00033	0.01805
Simple effects:						Residual	0.00604	0.07773
Distractor condition for mass nouns	-0.001	0.001		-0.440	.659			
Distractor condition for count nouns	-0.003	0.001		-2.397	.049			

Table 8 *Errors of each type as a percentage of total errors in each condition (determiner substitutions include countability congruent and incongruent determiner substitutions and false starts of determiners) and other error types (e.g., noun substitutions, omissions of nouns or determiners) and error sum for each target - distractor category for Experiment 2.*

	Target condition							
	Count (Singular)				Mass			
Error types	Countability incongruent determiner substitutions[a]	Countability congruent determiner substitutions[b]	Others	Total Number of Errors	Countability incongruent determiner substitutions[a]	Countability congruent determiner substitutions[b]	Others	Total Number of Errors
Distractor condition								
Countability Congruent	29.73%	0.00%	70.27%	37	26.32%	0.00%	73.68%	38
Countability Incongruent	51.61%	0.00%	48.39%	31	31.11%	0.00%	68.89%	45
Identity	36.36%	0.00%	63.64%	11	64.71%	0.00%	35.29%	17
Baseline	50.00%	0.00%	50.00%	12	40.00%	0.00%	60.00%	35

[a] Countability incongruent substitutions refer to substitutions by a count noun determiner for target mass nouns and a mass noun determiner for target count nouns (e.g., for mass nouns: a, few; for singular count nouns: some, little) which lead to a grammatically incorrect noun phrase (e.g., for mass nouns: *a rice, *few rice; for count nouns: *some apple).
[b] Countability congruent substitutions refer to substitutions by a count noun determiner for count nouns and mass noun determiner for mass nouns which are not the target determiner (e.g., for mass nouns: target determiner 'some', response: little; for count nouns: target determiner 'a', response: this) but lead to a grammatically correct noun phrase (e.g., for mass nouns: little rice, for count nouns: this apple).

Table 9 *Results of the naming accuracy analyses using the model: glmer (Accuracy ~ distractor condition * countability + presentation order + (1 + countability | participants) + (1 | targets), data = experiment 2, control = lmerControl (optimizer="bobyqa")) for each of the different distractor condition comparisons.*

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Identity - countability congruent							
(Intercept)	-4.661	0.315	-14.816	<.001			
Main effects:					Subject (Intercept)	1.191	1.091
Distractor condition: identity-countability congruent	1.064	0.231	4.617	<.001			
Countability: count-mass	0.180	0.392	0.460	.646	Target (Intercept)	0.428	0.654
Distractor condition x countability	0.383	0.461	0.830	.407			
Presentation order	-0.002	0.001	-1.720	.085	Countability	0.190	0.436
Simple effects:							
Distractor condition for mass nouns	0.437	0.151	2.891	.008			
Distractor condition for count nouns	0.628	0.174	3.604	.001			
Identity: Identity - countability incongruent							
(Intercept)	-4.468	0.302	-14.787	<.001			
Main effects:					Subject (Intercept)	0.855	0.925
Distractor condition: identity-countability incongruent	1.066	0.232	4.599	<.001			
Countability: count-mass	0.065	0.416	0.157	.876	Target (Intercept)	0.649	0.806
Distractor condition x countability	0.001	0.464	0.003	.998			
Presentation order	-0.004	0.001	-2.848	.004	Countability	0.352	0.593
Simple effects:							
Distractor condition for mass nouns	0.533	0.149	3.586	.001			
Distractor condition for count nouns	0.533	0.178	2.998	.005			
Identity: Identity - baseline							
(Intercept)	-5.187	0.362	-14.336	<.001			
Main effects:					Subject (Intercept)	0.873	0.934
Distractor condition: identity-baseline	0.431	0.260	1.656	.098			
Countability: count-mass	-0.711	0.467	-1.522	.128	Target (Intercept)	0.639	0.800
Distractor condition x countability	-0.683	0.520	-1.313	.189			
Presentation order	-0.001	0.002	-0.321	.748	Countability	0.244	0.494
Simple effects:							
Distractor condition for mass nouns	0.386	0.152	2.541	.033			
Distractor condition for count nouns	0.045	0.211	0.211	.833			

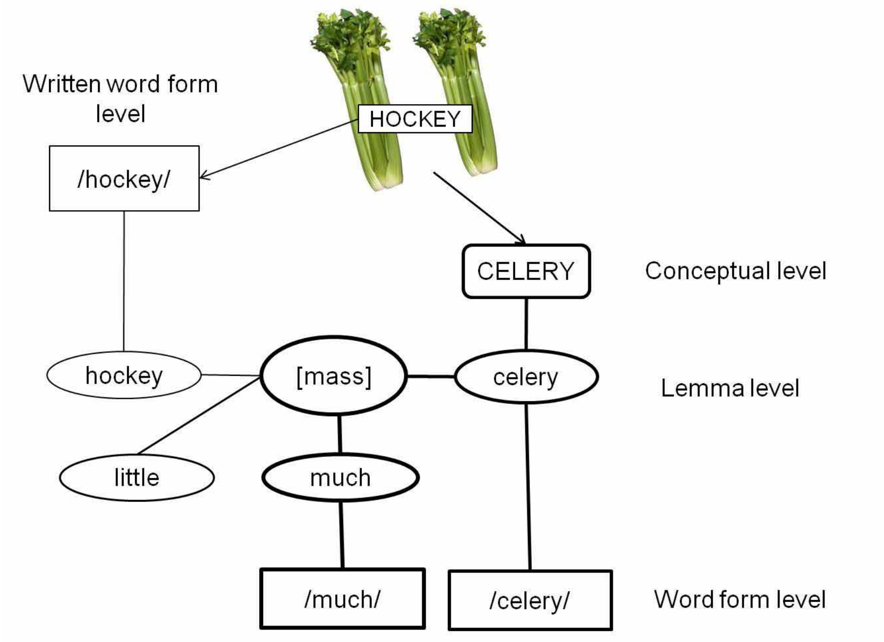
Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Baseline - countability congruent							
(Intercept)	-4.625	0.284	-16.274	<.001	Subject	0.722	0.850

Main effects:					(Intercept)		
Distractor condition: baseline-countablity congruent	-0.634	0.209	-3.041	.002			
Countability: count-mass	-0.423	0.357	-1.185	.236	Target (Intercept)	0.693	0.833
Distractor condition x countability	-1.084	0.417	-2.598	.009			
Presentation order	0.000	0.001	-0.205	.837	Countability	0.037	0.192
Simple effects:							
Distractor condition for mass nouns	-0.046	0.122	-0.377	.706			
Distractor condition for count nouns	-0.588	0.169	-3.479	.002			
Identity: Baseline - countability incongruent							
(Intercept)	-4.485	0.286	-15.663	<.001			
Main effects:							
Distractor condition: baseline-countability incongruent	-0.629	0.210	-3.003	.003	Subject (Intercept)	0.833	0.854
Countability: count-mass	-0.664	0.384	-1.731	.083	Target (Intercept)	0.730	0.854
Distractor condition x countability	-0.713	0.419	-1.701	.089			
Presentation order	-0.002	0.001	-1.291	.197	Countability	0.160	0.400
Simple effects:							
Distractor condition for mass nouns	-0.136	0.118	-1.156	.248			
Distractor condition for count nouns	-0.493	0.173	-2.847	.013			
Countability congruency: Countability congruent - countability incongruent							
(Intercept)	-4.116	0.268	-15.364	<.001			
Main effects:							
Distractor condition: countability congruent-incongruent	0.005	0.171	0.031	.975	Subject (Intercept)	0.969	0.984
Countability: count-mass	0.163	0.353	0.463	.644	Target (Intercept)	0.582	0.763
Distractor condition x countability	0.367	0.343	1.072	.284			
Presentation order	-0.003	0.001	-2.267	.284	Countability	0.516	0.718
Simple effects:							
Distractor condition for mass nouns	-0.089	0.117	-0.763	.891			
Distractor condition for count nouns	0.095	0.125	0.755	.891			

Table 10 *Results of the determiner accuracy analyses using the model: glmer (DetAccuracy ~ distractor condition * countability + presentation order + (1 + countability | participants) + (1 | targets), data = experiment 2, control = lmerControl (optimizer="bobyqa")) for each of the different distractor condition comparisons.*

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Identity - countability congruent							
(Intercept)	-5.827	0.457	-12.764	<.001			
Main effects:					Subject (Intercept)	1.2011	1.096
Distractor condition: identity-countability congruent	0.371	0.312	1.187	.235			
Countability: count-mass	-0.069	0.587	-0.117	.907	Target (Intercept)	0.8462	0.9199
Distractor condition x Countability	1.430	0.625	2.289	.022			
Presentation order	0.000	0.002	-0.108	.914	Countability	0.2876	0.5363
Simple effects:							
Distractor condition for mass nouns	-0.172	0.200	-0.86	.389			
Distractor condition for count nouns	0.543	0.240	2.264	.066			
Identity: Identity - countability incongruent							
(Intercept)	-5.145	0.372	-13.817	<.001			
Main effects:					Subject (Intercept)	0.728	0.853
Distractor condition: identity-countability incongruent	0.574	0.299	1.919	.056			
Countability: count-mass	0.128	0.526	0.244	.807	Target (Intercept)	0.483	0.695
Distractor condition x Countability	1.203	0.598	2.013	.044			
Presentation order	-0.003	0.002	-1.404	.160	Countability	1.005	1.002
Simple effects:							
Distractor condition for mass nouns	-0.014	0.184	-0.076	.939			
Distractor condition for count nouns	0.588	0.235	2.495	.038			
Identity: Identity - baseline							
(Intercept)	-6.418	0.473	-13.559	<.001			
Main effects:					Subject (Intercept)	1.357	1.165
Distractor condition: identity-baseline	-0.055	0.347	-0.158	.874			
Countability: count-mass	0.083	0.641	0.13	.896	Target (Intercept)	0.599	0.774
Distractor condition x Countability	0.123	0.693	0.178	.859			
Presentation order	0.002	0.002	1.079	.281	Countability	1.044	1.022
Simple effects:							
Distractor condition for mass nouns	0.056	0.188	0.299	1.00			
Distractor condition for count nouns	0.004	0.292	0.012	1.00			

Fixed effects:	Estimate	Std. Error	z-value	p-value	*Random effects:*	Variance	Std. Dev.
Identity: Baseline - countability congruent							
(Intercept)	-6.706	0.533	-12.59	<.001			
Main effects:							
Distractor condition: baseline-countability congruent	-0.459	0.320	-1.434	.152	Subject (Intercept)	1.228	1.108
Countability: count-mass	0.170	0.738	0.23	.818			
Distractor condition x Countability	-1.338	0.639	-2.093	.036	Target (Intercept)	1.119	1.058
Presentation order	0.003	0.002	1.362	.173	Countability	2.888	1.699
Simple effects:							
Distractor condition for mass nouns	0.105	0.209	0.504	.614			
Distractor condition for count nouns	-0.564	0.242	-2.328	.059			
Identity: Baseline - countability incongruent							
(Intercept)	-5.586	0.412	-13.557	<.001			
Main effects:							
Distractor condition: baseline-countability incongruent	-0.638	0.304	-2.102	.036	Subject (Intercept)	0.861	0.928
Countability: count-mass	0.299	0.550	0.543	.587			
Distractor condition x Countability	-1.089	0.607	-1.795	.073	Target (Intercept)	0.582	0.763
Presentation order	0.000	0.002	-0.071	.944	Countability	0.853	0.924
Simple effects:							
Distractor condition for mass nouns	-0.047	0.191	-0.244	.808			
Distractor condition for count nouns	-0.591	0.236	-2.51	.036			
Countability congruency: Countability congruent - countability incongruent							
(Intercept)	-5.109	0.368	-13.889	<.001			
Main effects:							
Distractor condition: countability congruent-incongruent	-0.210	0.263	-0.799	.425	Subject (Intercept)	0.8185	0.9047
Countability: count-mass	0.473	0.492	0.963	.336			
Distractor condition x Countability	0.188	0.527	0.358	.721	Target (Intercept)	0.5693	0.7545
Presentation order	-0.002	0.002	-0.974	.330	Countability	0.6443	0.8027
Simple effects:							
Distractor condition for mass nouns	-0.152	0.202	-0.756	1.00			
Distractor condition for count nouns	-0.058	0.170	-0.342	1.00			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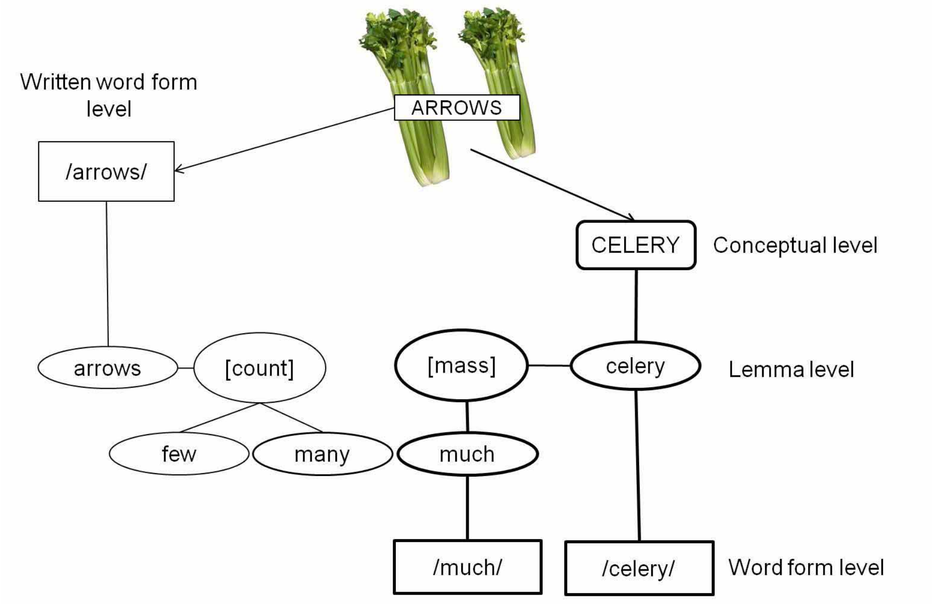
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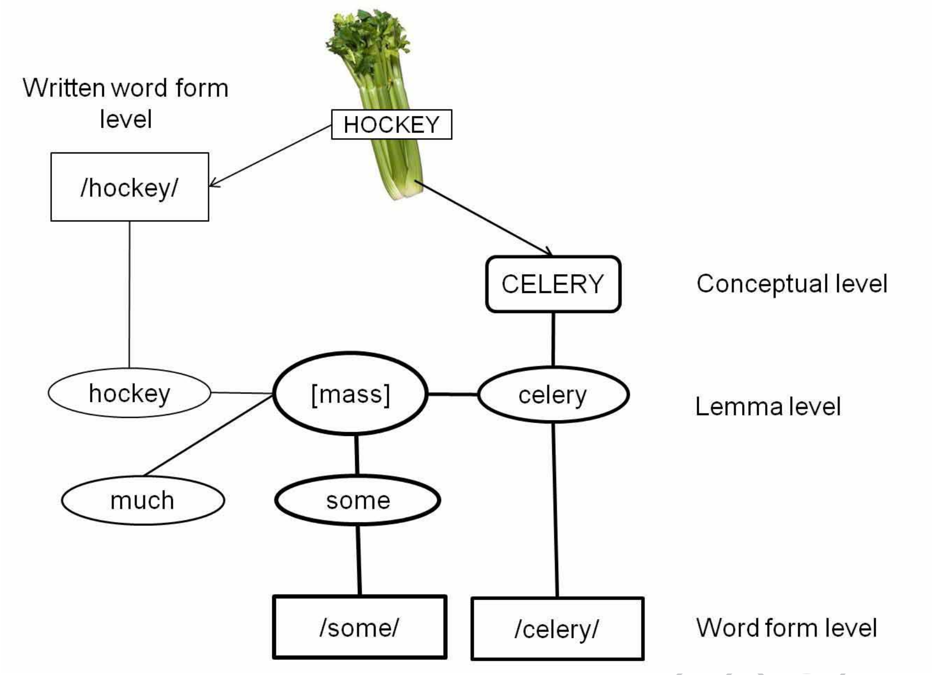
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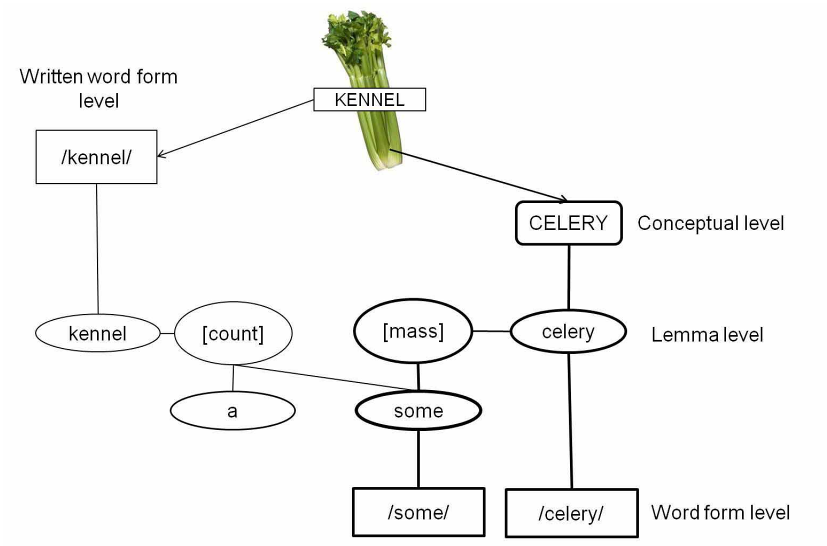
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