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Suppression in interpreting adjective noun combinations and the nature of the lexicon

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Abstract

A common assumption about our internal lexicon is that the meaning of words is underspecified and this underspecified representation is filled in based on the context in which the word occurs. In this paper I would like to explore a different hypothesis, that words are stored with overspecified representations which are ‘trimmed down’ by the context. This view seems to be in line with a well-known mechanism from psycholinguistics: suppression. Many studies have shown that conceptual properties of a word are initially activated but subsequently suppressed when these properties are in conflict with the context the word occurs in. This mechanism has not been tested, however, in a context where compositional application takes place as between an adjective and a noun. In this study I will discuss two lexical decision experiments testing the interpretation of two types of adjective noun combinations. For both types of combinations it is expected that the representation of the noun undergoes a change due to the conflicting information provided by the adjective. It is hypothesized that the properties of the noun that are in conflict with the adjective are initially activated, but subsequently suppressed to form a coherent representation of the adjective noun combination. While the results provide evidence for the initial activation of the conceptual properties, no evidence for the subsequent suppression was found. The initial activation shows that also in the case of adjective noun combinations, conceptual features do not ‘wait for’ an initial well-formed semantic structure. The lack of evidence for suppression primarily suggests the need for further research. If future experiments confirm that suppression does not take place within the time frame tested in the experiments, we must conclude, based on experimental findings by Schumacher (2013), that conceptual specification takes place after the shift in reference of the noun.

1. INTRODUCTION

Word meanings are flexible. The same word may have a different interpretation dependent on the context. The word mouse clearly means something different in (1) than in (2).

(1) The mouse was running around in circles in its cage.
(2) My new laptop came with an optical mouse.

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But the variation in meaning can also be more subtle. We probably build a slightly different representation of fish in (3) than we do in (4).

(3) For his fifth birthday, my nephew asked for a bowl with a fish.

(4) During our diving trip, we came across this beautiful fish.

Words can also be used with a meaning that greatly diverges from its usual interpretation such as in (5).

(5) The lady next door is such a mouse.

All these examples raise the question how the meaning of words is stored in our mental lexicon and how we get from this stored meaning to the interpretation a word receives in a particular context. Several answers to this question have been proposed in the literature. A common assumption is that the meaning of words is underspecified and this underspecified representation is filled in based on the context in which the word occurs. In this paper I would like to explore the opposite hypothesis, that words are stored with overspecified representations which are ‘trimmed down’ by the context.

This view seems to be in line with a well-known mechanism from psycholinguistics, suppression. Many studies have shown conceptual properties of a word are initially activated but subsequently suppressed when these properties are in conflict with the context the word occurs in. This mechanism has not been tested, however, in a context where compositional application takes place as for example between an adjective and a noun. In this paper, I will report the results of two lexical decision experiment that tested two types of adjective noun combinations. The first experiment investigates adjective noun combinations involving metonymic type coercion like stone lion. The second experiment tests adjective noun combinations which do not lead to coercion but in which a central property of the noun is contradicted by the adjective, such as fried chicken (which is still a chicken but does not have feathers, for example). For both types of combinations I expected that the representation of the noun would undergo a change due to the conflicting information provided by the adjective. My hypothesis was that features of the noun would be initially activated but subsequently suppressed because it is incompatible with the meaning of the adjective. This would indicate that conceptual specification is not dependent on an initial well-formed semantic structure. However, while the results provide evidence for the initial activation, no evidence for suppression was found.

In the next section I will first discuss several views on the nature of word meaning and I will provide some theoretical arguments against an underspecification approach. In Section 3, I will discuss some studies that tested the mechanism of suppression in several types of contexts. In Section 4, and 5, I will discuss the two experiments. In section 6, I will discuss what the unexpected findings mean for my hypothesis and for the view on the nature of lexical meaning in more general. Section 7 concludes the paper.

2. THE NATURE OF THE LEXICON

As outlined in the introduction, word meanings are flexible and this raises the question how words are stored in our internal lexicon. One option is that all possible meanings are listed. However, words often have a flexible meaning without there being a clear cut distinction between the different senses. The adverb slow, for example, means something different in slow car than in slow food. But are these meanings different enough to be listed separately?
Furthermore, words are often used in a novel and creative way, which would not be possible if all possible uses of a word were listed. These aspects of language make it implausible that speakers simply memorize all meanings of a word (also see Pustejovsky 1995 for an extensive argumentation against a sense enumeration approach). A common theory about the lexicon entails that the semantics of words are underspecified and that more specific information is filled in by the context (e.g. Bierwisch 1983, Reyle 1993, Blutner 1998, 2004). There are two ways in which such an underspecification approach can be viewed. Firstly, one can regard it as describing the situation in which the same word may have different conceptual specifications and out of context we do not know which one applies. As this more or less describes the situation sketched in the introduction, it is hard to disagree with such an explanation of underspecification. However, this does not tell us very much about the mechanisms by which we eventually do obtain a specified representation. In some works the underspecification approach is presented as a theory of how we build a meaning representation.

Bierwisch and Schreuder (1992) for example argue for a two-level semantics with a conceptual level (CS for conceptual structure) in addition to an underspecified semantic level (SF for semantic form). They illustrate the distinction between SF and CS by means of the examples in (6) and (7) (p. 31).

(6) Why do you want to leave the bank?
(7) a. He left the institute an hour ago.
   b. He left the institute a year ago.

According to Bierwisch and Schreuder, the word bank in (6) is lexically ambiguous, leading to two different SF’s. The word institute in (7), on the other hand, is not ambiguous in the same way bank is, but it has different conceptual interpretations. In (a) the institute most likely refers to a building (and leave is interpreted as a change of place) while in (b) it most likely refers to an institution (and leave is interpreted as a change in affiliation). In contrast to the ambiguity of bank, the difference between these two readings of institute is not reflected in SF but in CS.

In more precise terms, they qualify the different levels and the relation between them as follows. SF consists of semantic constants (for leave they are DO MOVE, FIN and LOC) and variables like x, y, z. For both types of elements it holds that they are assigned to specific semantic categories that determine the type of conceptual information that can be associated with them and that determine the combinatorial structure of SF. The interpretation in CS is determined by this information in SF and an interpretation mapping Int. As for the mapping Int, Bierwisch and Schreuder indicate that they cannot be very precise about the working of it yet, but in general it works as follows. Applied to the semantic form SF (E_i) of particular instance of a word E_i of an expression E in a context Ct_i, Int yields a conceptual structure that modifies Ct_i by the particular contribution that E_i makes under the condition of Ct_i. This is represented in (8) (Bierwisch and Schreuder 1992, p. 34).

(8) \text{Int} (\text{SF} (E_i), \text{Ct}_i) = (\text{CS} (E_i), \text{Ct}_i)

I will come back to this representation at the end of this section. First I will discuss a different but in relevant respects similar view of the lexicon by Blutner (1998, 2004).
Blutner (1998, 2004) argues for Radical Underspecification, a view which he summarizes as follows (Blutner 1998, p. 18):

a. Every lexical unit determines an underspecified representation (i.e., a representation that may contain, for example, placeholders and restrictions for individual and relational concepts).

b. The combinatorial system of language determines how lexical units are combined into larger units.

c. There is a system of type and sortal restrictions which determines whether structures of a certain degree of (under) specification are well-formed.

d. There is a mechanism of contextual enrichment (pragmatic strengthening based on contextual and encyclopedic knowledge).

Blutner argues that step d could be instantiated by a mechanism that fills in underspecified lexical representations by means of abduction rules. For example, the underspecified semantic representation of *red apple*, would be as in (9) (Blutner 1998, p. 6).

\[(9) \text{APPLE}(d) \land \text{PART}(d, x) \land \text{COLOR}(x, u) \land u = \text{red}\]

The representation in (9) specifies that some part of the apple is red but not which part. This specification is obtained by abduction rules which determine the “price” of interpreting *red* as referring to the color of the peel of the apple as opposed to the color of the stem or the flesh. The price is determined based on a knowledge base containing clauses of the form \(p_1, \ldots, p_n \rightarrow q\), where the literals \(p_j\) in the antecedent are annotated with weights. In this example interpreting *red* as referring to the color of the pulp is more costly than interpreting *red* as referring to the color of the peel.

Both Bierwisch and Schreuder (1992) and Blutner (1998, 2004) assume that the underspecified semantic level contains the information about how the semantics of individual words can be combined into more complex semantic representations. This suggests that conceptual enrichment takes place after the underspecified semantic representations have been combined to a semantically well-formed (but underspecified) whole and that the possible enrichments of individual words have already been narrowed down by the words they are combined with. This is also what Bierwisch and Schreuder (1992) seem to explicitly suggest in the following fragment which pertains to the working of *Int* as represented in (8) above (Bierwisch and Schreuder 1992, p. 34):

Even though in the pair \((\text{CS}(E_i), C_{ti})\) the particular conceptual interpretation of \(E_i\) is separated from its actual setting \(C_{ti}\), it should be noted that this does not in general mean that \(\text{CS}(E_i)\) is an independent conceptual unit or configuration. To see this point, one might think of the interpretation of (5a) and (5b) (examples (7a) and (7b) above, LH), where the scripts of physical motion on the one hand and change of social affiliation on the other integrate the conditions specified by the SF of *leave* and *institute*, so that no conceptual unit that corresponds to all and only the conditions specified by the SF of *leave* needs to show up in the conceptual structures in question \([\ldots]\). To put it differently, the ingredients of \(\text{CS}(E_i)\) that are due to SF \((E_i)\) need not be conceptually autonomous against those that are due to \(C_{ti}\).

This fragment suggests that the combination of the semantic forms of, in this case, *leave* and *institute* already selects the relevant conceptual information, or script in terms
of Bierwisch and Schreuder, so that alternative conceptual specifications play no role in the realization of the eventual representation of the meaning of the utterance.

In sum, both Bierwisch and Schreuder's (1992) and Blutner's (2004) approach to underspecification entail that conceptual enrichment takes place based on an initial underspecified semantic representation. In this paper I would like to explore the opposite view, that is, that it is not the case that underspecified representation are enriched by the context the word occurs in but that words come with rich meaning representations that are trimmed down by the context and that it is those rich representations that are combined to form a meaningful whole (also see Hogeweg 2012 and Hogeweg 2016). In Sections 4 and 5, I will discuss two experiments that were designed to test this alternative view of the lexicon. In section 2.1, however, I will first discuss some studies that I consider to provide theoretical arguments for overspecification.

2.1. Arguments for overspecification
The first reason for exploring the alternative hypothesis outlined in the previous section is that conceptual knowledge may be needed to determine the truth conditions of an utterance. A well-known example is formed by color denoting adjectives. While the adjectives seem to behave intersectively at first sight, they actually do not (e.g. Quine 1960, Lahav 1989, Blutner 2004). For example, *red* in *red apple* denotes the color of the skin of the apple while *red* in *red grapefruit* denotes the color of the inside of the grapefruit. Based on examples like these, Blutner et al. (2004) argue that compositionality alone is not sufficient to derive systematicity of meaning (meaning being truth-functional content). Note that while this observation is an argument against a general approach in which conceptual information is added on top of a truth-conditionally determined semantic representation, it is not necessarily an argument against the two theories discussed above, as it is not completely clear to what extent Bierwisch and Schreuder (1992) and Blutner (1998, 2004) assume the semantic representation alone to determine the truth-conditions of an utterance. In fact, the approach by Blutner was partly inspired by the problem of the indeterminacy of color denoting adjectives. The type of solution I will propose in this paper is different however. As (9) showed, Blutner's (2004) solution is that the result of the combinatorial semantic process remains undetermined as to which part of the referent of the noun the color refers to. The solution I will explore, is that compositional processes take rich lexical representations as their input, including what is usually considered to be conceptual knowledge.

This solution is in line with for example Vicente (2012), who argues for complex lexical representations based on so called Travis cases. Travis cases refer to utterances which according to Travis (e.g. 1985, 1996, 2000) have different truth-conditions on different occasions. One of the examples that Vicente discusses is the utterance (taken from Travis 1996) in (10).

(10) *The leaves are green.*

If (10) is said about some leaves that have been painted green but were originally red, the utterance is judged to be true in a context where a photographer is looking for green leaves for her picture but false in a context where a botanist is looking for green leaves. Vicente proposes that words or more precisely, nouns come with complex lexical representations. These representations are similar to the ones proposed in Pustejovsky's (1995) Generative Lexicon but contain even more information, including knowledge that by many would be considered world knowledge instead of semantic knowledge. This knowledge includes
information that leaves, or more generally physical objects, can have surface properties that can be different from their original properties. The property expressed by green in (10) can apply to the apparent surface or to the original surface. Without further context it cannot be determined how green modifies leaves precisely, that is, which specific composition rule to apply, leading to the varying truth-conditions as described above. The point is that this indeterminacy is caused by the structure of the lexical representation, that is, the indeterminacy of composition rules and therefore of the truth-conditions of a particular utterance (out of context), is dependent on the representation of the noun having a detailed, complex structure.

Another example of cases where conceptual information is needed to determine truth-conditions involves reciprocals as discussed in (amongst others) (Kerem, Friedmann and Winter 2009) and Poortman (2017). Reciprocals such as each other can describe a range of situations varying in the amount of relations involved, as illustrated in (11).

(11) a. Bill, Sue and John know each other.
    b. Bill, Sue and John are pinching each other.

An utterance such as (11a) typically describes a situation in which each in individual knows each other individual, whereas an utterance such as (11b) typically involves less relations and can be considered true in a situation in which each individual only pinches one other individual. Poortman (2017) argues and experimentally shows that this variation in meaning is truth-conditional and, more importantly, that these truth-conditions are determined based on precise conceptual knowledge of the verb involved. More precisely, she argues and shows that the interpretation of a reciprocal sentence depends on knowledge of the typical number of patients that are involved in the action denoted by the verb. While it is not strictly impossible to pinch multiple people at the same time, an act of pinching typically involves only one patient. Consequently, an utterance such as (11b) is generally considered to be true in a situation where each individual pinches one other individual.

To sum up, the first reason for wanting to explore the assumption of rich lexical representations is that sometimes detailed conceptual information is needed to determine the truth-conditions of an utterance. This indicates that conceptual specification is not dependent on an initial underspecified semantic (truth-conditional) representation of the words combined. Moreover, conceptual information is needed to determine how to properly combine the representations of individual words (cf. Vicente 2012). The second, and for this paper most relevant reason, is that assuming overspecified lexical representations seems to be more in line with well-attested mechanism in the field of psycholinguistics: suppression. I will discuss the mechanism in the next section.

3. SUPPRESSION

Most authors agree that semantic information that is initially activated needs to be suppressed if it is disruptive in coming to a coherent interpretation of a word or phrase in context, although the precise nature and scope of the mechanism of suppression is under debate (see Giora 2008 for a discussion). The mechanism of suppression has been shown to play a role in several areas of language comprehension, such as anaphoric reference (Gernsbacher 1989) and negation (e.g. Giora, Fein, Aschkenazi, Alkabets-Zlozover 2007).
In this section I will discuss a number of studies that show that suppression takes place when words are placed in a (atypical) context.

One of the first to discuss the mechanism of suppression in relation to the interpretation of words, was Swinney (1979). Swinney found that lexical decision for words related to both meanings of an ambiguous word like bug were facilitated over an unrelated control word even in a context strongly biased for one of the possible readings, such as (12) (Swinney 1979, P. 650):

(12) Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches and other bugs in the corner of his room.

However, the facilitation disappeared for the target word related to the contextually inappropriate sense (in this case spy) at three syllables following the occurrence of the ambiguous word, while it was still attested for the target word related to the contextually appropriate reading (ant in this case).

Rubio Fernández (2006) shows that suppression also plays a role in filtering out incompatible information when interpreting unambiguous words. She carried out a lexical decision experiment in which subjects were presented with sentences in which a central property of a noun clashed with the content of the sentence. An example is given in (13) (Rubio Fernández 2006, p. 123).

(13) In the final exam, the biology students had to dissect a cheetah.

In (13) the central property ‘fast’ of the noun cheetah clashes with the remainder of the sentence from which it becomes clear that the cheetah is dead. The priming effect (that is, the facilitation of the related target relative to an unrelated control) of the target word fast after hearing (13) was compared at 0, 400 and 1000 milliseconds (after the word-recognition point of the prime) to the priming effect after hearing a non-cancelling context such as (14) (Rubio Fernández 2006, p. 123).

(14) The expedition approached the territory of the cheetah.

Rubio Fernández found that at 0 milliseconds the target word was primed in both the cancelling and the non-cancelling condition. At 400 milliseconds, however, the target was primed only in the non-cancelling condition (at 1000 milliseconds target words were no longer primed in both conditions). This study shows that, as central properties are still activated at 400 milliseconds in neutral (non-cancelling) contexts, the loss of activation of the properties in conflicting contexts is due to active suppression instead of passive decay.

The mechanism of suppression has also been investigated in a context where words are used metaphorically. For example, Glucksberg, Newsome and Goldvarg (2001) investigated (amongst others) whether properties of a metaphorically used noun that are not relevant for the metaphorical interpretation are inhibited or suppressed1. They did so by presenting

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1 Glucksberg et al. themselves speak of inhibition. They indicate, however, that while the two terms, inhibition and suppression, are not strictly synonyms (suppression usually refers to the process where properties are initially activated and then suppressed while inhibition usually refers to a situation in which properties are not activated in the first place), they are not committed to either of the mechanisms as their experiment does not discriminate between the two.
subjects with a prime sentence followed (after 100 or 450 milliseconds\(^2\)) by a probe sentence. Subjects had to decide for each of the sentences whether they made sense or not. The prime sentences were either metaphorical (e.g. *my lawyer is a shark*) or literal (e.g. *sharks can swim*) and the probes either expressed a property that was related to the metaphorical use of the noun (e.g. *vicious*) or only to the literal use (e.g. *swim*). This led to four conditions which are exemplified in (15) (Glucksberg et al. 2001, p. 285).

(15) a. Metaphor prime, metaphor relevant probe, for example, “My lawyer was a shark/Geese are vicious.”

b. Metaphor prime, metaphor irrelevant probe, for example, “My lawyer was a shark/Geese can swim.”

c. Literal prime, metaphor relevant probe, for example, “The hammerhead is a shark/Geese are vicious.”

d. Literal prime, metaphor irrelevant probe, for example, “The hammerhead is a shark/Geese can swim.”

They found that subjects were significantly faster in deciding about the probe sentence containing the metaphor irrelevant property after the literal prime than after the metaphorical prime, indicating this property was suppressed (or inhibited, see footnote 1 above) in the latter condition.

Rubio Fernández (2007) also investigated the role of suppression in the interpretation of novel metaphors. In this study, subjects were presented with contexts consisting of two sentences, biased in favor of a metaphorical interpretation of a noun. For example, subjects heard the sentences as in (16).

(16) Nobody wanted to run against John at school. John was a cheetah.

After hearing the sentence, subject had to make a lexical decision about a word that was either related to the noun (*cheetah*) and compatible with the metaphorical interpretation (e.g. *fast*) or related to the noun but incompatible with the metaphorical interpretation (the target words of this type were all superordinates of the noun, in this case *cat*) or they were unrelated to the noun. The target words were again presented 0, 400, or 1000 milliseconds after the point at which the noun could be unambiguously identified. Rubio Fernández found that both the metaphor-relevant and the metaphor-irrelevant properties were recognized faster than the unrelated control at 0 and 400 milliseconds. At 1000 milliseconds, however, the metaphor-irrelevant properties (the superordinates) no longer showed shorter reaction times than the unrelated controls, while the metaphor-relevant properties still did. A previous study (Rubio Fernández et al. 2003) showed that superordinates are still activated at 1000 milliseconds in neutral context, which means that also in this study the loss of activation was not due to a passive decay but to active suppression. The fact that in this experiment suppression took place relatively late at 1000 milliseconds, Rubio Fernández explains by arguing that the interpretation of novel

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2 The authors intended to test all subjects with an interim interval of 450 milliseconds but due to a programming error, they tested the first 40 (of the 60) participants with an interval of 100 milliseconds. In their analysis, they did not find a significant difference between those two groups.
metaphors involves the construction of a new, ad hoc concept rather than the selection of a lexically encoded concept.

The literature on suppression seems to suggest that the activation of conceptual or encyclopedic information is not restricted by an intervening semantic representation but is activated as soon as a word is encountered and that elements of this representation have to be deleted to come to a coherent interpretation of the complete utterance. In other words, these findings suggest that instead of starting with an underspecified representation to which details are added based on the context, we start with a very rich, overspecified representation from which elements are deleted based on the context. However, the mechanism of suppression has, to my knowledge, not been investigated in contexts where compositional application takes place as for example between an adjective and a noun, while these are the contexts that are most relevant for the formal theories of lexical meaning that I discussed above. In the remainder of this paper, I report the results of two experiments that investigate whether suppression takes place in two types of adjective noun combinations. The first experiment investigates adjective noun combinations involving metonymic type coercion like _stone lion_. Adjective noun combinations like these have received much attention from formal semanticists like Partee (2010). Coerced nouns involve a shift in the meaning of the noun. Consequently, it involves a substantial altering of the set of conceptual features usually attributed to the noun and therefore forms a good testing case for investigating suppression. The second experiment tests adjective noun combinations which do not lead to coercion but in which a central property of the noun is contradicted by the adjective, such as _fried chicken_ (which is still a chicken but does not have feathers, for example). This type of adjective noun combination was chosen to find out whether there is a difference in the time needed to suppress the conflicting property, compared to the adjective noun combinations leading to coercion (as the coerced nouns could be argued to be (more) similar to the metaphors tested in the abovementioned study by Rubio Fernández (2007), for which suppression took place only at 1000 milliseconds). The second experiment will be discussed in Section 5. I will start with the discussion of the experiment testing the interpretation of adjective noun combinations involving coercion in Section 4.

4. EXPERIMENT 1

In this section I discuss an experiment that tests the interpretation of adjective noun combinations like _stone lion_, in which the noun shifts from its literal meaning to a meaning ‘representation/model of …’ (Partee 2010, p. 6). Partee (2010) proposes that the shift in meaning is the result of the Non-vacuity Principle which demands that in any given context, a predicate has to be interpreted such that both its positive and negative extension are non-empty. If we take this principle to be at work at the semantic level, and if we indeed assume that the possible enrichments are restricted by an intervening

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3 A note is in order about the nature of semantic priming. There are conflicting views on what causes the activation of related concepts. On the one hand there are spreading activation models which depend on association, on the other hand there are distributed models which explain the co-activation of related concepts by feature overlap. Evidence for both types of models have been provided in the literature (see for example Hutchison 2003 for an overview). The argumentation outlined in this paper depends on the latter type of model, it supposes that priming reflects a semantic and not a (purely) associative relation.
semantic level, conceptual enrichment should be based on the coerced representation of the noun. In other words, if it is assumed that conceptual enrichment takes place after the underspecified semantic representations have been combined to a semantically well-formed whole, we expect that features that are possessed by a lion but not by a stone lion are never activated and consequently need not be suppressed. If on the other hand, we adopt an overspecification view of the lexicon, we expect that such features are part of the initial representations. I therefore hypothesize that central properties of the noun are initially activated but suppressed at a later point in time when this property is in conflict with the adjective. In this section I report on an experiment testing this hypothesis. Before I turn to the design and results of the experiment, it is necessary to explain the background against which this experiment was conducted.

4.1. background

The experiment to be discussed in the next subsections was a replication of an earlier experiment (henceforth referred to as the initial experiment) with some changes in the design. The reason for redoing the experiment was that the results of the initial study were unclear and that this might have been caused by some aspects of the design and the conditions under which the experiment was conducted. Although I will not report on the initial experiment in detail, I will in this section provide the necessary information regarding this experiment in order to motivate the choices for the first experiment to be discussed in the sections 4.2 to 4.5.

For the initial experiment, we tested 36 sets of Dutch combinations with a noun and an adjective that expressed a constitutive material (e.g. stone) or an adjective that implied such a material (e.g. knitted). As the material expressed by the adjective was always incompatible with the natural material the referent of the noun is constituted of, the combination of the adjective and the noun always lead to coercion as defined by Partee (2010) (see previous section). For each combination, three target words were collected. One target word (henceforth called the AN-compatible property) expressed a property that was consistent with both the noun and the adjective noun combination (e.g. mane), one target word (henceforth called the AN-incompatible property) expressed a property that was consistent with the noun but not with the adjective noun combination (e.g. roars), and the third target word (henceforth called the unrelated property) was not related to the noun nor the adjective (e.g. akkoord ‘deal’). All targets were matched for frequency and pre-tested for their degree of association with the noun and the adjective noun combination. The unrelated target words functioned a baseline to determine the priming effect: if the targets from the other two categories (AN-compatible and AN-incompatible) are recognized faster than the unrelated ones (given that they are equally frequent), we can conclude that they are primed by the noun. The AN-compatible category functions as a baseline for the effect of suppression: if the AN-compatible targets are still primed at a certain point in time, but the AN-incompatible targets are not, we can conclude (given that the two target types are associated with the noun to the same degree) that the AN-incompatible targets are suppressed.

4 Because I built and conducted the experiment with the help of several student assistants, I will use the plural we when reporting on these activities.
For each of the adjective noun combinations a context was constructed. The context consisted of two sentences: an introductory sentence and the sentence containing the adjective noun combination. The second sentence always ended with the adjective noun combination. Because the adjectives and nouns resulted in unconventional combinations sometimes (e.g. gehaakte spijker ‘crocheted nail’), care was taken that the context made the combination plausible. This had a downside, namely that there was a risk that the other words in the sentence would also positively influence the activation level of the related target words in comparison to the unrelated control. Another consequence was that it was not always possible to create a context that was equally plausible for the adjective noun combination as for the noun in isolation. However, we were afraid that avoiding this altogether would make the sentences too unclear or even uninterpretable.

Subjects had to decide whether a visually presented target was an existing word in Dutch at either 0, 400 or 700 milliseconds after hearing the prime sentence. The 0-milliseconds condition (in which there is no pause between hearing the prime sentence and seeing the target word) was included to determine whether the related target types were primed at all. It was expected that at 0 milliseconds both the AN-compatible as well as the AN-incompatible target would be recognized faster than the unrelated controls. It was furthermore expected that this priming effect would disappear for the AN-incompatible targets at either 400 or 700 milliseconds. The 400 milliseconds interval was chosen because several studies have shown that suppression of conflicting meaning aspects occurs within this time frame (see Section 3). The choice for the 700 milliseconds interval was based on the finding by Rubio Fernández (2007) that for novel metaphors, suppression takes place at 1000 milliseconds (also see Section 3). As, intuitively speaking, coerced nouns like stone lion could arguably be placed somewhere in the middle of the scale ranging from literal to figurative language use, I decided to take an interval between 400 and 1000 as a first attempt to pinpoint the moment of suppression for this category.

As the goal of discussing this initial experiment was to provide the necessary background information for the experiment to be discussed in the next subsections, I will be brief on the results: they were messy. The raw data show that there is an increase in the reaction times in the AN-incompatible condition, compared to the AN-compatible condition at both 400 and 700 milliseconds, but the AN-incompatible condition remains faster than the unrelated condition. Changes in the analysis (such as the exclusion of slow subjects or the in- or exclusion of the factor Trial in the statistical model) caused big differences in the results and the conclusions that could be drawn from them. This could be due to several reasons. It could be due to the abovementioned properties of the context sentences which perhaps primed the AN-compatible and AN-incompatible properties to some degree independently from the target word itself. Furthermore, the fillers in the experiment (that is, sentences followed by a non-word) were of the same type as the test sentences (they also contained a noun in combination with an adjective expressing or implying a material), as a result of which a learning effect could have occurred due to which the subjects became less responsive to the unexpected combinations. In addition to this, there were many animal body parts and colors among the target words which during the course of the experiment might have started priming each other. Of course, it is also possible that we did not find a clear effect of suppression because it is not there. To rule out other possible explanations I
Lotte Hogeweg et al. redid the experiments with some improvements\(^5\), the details of which will be discussed in the following sections.

### 4.2. Subjects

Subjects for the first experiment were recruited by means of a database in which studies could be registered and subjects could sign up for it. They were mostly students from the Radboud University in Nijmegen. In total, 128 subjects participated in the experiment (25 males, mean age 23.2). They received a gift certificate of 5 euro for their participation.

### 4.3. Design

One of the changes with respect to the initial experiment concerned the design of the study. Instead of a three by three design with three SOA’s (0, 400 and 700 milliseconds) and three possible relations between the adjective noun combination and the target word (compatible, incompatible and unrelated), we decided to offer the same target words in a related and unrelated condition. This means that each adjective noun combination came with two target words, one compatible with the noun but not with the adjective noun combination (AN-incompatible) and one compatible with both the noun and the adjective noun combination (AN-compatible). In half of the instances these target words followed the sentence containing the related adjective noun combination and in half of the instances the target words followed one of the other test sentences without a related adjective noun combination. So for example, the word *roar* followed the sentence in (17) in the related condition and a sentence like (18) in the unrelated condition.

\[(17) \quad \text{Voor de ingang van het museum staat een stenen leeuw.} \]

   In front of the entrance of the museum stands a stone lion

   ‘In front of the museum, there is a stone lion.’

\[(18) \quad \text{In de tuin van de buurman staat sinds kort een marmeren vogel.} \]

   In the yard of the neighbor stands since shortly a marble bird

   ‘Since recently, there is a marble bird in my neighbor’s yard.’

Since the two factors (target type and relatedness) each represented two levels (AN-compatible versus AN-incompatible and related versus unrelated), this resulted in 4 conditions. In Table 1, each of the four conditions is exemplified.

The advantage of this change with respect to the initial experiment was that we could compare reaction times as responses to exactly the same words. Although we tried to control as much as possible for frequency and word length in choosing the unrelated words in the initial experiment, they were of course never exactly the same and could therefore have influenced the reaction times.

As the change in design created an extra factor (we now had two factors: target type with the levels AN-compatible and AN-incompatible, and relatedness with the levels related

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\(^5\) There were also some practical issues that, although not likely to be the cause of the particular pattern found, might be improved. For example, during the testing of the first number of subjects, the experimenter stayed in the room with (behind) the subject to make sure the experiment worked properly. Furthermore, the subjects were not wearing head phones and the experimental room was not completely sound proof.
and unrelated) and having a large number of conditions increases the amount of items and subjects needed to find an effect, we decided to test only two SOA’s. Since the raw data of the initial experiment indicated that the increase in reaction times for the AN-incompatible category already started at 400 milliseconds, and since we are interested in finding the earliest moment at which suppression takes place, we offered the target words at an interval of either 0 or 400 milliseconds after the prime sentence had ended. Experiment 2 therefore had a 2x2x2 design with target type (AN-compatible or AN-incompatible) and relatedness (related or unrelated) as within subject factors and SOA (0 or 400 milliseconds) as a between subject-factor.

4.4. Materials
We used 36 adjective noun combinations. For each combination we collected two target words, one target word that was compatible with the noun but not with the adjective noun combination (the AN-incompatible target type) and one target word that was compatible both with the noun and with the adjective noun combination (the AN-compatible target type). As in the initial experiment, the target words were matched for frequency, meaning that the difference in frequency was maximally one log-frequency, as listed in the CELEX database. A pretest was carried out to test the relation between the adjective noun combination and the two associated properties. In an online or offline version of a questionnaire, subjects were asked to judge the strength of the association between either the noun alone and one of the two properties or the adjective noun combination and one of the two properties. Subjects were asked to judge how ‘characteristic’ they thought the property was for the noun or adjective noun combination on a scale from 1 to 7. Target pairs were selected if the mean difference between the association value of the target property in relation to the noun compared to the association value of the target property in relation the adjective noun-combination was minimally 1,5 points bigger for the AN-incompatible

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**Table 1** The four conditions of Experiment 1

| Condition | Prime sentence | Target |
|-----------|----------------|--------|
| AN-compatible—related | Voor de ingang van het museum staat een stenen leeuw. | Manen 'mane' |
| | ‘In front of the museum, there is a stone lion.’ | |
| AN-compatible—unrelated | In de tuin van de buurman staat sinds kort een marmeren vogel. | Manen 'mane' |
| | ‘Since recently, there is a marble bird in my neighbor’s yard.’ | |
| AN-incompatible—related | Voor de ingang van het museum staat een stenen leeuw. | Brullen ‘roar’ |
| | ‘In front of the museum, there is a stone lion.’ | |
| AN-incompatible—unrelated | In de tuin van de buurman staat sinds kort een marmeren vogel. | Brullen ‘roar’ |
| | ‘Since recently, there is a marble bird in my neighbor’s yard.’ | |
property than for the AN-compatible property (that is, the addition of the adjective should lead to a bigger decrease in the association value of the AN-incompatible property than of the AN-compatible property)\(^6\).

As can be seen in examples (17) and (18), an additional change with respect to the initial experiment was that we shortened the contexts to one sentence. We also avoided, as much as possible, the use of words in the contexts sentences that could prime the target words independently from the relevant adjective noun-combination. It should be noted though that for the same reasons mentioned for Experiment 1, it could not be avoided altogether that the context sentence was in some sense related to the target words or that the context was more plausible for the adjective noun combination than for the noun in isolation, and consequently more plausible for the AN-compatible property than for the AN-incompatible property (see Section 4.1.). The full list of adjective noun combinations, AN-compatible properties, AN-incompatible properties, context sentences and their approximate English translations can be found in Appendix 1.

To avoid a possible learning effect we also added more and more diverse fillers in comparison to the initial experiment. In total we had 144 fillers. Some of these fillers contained an adjective expressing or implying a material of which some lead to coercion of the noun but most (111) fillers contained an adjective that did not express a material. Apart from an almost equal amount (88 versus 82) of words and non-words, the target items contained 10 questions in which the participants were asked a polar question about the prime sentence they just heard. These fillers were added to ensure that subjects paid attention to the content of the context sentences. The subjects could answer the questions by pressing the same buttons as they used for the lexical decision task.

In contrast with the initial experiment, items were not presented in random order but 'mirrored lists' were constructed such that the (different conditions of the) test items and the fillers occurred in the same order on each list.

Four lists were created per SOA, each containing 18 AN-compatible targets and 18 AN-incompatible targets, each of which 9 in the related condition and 9 in the unrelated condition. This means that each SOA was assigned to 64 subjects, each of which saw 9 items in each of the four conditions (in one of four possible combinations, dependent on the list).

### 4.5. Apparatus and procedure

The experiment was built and carried out using E-prime. Responses were made by means of a button-box containing five buttons. ‘Yes’-responses were given by pushing the leftmost key and ‘no’-responses were given by pushing the right-most key of the button-box. The sentences were presented through head phones and the words were presented in black letters in the middle of a white screen. During the presentation of the sentence and during the pauses a black cross was visible at the position where the word would appear. There was a break in the middle of the experiment during which the experimenter opened the booth.

\(^6\) This may seem like a small difference but the differences between the means for the several combinations were much bigger. The means for the association value for the AN-compatible properties in relation to the noun alone was 5.95 and in relation to the adjective noun-combination 4.96. For the AN-incompatible properties, these values were 6.07 and 2.22.
and asked how it was going. The subjects could restart the experiment again whenever they were ready.

In the next section I will discuss the results of the experiment. As a reminder: I hypothesized that both the AN-compatible and the AN-incompatible target words would be primed, that is, would show shorter reaction times in the related condition than in the unrelated condition at 0 milliseconds but that this difference would disappear for the AN-incompatible targets at 400 milliseconds.

### 4.6. Results

Reaction times that were more than two standard deviations above the general mean were treated as outliers. The mean reaction times per SOA per condition are listed in Table 2.

| Condition                                      | 0 milliseconds | 400 milliseconds |
|------------------------------------------------|----------------|------------------|
| AN-compatible (mane) related                   | 589            | 592              |
| AN-compatible (mane) unrelated                 | 599            | 596              |
| AN-incompatible (roars) related                | 592            | 595              |
| AN-incompatible (roars) unrelated              | 595            | 600              |
| Priming effect AN-compatible                   | 10             | 4                |
| Priming effect AN-incompatible                 | 3              | 5                |

All analyses were carried out in R (R Core Team, 2015) using the lme4 package (Bates, Maechler, Bolker & Walker, 2015) where needed. To determine whether priming and suppression took place when interpreting the adjective noun combinations, a generalized linear regression model with mixed effects and orthogonal sum-to-zero coding was carried out.

This model took the logged values of the target response time as a dependent variable, target type (AN-compatible or AN-incompatible) an relatedness as within-participant fixed effects, SOA as between-participant fixed effect, participant as a between-participant random effect and item as a within-participants random effect. The interaction between relatedness and target type was included as a random slope for participant, because these were within-participant fixed effects. SOA was included as a random slope for item, because it was a between-participant fixed effect. We included the fixed effects in the model because our hypothesis concerned their contribution to the outcome of the experiment (Gelman & Hill, 2007). Target frequency and Trial (the order the targets appeared in) was treated as a counterbalancing factor. Following Baguley (2009), we report simple rather than standardized effect sizes and confidence intervals. As the model does not give p-values, the t-value will be reported, where a t-value higher than 2 is considered to reflect a significant difference.

Results from the generalized linear regression model show that participants were faster when responding to related targets than to unrelated targets (point estimate = 0.014062, 95% CI = 0.002926 ... 0.025198, t = 2.5). The interaction between SOA, relatedness and target type was not significant (point estimate = 0.010902 95% CI = −0.032508 ... 0.054312), indicating that no evidence of suppression was found.
4.7. Discussion
Clearly, the data give no indication that the properties that are incompatible with the adjective are suppressed at 400 milliseconds. Perhaps this is related to the fact that the priming effect is very small: the difference between the means for the unrelated and related targets is, although significant, only 5.67 milliseconds. In any case, we can conclude that the results show that the nouns activate the related properties (but seemingly not to a very high degree) but there is no indication of suppression.

In the next section I will discuss the experiment testing the other type of adjective noun combination.

5. EXPERIMENT 2

Experiment 2 was designed to test whether a central property of a noun is initially activated but suppressed at a later point in time when this property is in conflict with the adjective the noun co-occurs with. The difference with Experiment 1 is that the adjective noun combinations in Experiment 2 did not lead to coercion. The goal of this experiment was to find additional evidence for suppression, that is, that it this mechanism plays a role in adjective noun combinations in (more) general, not just when coercion takes place. Furthermore, this type of adjective noun combination was tested to find out whether there would be a difference in the time needed to suppress the conflicting property, compared to the adjective noun combinations tested in Experiment 1.

5.1. Subjects
108 subjects participated in the experiment (36 males, mean age 20.9). They were all native speakers of Dutch and they were mostly but not exclusively students of the Radboud University Nijmegen. The subjects were recruited at the university cafeteria and they received 5 euro for their participation.

5.2. Design and materials
Like the initial experiment, Experiment 3 consisted of one within subject factor, relatedness, with three levels (AN-compatible, AN-incompatible and unrelated). We came up with 58 adjective noun combinations in which the adjective cancelled a central property of the noun (e.g. gebraden kip ‘fried chicken’). For each combination we collected three words, one word expressing a property that was compatible with the noun but incompatible with the adjective noun-combination (AN-incompatible) (e.g. veer ‘feather’), one word that was compatible with both the noun and the adjective noun-combination (AN-compatible) (e.g. vleugel ‘wing’) and one word that was unrelated to the noun (e.g. kamp ‘camp’). The difference in frequency between the three target words was maximally one log-frequency, as listed in the CELEX database. We pretested the AN-compatible and AN-incompatible words in the same way as in Experiment 1. The selection criteria based on the pretest were the same as for experiment 1 as well. A total of 30 sets were selected. For each adjective noun pair a context consisting of two sentences was created, as in example (19). The full list

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7 Because Experiment 2 was conducted in between the initial experiment and Experiment 1, we used the same design and procedure as in the initial experiment and not the (possibly) improved methods and practice of Experiment 1.
of adjective noun combinations, AN-compatible properties, AN-incompatible properties, context sentences and their approximate English translations can be found in Appendix 2.

(19) *Mijn buurman is niet per se een dierenliefhebber. Zijn enige beest in huis is een gebraden kip.*

‘My neighbor is not really an animal lover. The only animal in his house is a fried chicken.’

In sum, each adjective noun pair was presented in three conditions, illustrated in Table 3 for the adjective noun pair *opgezette kicker* ‘taxidermied frog’.

Three lists were created each containing only one type of target per adjective noun pair. Each list contained 10 targets per condition. To these test sentences 30 sentences were added that were followed by a non-word. We mostly used the adjective noun combinations that did not make the pretest for this purpose. As in the initial experiment, the targets followed the prime sentence after a pause of either 0, 400 or 700 milliseconds. Each participant was assigned one of the SOA’s, making this a between participants factor. This means that each SOA was assigned to 36 subjects, each of which saw 10 items in each condition (in one of three possible combinations, dependent on the list).

In the next section, I will discuss the result of the experiment. As a reminder: I hypothesized that the AN-compatible and the AN-incompatible target words would be recognized faster, that is would show shorter reaction times, at 0 milliseconds but that the AN-incompatible targets would no longer be facilitated at either 400 or 700 milliseconds.

5.3. Results

Two subjects were excluded from the analysis, one because his mean reaction time was two standard deviations above the average of all subjects means and one because he answered incorrectly on more than half (17 out of 30) of the test items. Of the remaining 106 subjects, data were treated as outliers if they were more than 2 standard deviations above the general mean reaction time (based on all correctly answered test items by the remaining 106 subjects). The mean reaction times per condition are listed in Table 4. The priming effect (mean reaction time compared to the unrelated condition) for the AN-compatible and AN-incompatible condition per SOA is presented as well.

All analyses were again carried out in R (R Core Team, 2015) using the lme4 package (Bates, Maechler, Bolker & Walker, 2015) where needed. To determine whether priming and suppression took place when interpreting the adjective noun combinations, a generalized
Table 4  Mean reaction times per condition Experiment 3

| Condition                  | 0 milliseconds | 400 milliseconds | 700 milliseconds |
|---------------------------|----------------|------------------|------------------|
| AN-compatible             | 638            | 606              | 642              |
| AN-incompatible           | 643            | 619              | 651              |
| Unrelated                 | 706            | 682              | 718              |
| Priming effect AN-compatible | 68             | 76               | 76               |
| Priming effect AN-incompatible | 63            | 63               | 67               |

Linear regression model with mixed effects and orthogonal sum-to-zero coding was carried out.

This model took the logged values of the target response time as a dependent variable, target type (AN-compatible, AN-incompatible or unrelated) as a within-participant fixed effect, SOA as between-participant fixed effect, participant as a between-participant random effect and item as a within-participant random effect. Target type was included as a random slope for participant, because these were within-participant fixed effects. SOA was included as a random slope for item, because it was a between-participant fixed effect. Target frequency was treated as a counterbalancing factor. Because the order of the items was completely random (in contrast with the mirrored lists in Experiment 1), Trial was added as a fixed effect as well. Following Baguley (2009), we report simple rather than standardized effect sizes and confidence intervals. As the model does not give p-values, the t-value will be reported, where a t-value higher than 2 is considered to reflect a significant difference.

To determine whether priming took place, the two related target types, AN-compatible and AN-incompatible, together were compared to the unrelated target types. Results from the generalized linear regression model show that participants were slower when responding to the unrelated target types than to the two related targets (point estimate $= -0.10459546$, 95% CI $= -0.13843196 \ldots -0.07075896$, $t = -6.2$). To determine whether suppression took place the interaction between the factor SOA and target type was computed, such that for SOA the level 0 was compared to the levels 400 and 700 combined and for the factor target type the levels AN-compatible and AN-incompatible were contrasted. If suppression took place, the AN-incompatible target types should start to become slower than the AN-compatible target types at either 400 or 700 milliseconds. This interaction was not significant (point estimate $0.01593029$, 95% CI $= -0.01963765 \ldots 0.05149823$, $t = 0.9$), indicating that no evidence for suppression was found.

5.4. Discussion

The results show that there is a clear priming effect for the related properties compared to the unrelated words. There is no sign of suppression at either 400 or 700 milliseconds. An explanation could perhaps partly be found in the nature of the material. Some of the AN-incompatible properties were near antonyms of the property-cancelling adjective (e.g. donkere ‘dark’ and wit ‘white’, gesuikerde ‘sugared’ and zout ‘salty’) due to which the adjective actually might have primed the property instead of suppressing it. For some AN-incompatible properties it may have held that the AN-incompatible property was too directly related to the property-cancelling adjective, the AN-incompatible property for the
adjective noun-combination *leeg zwembad* ‘empty pool’ was for example *water* ‘water’. As what makes a pool empty is precisely a lack of water, this combination may unintentionally have primed the target word as well. On the other hand, these types of sets only formed a subset of the material in the experiment and as the data show there is not the slightest trend towards suppression.

In the next section I will discuss the two experiments combined.

6. GENERAL DISCUSSION

I expected that properties that were associated with a noun would be initially activated and subsequently suppressed when this property was incompatible with the adjective the noun was combined with. In the two experiments described above, we found the initial activation but no evidence for suppression was found. This could be due to several reasons.

Firstly and most importantly, absence of evidence is of course not the same as evidence of absence. The fact that I did not find suppression in my experiments does not mean that the effect does not occur when adjective noun combinations like these are encountered in natural language. It could be due to the way my experiments were designed or conducted that the effect of suppression did not take place or did not surface in the data. I already pointed out the possible shortcomings in the material of the experiments. One way to minimize problems like these, would be to more thoroughly pretest the material. For example, the pretests now only targeted the association between the target words and the noun either with or without the adjective. For future experiments, the association between the target words and the adjectives themselves as well as the association between or plausibility for (parts of) the context sentences could be measured as well.

For Experiment 1 (and the initial experiment) it furthermore held that some of the adjective noun-combinations were quite conventional (such as *rubberen eend* ‘rubber duck’ and *stenen leeuw* ‘stone lion’) while others clearly were not (such *gehaakte spijker* ‘crocheted nail’). It could be that these two types of combinations behave differently. Future experiments should therefore also use more homogeneous material or perhaps explicitly test the difference in response to both types of combinations.

There might also have been unintended practical circumstances that prevented the effect of suppression to surface in the experiments. For example, because the hardware of the recording devices changed before recording the last set of items for Experiment 1, they had a slightly different quality than the rest of them. Although I judged this as hardly or not noticeable at the volume at which the subject heard the sentences (and, as these sentences were followed by both words and non-words, otherwise unlikely to be the cause of the pattern found), one can never completely rule out that the practical circumstances of the experiment have an influence on the processes that play a role during language use.

However, another possible explanation for not finding evidence for suppression is of course that it is not there. The fact that I did not find it in three experiments (including the initial experiment) does make this a more plausible option than when I had not found it in only one experiment. If indeed suppression does not take place between 0 and 700 milliseconds, this means that it either does not take place at all or it takes place later than 700 milliseconds. In Section 3, I discussed several studies that showed that properties of a word are suppressed when they are incompatible with the context the word appears in. As in the three experiments discussed in this paper basically the same situation occurred (a central property of a word was incompatible with the context) it seems unlikely that
suppression does not take place at all. It seems a more plausible option, therefore, that suppression takes place later than 700 milliseconds. A reason for this might be that in my experiments the incompatibility only became apparent when the adjective was heard. In the studies discussed in Section 3, it was usually the complete sentence that made the target property unlikely, such as example (20) from the aforementioned study by Rubio Fernández (2006, p. 125):

(20) *Even though the bottle had been open for a week, John finished off the champagne*

The property to be suppressed for sentence (20) was ‘bubble’. The cancellation of this property is due to the information provided in the first part of the sentence. One could say that, as a result of this, the subjects are prepared for the adjustment of the representation of *champagne*. In a sentence like (17) from Experiment 1, repeated here as (21), such a preparation is much less the case, as the cancellation of the property is caused by the adjective immediately preceding the noun, due to which subjects might need longer to realize the incompatibility.

(21) *Voor de ingang van het museum staat een stenen leeuw.*

‘In front of the entrance of the museum, there is a stone lion.’

The fact that the initial experiment did show some sign of suppression could be explained by the nature of the test sentences in that experiment. As discussed in Section 4, it was not always possible to create a context that was equally plausible for the adjective noun combination as for the noun in isolation. As a result, these sentences were more like the sentences that were tested in the earlier studies discussed in Section 3 (and exemplified by (20) above) and they may have caused suppression to some degree within the timeframe of 700 milliseconds.

So, the first (and perhaps most important) conclusion we can draw is that more experiments are necessary to test the role of suppression in adjective noun combinations. Those experiments should (amongst others) include an SOA larger than 700 to find out if suppression takes place later than the time frame I tested in my experiments. As discussed in Section 3, Rubio Fernández (2007) found that in interpreting novel metaphors, suppression takes place at 1000 milliseconds. If indeed suppression takes place later than 700 milliseconds for coerced nouns, this might indicate that they are like metaphors in that they involve the construction of a new concept rather than the selection of a preexisting meaning (although this explanation is less likely for the adjective noun combinations tested in Experiment 3). An interesting finding in this respect is done by Schumacher (2013). With an ERP-experiment, she found an enhanced positivity between 550 and 750 milliseconds when people interpreted phrases which involved a conflict between a material adjective and an animate entity, like *wooden turtle* (relative to phrases which did not involve such a conflict). Schumacher argues that the late positivity reflects a referent shift whereby ‘the original denotation of an expression is abandoned in favor of a contextually more appropriate reference’ (p.10).

At the beginning of Section 4, I formulated the predictions of the two opposing views on the lexicon as follows: if it is assumed that conceptual enrichment takes place after the underspecified semantic representations have been combined to a semantically well-formed whole, we expect that features that are possessed by a lion but not by a stone
lion (such as ‘roars’) are never activated and consequently need not be suppressed. That is, the conceptual features are specified only after the words have been combined (see the discussion of Blutner 1998, 2004 and Bierwisch and Schreuder 1992 in Section 2). If on the other hand, we adopt an overspecification view of the lexicon, we expect that such features are part of the initial representations and need to be suppressed if they are in conflict with context they occur in. Now, if it is indeed the case that suppression takes place later than 700 milliseconds, then, given the findings of Schumacher (2013), this seems hard to reconcile with the overspecification view. In that case, the semantic adjustment (the shift in reference) takes place before the conceptual adjustment (the suppression). On the other hand, the fact that we did find a priming effect in the two experiments indicates that conceptual features are activated immediately, also in cases where a conflict exists between two more directly (compositionally) related parts of a phrase, an adjective and a noun (compared to previous experiment where the conflict was caused by the more general context in which the noun occurred). This contradicts the prediction made by the underspecification view as described above. So should suppression indeed turn out to take place after 700 milliseconds, what type of model would be able to explain this? For now, I can think of two possible scenarios.

The first scenario entails that lexical representations are overspecified but that suppression takes place in different stages. If the representation of a noun such as lion contains information about the material the animal is made up of, as the overspecification view suggests, it is this information that will be in direct conflict with the denotation of the adjective stone. Perhaps this initial contradiction between the information contributed by the adjective and the information contributed by the noun is what drives the shift in reference, after which dependent features such as ‘roars’ are suppressed in a later stage.

The second scenario would be that, in line with Bierwisch and Schreuder (1992), there are two levels of meaning, a semantic level and a conceptual level. However, the two levels are activated simultaneously, making the conceptual information available if needed to determine the truth conditions of the utterance (as discussed in Section 2). Subsequently, a semantic structure is formed based on the information provided by the semantic level (in terms of Blutner’s (2004) type and sortal restrictions for example), and the conceptual level is adjusted (trimmed down) based on this.

What the choice between the two scenarios comes down to, I think, is the question how much information is needed at this semantic level to account for all possible combinations. Answering this question probably requires an intricate interplay between theoretical analyses and experimental testing. If phrases like paper needle and fried chicken, which are not considered to be (prototypical) examples of coercion, display a similar behavioral pattern involving a shift in reference followed by suppression, the semantic level has to encompass quite some detail to be able to detect the conflicting information. At that point the two scenarios basically become indistinguishable.

7. CONCLUSION

In this paper I discussed two experiments testing the interpretation of adjective noun combinations. My hypothesis was that conceptual features associated with the noun would be initially activated but suppressed when these features were in conflict with the adjective the noun occurred with. Evidence was found for the initial activation but not for the
subsequent suppression. The initial activation shows that also in the case of adjective noun combinations, conceptual features do not ‘wait for’ an initial well-formed semantic structure. The lack of evidence for suppression primarily suggests the need for further research. If it is indeed the case that suppression does not take place within 700 milliseconds, the means that the conceptual specification takes place after the shift in reference as found by Schumacher (2013).

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Appendix 1—Materials experiment 1: original adjective noun combinations, AN-compatible and AN-incompatible target words, contexts and their approximate English translations

| Adjective noun combination | AN-compatible target word | AN-incompatible target word |
|----------------------------|---------------------------|-----------------------------|
| 1  stoffen fiets            | wiel                      | rijden                      |
| 2  vilt nr pruim            | paars                     | pit                         |
| 3  gipsen oliebol           | rond                      | vet                         |
| 4  badstof rog              | plat                      | zwm en                      |
| 5  chocolade muis           | klein                     | grij                        |
| 6  gehaakte slak            | huisje                    | traag                       |
| 7  gehaakte spijker         | kop                       | scherp                      |
| 8  vilt bloem               | kleur                     | geur                        |
| 9  plastic aardbei         | rood                      | zoet                        |
| 10 marsepeinen auto        | wiel                      | rijden                      |
| 11 kunststof lavendel      | paars                     | geur                        |
| 12 papieren pizza          | rond                      | kaas                        |
| 13 kartonnen telefoon       | hoor                      | bellen                      |
| 14 marsepeinen klok        | wijzer                    | tikken                      |
| 15 glazen konijn           | oor                       | zacht                       |
| 16 glazen olifant          | slurf                     | ivoor                       |
| 17 plastic lolly           | kleur                     | zoet                        |
| 18 kunststof peper         | rood                      | heet                        |
| 19 plastic citroen         | geel                      | zuur                        |
| 20 rubberen kikker         | groen                     | springen                    |
| 21 stenen pauw             | staart                    | veer                        |
| 22 gipsen hoofd            | neus                      | haan                        |
| 23 marsepeinen paddenstoel | stip                      | giftiq                      |
### Table 1: Adjective Noun Combinations and AN-Compatible/Incompatible Target Words

| Adjective Noun Combination | AN-Compatible Target Word | AN-Incompatible Target Word |
|---------------------------|---------------------------|-----------------------------|
| gehaakte sneeuwpop         | wit                       | koud                        |
| plastic drol              | bruin                     | stank                       |
| viltens haas              | oor                       | stank                       |
| rubberen eend             | snavel                    | kwaken                      |
| pluche kanarie            | geel                      | fluiten                     |
| rubberen augurk           | groen                     | zuur                        |
| stoffen varken            | krulstaart                | knorren                     |
| stenen luchtballon        | mand                      | vuur                        |
| stenen leeuw              | manen                     | brullen                     |
| stenen vlieger            | ruit                      | zweeven                     |
| marmeren vogel            | vleugel                   | veer                        |
| papieren schaap           | wit                       | zacht                       |
| viltens sigaar            | bruin                     | stank                       |

### Contexts

1. Als decorstuk bij de musical gebruikten ze een stoffen fiets.
2. Bij de Ikea vond ik tussen de snuisterijen een viltens pruim.
3. In de etalage van de bakker op de hoek ligt een gipsen oliebol.
4. Tussen de knuffels van Sofietje ligt een badstof rog.
5. Op 5 december vond ik in mijn schoen een chocolade muis.
6. Als kraamcadeau kocht ik voor Teuntje een gehaakte slak.
7. Als surprise maakte Maaike voor haar vader een gehaakte spijker.
8. Als cadeautje kreeg Ingrid van haar dochtertje een papieren pizza.
9. In de kleuterklas knutselden de kinderen een kartonnen telefoon.
10. Voor een bestelling werkte de banketbakker aan een marsepeinen klok.
11. Na de safari kocht Petra in de souvenirwinkel een glazen olifant.
12. In de speelgoedwinkel kocht Simone een plastic lolly.
13. De keuken van de buren was versierd met een kunststof peper.
14. Bij mijn broer ligt in de fruitschaal alleen een plastic citroen.
15. Voor haar verzameling kocht tante Bep een glazen konijn.
16. De speelgoedwinkel kocht Simone een plastic lolly.
17. In de speelgoedwinkel kocht Simone een plastic lolly.
18. De keuken van de buren was versierd met een kunststof peper.
19. Bij mijn broer ligt in de fruitschaal alleen een plastic citroen.
20. Op het bureau van mijn opa stond altijd een rubberen kikker.
21. In de speelruimte bij ons in de buurt staat een stenen pauw.
22. In de hoek van het handarbeidlokaal staat een gipsen hoofd.
23. Gisteren kreeg Liesje bij haar oma een marsepeinen paddenstoel.
24. Na de naaiworkshop kwam Erika thuis met een gehaakte sneeuwpop.
25. Mijn buurjongetje liet mij van de week schrikken met een plastic drol.
26. Voor pasen maakten wij vroeger op school altijd een viltens haas.
Roderick speelt in bad nog steeds met een rubberen eend.
Voor zijn kleine neefje kocht Peter een pluche kanarie.
Bij de speelkeuken die ik laatst kocht zat een rubberen augurk.
Na het schoolreisje kocht Sammie in de souvenirwinkel een stoffen varken.
De schutting van de buren is versierd met een stenen luchtballon.
Voor de ingang van het museum staat een stenen leeuw.
Boven de schouw van de familie Jansen hangt een stenen vlieger.
In de tuin van de buurman staat sinds kort een marmeren vogel.
Vandaag hebben de kinderen geknutseld aan een papieren schaap.
Bij de fopwinkel kocht Christiaan gisteren een vilten sigaar.

### Approximate translations materials Experiment 1

| Adjective noun combination | AN-compatible target word | AN-incompatible target word |
|----------------------------|---------------------------|-----------------------------|
| 1 cloth bike               | wheel                     | ride                        |
| 2 felt plum                | purple                    | pit                         |
| 3 plaster deep fried dough ball | round           | greasy                      |
| 4 terry cloth ray          | flat                      | swim                        |
| 5 chocolate mouse          | small                     | grey                        |
| 6 crocheted snail          | house                     | slow                        |
| 7 crocheted nail           | head                      | sharp                       |
| 8 felt flower              | color                     | smell                       |
| 9 plastic strawberry       | red                       | sweet                       |
| 10 marzipan car            | wheel                     | drive                       |
| 11 plastic lavender        | purple                    | smell                       |
| 12 paper pizza             | round                     | cheese                      |
| 13 cardboard telephone     | receiver                  | call                        |
| 14 marzipan clock          | pointer                   | tick                        |
| 15 glass rabbit            | ear                       | soft                        |
| 16 glass elephant          | trunk                     | ivory                       |
| 17 plastic lollypop        | color                     | sweet                       |
| 18 plastic pepper          | red                       | hot                         |
| 19 plastic lemon           | yellow                    | sour                        |
| 20 rubber frog             | green                     | jump                        |
| 21 stone peacock           | tail                      | feather                     |
| 22 plaster head            | nose                      | hair                        |
| 23 marzipan mushroom       | dot                       | poisonous                   |
| 24 crocheted snowman       | white                     | cold                        |
| 25 plastic turd            | brown                     | smell                       |
| Adjective noun combination | AN-compatible target word | AN-incompatible target word |
|---------------------------|---------------------------|----------------------------|
| 26 felt hare              | ear                       | fast                       |
| 27 rubber duck            | beak                      | quack                      |
| 28 plush canary           | yellow                    | whistle                    |
| 29 rubber pickle          | green                     | sour                       |
| 30 cloth pig              | curly tail                | groin                      |
| 31 stone hot air balloon  | basket                    | fire                       |
| 32 stone lion             | mane                      | roar                       |
| 33 stone kite             | diamond                   | flow                       |
| 34 marble bird            | wing                      | feather                    |
| 35 paper sheep            | white                     | soft                       |
| 36 felt cigar             | brown                     | smell                      |

### Contexts

1. As a prop for the musical, they used a cloth bike.
2. At the Ikea, I found a felt plum between the trinkets.
3. In the window of the bakery, there is a plaster deep fried dough ball.
4. Among Sophietje’s stuffed animals, there is a terry cloth ray.
5. On December 5th, I found a chocolate mouse in my shoe.
6. As a birth gift, I bought Teuntje a crocheted snail.
7. As a surprise gift, Maaike made her father a crocheted snail.
8. As a gift, Ingrid got a felt flower from her daughter.
9. In the play room, I tripped over a plastic strawberry this morning.
10. My brother’s cake was decorated with a marzipan car.
11. At my grandmother’s place, there was always a vase with plastic lavender.
12. While playing restaurant, the children served a paper pizza.
13. In kindergarten, the children created a cardboard telephone.
14. For an order, the confectioner worked on a marzipan clock.
15. For her collection, aunt Bep bought a glass rabbit.
16. After the safari, Petra bought a glass elephant in the gift shop.
17. In the toy store, Simone bought a plastic lollypop.
18. Our neighbor’s kitchen is decorated with a plastic pepper.
19. My brother’s fruit bowl only contains a plastic lemon.
20. On my grandfather’s desk, there always was this rubber frog.
21. At the playground near our home, there is a stone peacock.
22. In the corner of the crafts room, there is a plaster head.
23. Yesterday, Liesje got a marzipan mushroom at her grandmother’s.
24. After the sowing workshop, Erika came home with a crocheted snowman.
25. The boy next door scared me this week with a plastic turd.
26. We always used to make a felt hare at school for Easter.
27. Roderick still pays with a rubber duck when he’s taking a bath.
28. For his little nephew, Peter bought a plush canary.
29. The play kitchen I bought recently came with a rubber pickle.
30 After the school trip, Sammie bought a cloth pig in the gift shop.
31 The neighbor’s fence is decorated with a stone hot air balloon.
32 In front of the museum’s entrance, there is a stone lion.
33 Above the mantelpiece of the Jansen family, there is a stone kite.
34 Since recently, there is a marble bird in my neighbor’s yard.
35 Today, the children fabricated a paper sheep.
36 Yesterday, Christiaan bought a felt cigar at the joke store.

### Appendix 2—Materials experiment 2: original adjective noun combinations, AN-compatible and AN-incompatible target words, contexts and their approximate English translations

| Adjective noun combination | AN-compatible target word | AN-incompatible target word |
|---------------------------|---------------------------|-----------------------------|
| 1 beslagen bril            | montuur                   | transparant                 |
| 2 dode bij                 | streep                    | zoemen                      |
| 3 dode eend                | snavel                    | kwaken                      |
| 4 donkere wolk             | regen                     | wit                         |
| 5 dorre boom               | tak                       | groen                       |
| 6 elektrische kachel       | warm                      | hout                        |
| 7 fijngestampt suikerklontje | zoet                     | vierkant                    |
| 8 gebraden kip             | vleugel                   | veer                        |
| 9 gekarameliseerde suiker  | zoet                      | wit                         |
| 10 geland vliegtuig        | groot                     | hoog                        |
| 11 gestrande auto          | wiel                      | rijden                      |
| 12 gesuikerde pinda        | bruin                     | zout                        |
| 13 halve pizza             | kaas                      | rond                        |
| 14 kale struik             | tak                       | groen                       |
| 15 kapotte gloeilamp       | glas                      | licht                       |
| 16 leeg zwembad            | blauw                     | water                       |
| 17 neergeschoten vogel     | veer                      | vliegen                     |
| 18 opgezette kikker       | groen                     | springen                    |
| 19 opgezette leeuw         | manen                     | brullen                     |
| 20 opgezette kanarie       | geel                      | fluiten                     |
| 21 opgezette vlinder       | kleur                     | vliegen                     |
| 22 oude koffie             | zwart                     | heet                        |
| 23 platgetrapte lieveheersbeestje | rood                   | vliegen                     |
| 24 stilstaande klok        | wijzer                    | tikken                      |
| 25 stilstaande trein       | geel                      | snel                        |
| 26 uitgedroogde sinaasappel | oranje                    | sappig                      |
| 27 uitgemergeld varken     | roze                      | dik                         |
| 28 vegetarische lasagne    | tomaat                    | gehakt                      |
| 29 verpulverd pepermun
tje | wit                       | rond                        |
| 30 versplinterde knikker   | glas                      | rollen                      |
1 Als ik ’s winters weer thuis kom kan ik een tijdje niet zien. Door de warmte krijg ik meteen een beslagen bril.
2 Je moet altijd uittuiken als je buiten eet. Gisteren lag er op mijn lepel ineens een dode bij.
3 Misschien moeten we de gemeente eens bellen. Bij de vijver ligt al dagen een dode eend.
4 De herfst is weer begonnen. Ik zag net al een donkere wolk.
5 Het mag wel weer lente worden. Ik kijk al maanden uit op een dorre boom.
6 Mijn zusje woont in een kraakpand. Ze maakt gebruik van een elektrische kachel.
7 De schoonmaakster had niet goed gestofzuigd. Op de vloer lag een fijngestampt suikerklontje.
8 Mijn buurman is niet per se een dierenliefhebber. Zijn enige beest in huis is een gebraden kip.
9 Ik ben lekker bezig geweest in de keuken. Ik heb koekjes gemaakt van deeg en gekarameliseerde suiker.
10 Af en toe gaan we een dagje naar Schiphol. Mijn vriend kan uren staan kijken naar een geland vliegtuig.
11 Vorig weekend gingen we naar Amsterdam. Langs de kant van de weg zagen we een gestrande auto.
12 Ik had een zak rozijnen gekocht. Opeens vond ik tussen de rozijnen een gesuikerde pinda.
13 Gisternacht kreeg ik opeens honger. Gelukkig was er nog een halve pizza.
14 We willen deze zomer de tuin op gaan knappen. Nu staat er alleen nog maar een kale struik.
15 Ik wilde gisteravond iets zoeken in de garage. Maar aan het plafond hing alleen een kapotte gloeilamp.
16 De camping was dit jaar niet zo’n succes. De enige faciliteiten waren een bouwkeet en een leeg zwembad.
17 Mijn vriend ging op mini-safari vorige week. Hij kwam thuis met een neergeschoten vogel.
18 Mijn oom is bioloog. Op zijn werkbureau staat een opgezette kikker.
19 Het museum in ons dorp is een beetje saai. Het hoogtepunt is een opgezette leeuw.
20 Het huis van mijn oom staat vol met rare dingen. Zo heeft hij bijvoorbeeld een opgezette kanarie.
21 Mijn broer verzamelt insecten. Zijn laatste aanwinst is een opgezette vlinder.
22 Het was hoog tijd om mijn kamer weer eens op te ruimen. Op het nachtkastje stond al een hele poos een kop oude koffie.
23 Ik kijk altijd naar de grond als ik op straat loop. Net zag ik een platgetrapt lieveheersbeestje.
24 Gisteren was ik bij de dokter. In de wachtkamer hing een stilstaande klok.
25 Ik was laatst een half uur te laat op mijn werk. Ik kon de spoorwegovergang niet over vanwege een stilstaande trein.
26 Ik haalde gisteren mijn tas eindelijk leeg. Tussen de papieren vond ik een uitgedroogde sinaasappel.
27 Mijn buurman zorgt echt niet goed voor zijn dieren. Op zijn erf zag ik een uitgemergeld varken.
28 Mijn vriend is nogal kieskeurig met eten. Ik heb voor hem vanavond een vegetarische lasagne.
29 Er is niets meer te eten in huis. Op de grond ligt alleen nog een verpulverd pepermuntje.
Approximate translations materials Experiment 2.

| Adjective noun combination | AN-compatible target word | AN-incompatible target word |
|----------------------------|----------------------------|-----------------------------|
| 1  | fogged glasses | frame | transparent |
| 2  | dead bee | stripe | buzz |
| 3  | dead duck | beak | quack |
| 4  | dark cloud | rain | white |
| 5  | dry tree | branch | green |
| 6  | electric stove | warm | wood |
| 7  | crushed sugar lump | sweet | square |
| 8  | fried chicken | wing | feather |
| 9  | caramelized sugar | sweet | white |
| 10 | landed plane | big | high |
| 11 | stranded car | wheel | drive |
| 12 | sugared peanut | brown | salty |
| 13 | half pizza | cheese | round |
| 14 | barren bush | branch | green |
| 15 | broken light bulb | glass | light |
| 16 | empty pool | blue | water |
| 17 | shot bird | feather | fly |
| 18 | taxidermied frog | green | jump |
| 19 | taxidermied lion | mane | roar |
| 20 | taxidermied canary | yellow | whistle |
| 21 | taxidermied butterfly | color | fly |
| 22 | old coffee | black | hot |
| 23 | crushed lady bug | red | fly |
| 24 | stopped clock | pointer | tick |
| 25 | stopped train | yellow | fast |
| 26 | dried out orange | orange | juicy |
| 27 | starved pig | pink | fat |
| 28 | vegetarian lasagna | tomato | meat |
| 29 | crushed peppermint | white | round |
| 30 | splintered marble | glass | role |

Contexts

1. In the winter, I’m always incapable of seeing for a moment when I get home. Due to the heat, I immediately get fogged glasses.
2. You always have to pay attention when you are eating outside. I suddenly found a dead bee on my spoon yesterday.
3. Maybe we should call the municipality. There’s been a dead duck lying near the pond for days now.
4. Fall has started again. I just saw a dark cloud already.
5. I would not mind if it became spring again. I’ve been looking at a dry tree for months now.
Contexts

6 My sister lives in a squatted house. She uses an electric stove.
7 The cleaning lady had not vacuumed very well. There was a crushed sugar lump on the floor.
8 My neighbor is not really an animal lover. The only animal in his house is a fried chicken.
9 I’ve been working nicely in the kitchen. I made cookies with dough and caramelized sugar.
10 Once in a while we go on a day trip to Schiphol. My boyfriend can look at a landed plane for hours.
11 Last week we went to Amsterdam. We saw a stranded car at the side of the road.
12 I bought a pack of raisins. Suddenly I found a sugared peanut between the raisins.
13 last night I suddenly became hungry. Luckily there was half a pizza left.
14 This summer, we want to renovate our yard. All there’s left now is a barren bush.
15 Yesterday evening I wanted to find something in the garage. But there was only a broken light bulb hanging from the ceiling.
16 This year the camping was not such a success. The only facilities were a construction shed and an empty pool.
17 My friend went on a mini-safari last week. He came home with a shot bird.
18 My uncle is a biologist. On his office desk, there is a taxidermied frog.
19 The museum in our village is quite boring. The highlight is a taxidermied lion.
20 My uncle’s house is full of strange objects. He has a taxidermied canary for example.
21 My brother collects insects. His latest purchase is a taxidermied butterfly.
22 It was about time I cleaned my room again. There’s been a cup of old coffee on my nightstand for a while now.
23 I always look down when I’m walking on the street. Just now, I saw a crushed lady bug.
24 I was at the doctor yesterday. A stopped clock hung on the wall in the waiting room.
25 Recently, I was half an hour late for work. The level crossing was blocked by a stopped train.
26 I finally emptied my bag yesterday. Between the papers I found a dried out orange.
27 My neighbor really does not take good care of his pets. On his farmyard I saw a starved pig.
28 My friend is kind of picky when it comes to food. Tonight I will serve him a vegetarian lasagna.
29 There is nothing left to eat in the house. There is only a crushed peppermint on the floor.
30 My sister came home yesterday with an aching foot. She stepped in a splintered marble at the playground.

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