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To cite this article: Andreas Brocher, Sofiana Iulia Chiriacescu & Klaus von Heusinger (2016): Effects of Information Status and Uniqueness Status on Referent Management in Discourse Comprehension and Planning, Discourse Processes, DOI: [10.1080/0163853X.2016.1254990](https://doi.org/10.1080/0163853X.2016.1254990)

To link to this article: <https://doi.org/10.1080/0163853X.2016.1254990>



Published online: 27 Dec 2016.



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Effects of Information Status and Uniqueness Status on Referent Management in Discourse Comprehension and Planning

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ABSTRACT

In discourse processing, speakers collaborate toward a shared mental model by establishing and recruiting prominence relations between different discourse referents. In this article we investigate to what extent the possibility to infer a referent's existence from preceding context (as indicated by the referent's information status as inferred or brand-new) and a referent's unique identifiability (as indicated by a referent's uniqueness status) affect (1) ambiguous pronoun resolution in comprehension and (2) the bias to mention a referent again and make it topic in discourse planning. In Experiment 1, a visual-world eye-tracking experiment, we found that ambiguous pronouns are more likely to be interpreted as linked to the direct object of the preceding sentence when the associated referent was inferred and unique than when it was inferred and non-unique. For brand-new referents, uniqueness status did not affect ambiguous pronoun resolution. In Experiment 2, a story continuation experiment, we found that inferred and unique referents were mentioned again and made topic less often than inferred and non-unique referents as well as brand-new referents. Results are discussed within a dual-process activation model, which distinguishes the activation of a noun phrase's concept through inference relations and the activation of a noun phrase's referent through the referent's uniqueness status.

Introduction

It is well understood that discourse processing in general and referent management in particular involve mental models that are mutually available to speakers and hearers. Without such shared models, referent tracking would be very difficult, if not impossible. In this article we focus on the question of how the way a referent is introduced into discourse affects discourse comprehension and discourse planning. For comprehension, we use ambiguous pronoun resolution. For planning, we use a story continuation task. Importantly, we distinguish two parameters that are involved in the introduction of a new discourse referent: the activation of a concept, associated with a noun phrase's descriptive material, and the activation of a referent. Although both parameters have been documented in the literature in various ways, their contribution to referent introduction has only rarely been explicitly articulated, let alone systematically investigated.

It has repeatedly been shown that referent activation interacts with grammatical role and thematic role. All other things being equal, subject referents and goal referents are more available to speakers in ambiguous pronoun resolution and story continuation tasks than object referents and source referents, respectively (Arnold, 2001; Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000; Arnold & Wasow, 2000; Brennan, 1995; Crawley & Stevenson, 1990; Gernsbacher, 1990; Gordon, Grosz, & Gilliom, 1993; Kaiser, 2011; Stevenson, Crawley, & Kleinman, 1994; Stevenson, Knott, Oberlander, & McDonald, 2000). Furthermore, and more on the side of concept activation, verb semantics (i.e., the

implicit causality expressed by a verb) can lead speakers to develop specific expectations about which referent an ambiguous pronoun is likely to refer to and which referent is likely to be mentioned next (Arnold, 2001; Fukumura & Van Gompel, 2011; Garvey & Caramazza, 1974; Hartshorne & Snedeker, 2012; Pyykkönen & Järviö, 2010). A robust finding is that the stronger the implicit causality denoted by a verb points to a specific referent, the more likely it is that speakers mention that referent again. Another finding is that the amount of conceptual information embedded in a noun phrase affects the type of referring expression a speaker uses to mention the denoted referent: The conceptually richer a noun phrase is, the more likely it is that a pronoun will be used to refer to the denoted referent later on (Karimi, Fukumura, Ferreira, & Pickering, 2014).

One shortcoming of previous studies is that referent activation and concept activation have been manipulated between linguistic items, for example, between the subject or object of a sentence on the one hand and the verb on the other. In addition, the two processes have not always directly been linked to the referent of interest. For example, in many studies it was the concept of the verb that more or less strongly pointed to a specific referent, not the concept of the referent itself. Indeed, we know very little about how referent and concept activation affect discourse comprehension and planning when they both occur at the very introduction of a new discourse referent. Considering previous research, we would expect that the two processes additively increase referent availability (e.g., when an ambiguous pronoun needs to be resolved or a discourse be continued). Referents with highly activated concepts should be more available to speakers than referents whose concepts are only weakly activated. In the same vein, referents that are activated in grammatically or thematically prominent positions should be more available to speakers than referents that are activated in grammatically and thematically less prominent positions.

However, in addition to some more theoretical considerations, some empirical evidence suggests that referent activation and concept activation may interact in an interesting, nonadditive way. For example, Stevenson et al. (1994) found that grammatical role (referent activation) and implicit causality encoded at the verb (concept activation) affect referent management differently depending on whether or not a pronoun needs to be disambiguated (Rohde & Kehler, 2014; see also Kehler & Rohde, 2013).

The goal of the present study is to systematically investigate the contribution of referent activation and concept activation to (1) ambiguous pronoun resolution and (2) discourse planning and to do so for cases where the two processes occur at the very introduction of a new discourse referent. The present study is therefore not only important for understanding the dynamicity underlying referent processing (Arnold, 2001) but also important because there has been no explicit model in the empirical literature sketching how referent activation and concept activation may or may not affect referent introduction.

To zoom in on the approach we take in the present study, consider the following example. When we newly introduce the noun phrase *a construction worker* into a discourse, we not only introduce a new referent, namely the referent denoted by that noun phrase, we also introduce a concept CONSTRUCTION WORKER associated with that referent, namely properties that characterize a construction worker. In many instances, concept and referent activation occur simultaneously. That is, a noun phrase that introduces a referent also introduces a concept. However, there are cases in which concept activation and referent activation can be disentangled. For example, when we hear or read about a construction site, we can expect there to be an owner and/or construction workers. In this case, the concepts of OWNER and CONSTRUCTION WORKER become available before the noun phrases denoting the respective referents (owner, construction worker) are explicitly introduced. The definite or indefinite article on the noun phrases, then, indicates whether the referent can be uniquely identified, such as for *the owner*, or not, such as for *a construction worker*. In short, at the level of concept activation, we manipulate the information status of referents (Prince, 1981b, 1992). At the level of referent activation, we manipulate the uniqueness status of referents (Abbott, 2010; Hawkins, 1978; Heim, 1991).

Previous studies on uniqueness status and information status

Discourse referents can be introduced by proper names, personal pronouns, demonstrative pronouns, and descriptive noun phrases. Proper names and pronouns contain very little descriptive content (such as gender, number, and animacy information; Abbott, 2002; Burge, 1973; Gordon et al., 1993; Sanford, Moar, & Garrod, 1988; von Heusinger & Wespel 2007). Proper names are directly linked to their referent and refer to it by convention. For example, the proper name *Peter* refers to the referent that has the name “Peter.” Personal pronouns (in English or German), on the other hand, establish reference according to their (lexically encoded) functions and typically identify the most prominent discourse entity in preceding context that agrees with it in gender and number (Brennan, Friedmann, & Pollard 1987; Gordon et al., 1993; Nunberg 1993).

In contrast to proper names and pronouns, descriptive noun phrases, such as definite and indefinite noun phrases (e.g., *the owner* or *a construction worker*) identify their referent by an interaction of the function of the article (e.g., the definite article *the* or the indefinite article *a(n)*), the meaning of the descriptive material (*owner*, *construction worker*), and their link to the preceding context (e.g., *construction site*). Because, unlike pronouns and proper names, definite and indefinite noun phrases (henceforth definites and indefinites, respectively) allow for a disentanglement of concept and referent activation in referent management, we review these noun phrases in some more detail.

In classical semantics (for overviews see Heim, 1991, 2011), indefinites are treated as quantifiers that assert the nonemptiness of the set denoted by their descriptive content. Definites, in contrast, are assumed to identify their referent by an existential and uniqueness condition (Abbott, 2010; Elbourne, 2013; Hawkins, 1978; Russell, 1905; see also Chambers, Tanenhaus, Eberhard, Filip, & Carlson, 2002). Within the framework of dynamic semantics (Heim, 1982; Kamp 1981; Karttunen, 1969), both definites and indefinites are analyzed as expressions that introduce discourse referents into a discourse. Both types of expressions denote a concept through their descriptive content and then assign a referent to that concept. Importantly, when a noun phrase is definite rather than indefinite marked, referent assignment must satisfy a uniqueness condition. That is, definites indicate that exactly one referent falls under the descriptive content of the noun phrase and that this referent can be uniquely identified. In contrast, indefinites lack a uniqueness condition, leading to a non-uniqueness implicature (Christophersen, 1939; Heim, 2011). To take an example, when we hear of *the pedestrian* at a construction site rather than *a pedestrian* at a construction site, we infer in the former but not the latter case that there is exactly one pedestrian at the construction site. Thus, the uniqueness condition applies to the definite *the pedestrian* and not to the indefinite *a pedestrian*.

In addition to the different functions of a noun phrase’s definiteness marking, the concept associated with the descriptive material of the noun phrase can have different statuses with respect to the information that is provided by the discourse. Prince (1981b, 1992) has termed this inferential relation as the information status of a referential expression or referent. She proposes a three-way distinction concerning different levels of information status and suggests that a referent can be given, inferred (or inferable), or brand-new in discourse context. More specifically, when a referent can be linked to a coreferential expression in the preceding discourse with the same or a more comprehensive description, it is categorized as *given*. When the description denoted by a noun phrase can be inferred from another descriptive expression in preceding discourse, such as *a construction worker* from the anchor *construction site*, thereby triggering an inference relation, the referent is categorized as *inferred* (or *inferable*). Finally, when the descriptive content denoted by a noun phrase has no obvious link to the preceding context, such as *a pedestrian* to *a construction site*, the referent is categorized as *brand-new*. In this article we only test inferred and brand-new referents, because given referents do not allow for a disentanglement of concept and referent activation for definites and are generally pragmatically infelicitous for indefinites.

Note that definites can fulfill their uniqueness condition in different ways, depending on the information status of the denoted referent. In the case of inferred referents, one take, which is compatible with work by Barsalou and colleagues, is that definites not only express a functional concept that takes its open argument from a conceptual frame provided in preceding discourse (Barsalou, 1992; Löbner, 1985, 1998; Minsky, 1977; Wu & Barsalou, 2009); they also introduce extensive descriptive content that sufficiently restricts the potential referents to exactly one (see Hawkins [1978] for *unfamiliar* or Prince [1981b] for *containing inferable*). For example, the concept of a CONSTRUCTION SITE activates the existence of exactly one owner, leading to *the owner* rather than *an owner*. In contrast, in the case of brand-new referents, definites express a concept that a hearer can assume to be uniquely identifiable. For example, when we hear of *the pedestrian at a construction site*, we infer that there is exactly one pedestrian at the construction site.

With respect to information status and uniqueness status in the empirical literature, there has been very little systematic work, in particular with respect to a distinction of concept activation and referent activation (Arnold & MacDonald, 1999; Burkhardt, 2006; Schumacher, 2009). This is the more surprising considering that explicit accounts have been provided in theoretical investigations (e.g., Elbourne, 2013; Hawkins, 1978; Lyons 1999; Prince, 1981b, 1992). One study that addressed potential differences in the processing of uniqueness and information status is Schumacher (2009; see also Burkhardt, 2006). In a comprehension experiment eliciting event-related brain potentials, participants read short stories consisting of two sentences, a context sentence and a target sentence. Target sentences either mentioned a referent that could be uniquely identified by means of a definite article (*the speaker*) or a referent that could not be uniquely identified by means of an indefinite article (*a speaker*). Importantly, context sentences (1) already introduced the target referent (*a speaker*), (2) provided an anchor by which the target referent could be inferred (*a talk*), or (3) did not contain any information about the target referent (*Peter met Hannah*). We should point out that Schumacher's materials led to a pragmatically infelicitous use of *a speaker* when (the coreferential noun phrase) *speaker* had already been introduced. Although the two instances of *speaker* could refer to two independent referents, hearers might also have interpreted them to be coreferential in the experiment. This might have led to a violation of the nonfamiliarity constraint of indefinites and affected the observed results.

Schumacher found that the N400, a negative-going brain wave component associated with ease of lexical retrieval (the more negative, the harder to process), was most negative for referents that could not be inferred (*Peter met Hannah—~~a~~/the speaker*) and least negative for referents that had already been introduced (given referents), with referents whose concepts were made available by the preceding anchor falling in between (*a talk—~~a~~/the speaker*). This indicates that a referent's ease of retrieval from memory is positively correlated with its information status (given > inferred > brand-new). In other words, when the concept of a referent is available before the referent is explicitly introduced by a noun phrase, referent retrieval is easier than when concept and referent are introduced simultaneously. Interestingly, Schumacher also found an effect of uniqueness status (definite vs. indefinite article) at the onset of the article. Definite articles elicited more pronounced frontal negativities than indefinite articles. These stronger negativities for definite than indefinite articles point to differences in processing ease associated with a referent's uniqueness status. The need to uniquely identify a referent in discourse may be more demanding than not being required to do so (Heim, 2011).

In this article we aim at further testing and refining the observed differences between definites and indefinites and inferred and brand-new referents and their interaction. The goal was to develop a model that allows us to treat concept activation and referent activation as two separate processes at referent introduction, that is, without ascribing the two processes to different linguistic materials, such as verb (concept activation) and subject (referent activation). The model also allows us to test concept activation and referent activation in both discourse comprehension and discourse planning (Kehler, Kertz, Rohde, & Elman, 2008; Kehler & Rohde, 2013; Rohde & Kehler, 2014; Stevenson et al., 1994, 2000). To that end, it points to two different, but related, notions of expectation. For

comprehension, the model assumes that specific concepts (i.e., anchors) in a discourse lead hearers or readers to expect some referents more than others and more expected referents should be better candidates in resolving an ambiguous pronoun than less expected referents. This is predicted because the concept of expected but not the concept of unexpected referents is already activated at referent encounter. Importantly, when a referent is explicitly mentioned, expectation can be addressed in different ways, for example, by uniquely identifying a referent or by triggering a non-uniqueness implicature. Concept and referent activation in comprehension are tested in Experiment 1.

For discourse planning, the model assumes that concept activation and referent activation lead to different degrees of referent (un)expectedness, triggering different degrees of importance, informativity, or noteworthiness. We focus on two specific expectation-based principles that we refer to as Discourse Saturation Principle and Topic Saturation Principle. The Discourse Saturation Principle reflects the assumption that a speaker/writer only introduces a discourse-new (and hearer-new) referent when she or he plans to provide more information about that referent later on. In other words, newly introduced and unexpected referents (in syntactic prominent positions such as the subject or object position) seem particularly important or noteworthy and thus raise some pressure that they will be mentioned again. The Topic Saturation Principle predicts that newly introduced and unexpected referents become the sentence topic early on in subsequent discourse. Effects of concept and referent activation on the two principles of discourse planning are tested in Experiment 2.

Experiment 1: Discourse comprehension

Experiment 1 is an eye-tracking experiment using a visual world paradigm. Participants listened to short stories (Table 1) while looking at a computer screen that showed three pictures. We investigated to what extent a referent’s information status (i.e., concept activation) and uniqueness status (i.e., referent activation) affect ambiguous pronoun resolution. The rationale was that differences in information status and uniqueness status might make a referent more or less available when an ambiguous pronoun is presented. Importantly, the more available a referent is at pronoun encounter, the larger the proportion of looks to the picture depicting that referent should be (relative to the proportion of looks to the remaining pictures on the screen; Arnold, 1998; Brennan et al., 1987; Chafe, 1994; Givón, 1983; Gundel, Hedberg, & Zacharski, 1993). Crucially, at pronoun encounter, comprehenders need to uniquely identify the referent to which the pronoun refers.

More specifically, we were interested in whether the information status (inferred vs. brand-new referent) and uniqueness status of an object referent (unique vs. non-unique referent) can affect a hearer’s interpretation of an ambiguous pronoun. We tested whether preactivation of a referent’s concept through an anchor boosts the availability of the referent once it is introduced. That is, for an inferred referent, the referent’s concept is available before the referent is explicitly introduced (construction site activates the concepts of an owner and the concept of a construction worker [2a–b] in Table 1), whereas concept and referent activation should occur simultaneously for brand-new referents (construction site does not activate the concept of a

Table 1. Sample Experimental Materials.

(1) The construction site at the neighbor’s was loud and dusty.	
(2) Philip stared at _____	(a) the dirty owner. (b) a dirty construction worker. (c) the pedestrian at the fence. (d) a pedestrian at the fence.
(3) When the dust dispensed, he stepped back and rubbed his eyes.	

Materials are translated from German. Sentences (1) and (3) were identical in all conditions. The referent in direct object position in sentence (2) was manipulated to yield inferred/unique (2a), inferred/non-unique (2b), brand-new/unique (2c), and brand-new/non-unique (2d).

pedestrian [2c–d] in Table 1). Materials of Experiment 1 also allowed us to zoom in referent activation by testing whether there is a difference in ambiguous pronoun resolution between referents that can be uniquely identified (2a, 2c) and referents that cannot (2b, 2d) as well as whether this difference would equally hold for referent activation of inferred and brand-new conditions.

Predictions

In Experiment 1 we tested two competing hypotheses. If information status and uniqueness status equally and additively contribute to the availability of a discourse referent at pronoun encounter, inferred definites (*the owner*) should be particularly available because their concept is preactivated through an anchor in context and therefore highly familiar to a comprehender (Burkhardt, 2006; Schumacher, 2009) and because their referent is uniquely identifiable through definiteness marking (Givón, 1983; Gundel et al., 1993; see also Chambers et al., 2002). In contrast, the availability of brand-new indefinites (*a pedestrian*) should be comparably low because their concept has neither been activated before referent encounter nor can the referent be uniquely identified. Finally, the availability of inferred indefinites (*a construction worker*) and brand-new definites (*the pedestrian*) should fall in between inferred definites and brand-new indefinites, because they either benefit from preactivation of the concept (inferred indefinites) or from unique identifiability of the referent (brand-new definites).

A second possibility is that a referent's uniqueness status differently affects ambiguous pronoun resolution for brand-new and inferred referents. For brand-new referents and following Heim (1982), Kamp (1981), and Karttunen (1969), these referents might always function as introduction of a new discourse referent into discourse (*construction site... a/the pedestrian*). Unique identifiability might then not be important because hearers focus on the existence of the referent rather than the referent itself. For inferred referents, on the other hand, the concept associated with the descriptive content is already inferentially linked to a preceding anchor and, therefore, already familiar to a comprehender once it is explicitly mentioned. In these cases, the definite article uniquely identifies the referent that falls under the linking concept (*construction site... the owner*) and can directly inherit the activation from the concept activation. The indefinite article, on the other hand, implicates that there might be more than one referent of the inferred set (*construction site... a construction worker*). If this were the case, the referent may not directly benefit from activation of the concept. In other words, inferred indefinites may not strongly signal to a comprehender that the associated referent is highly activated. This idea finds support from the observation that strong indicators of high activation, such as indefinite demonstratives, are not licensed in inferred contexts (*a conference... ?this participant*; see Ionin, 2006; MacLaran, 1982; Prince, 1981a).

Methods

Participants

Forty students of the University of Cologne participated in the experiment for monetary compensation (EUR 7 per hour). All participants were monolingual speakers of German and self-reported normal or corrected-to-normal vision. For all data presented in this article, no participant took part in more than one experiment.

Materials

We constructed 24 short stories like the one in Table 1 (see Appendix A for a sample set of stimuli along with their English translations). All experimental stories comprised three sentences. The first sentence set up a specific context (e.g., a construction site; Table 1). The second sentence introduced two male referents into the discourse. The referent in subject position was always a proper name (e.g., *Philip*), whereas the referent in direct object position was always a full noun phrase (e.g., *the*

dirty owner). No additional human referents were introduced in an experimental story. Note that we opted for proper names for referents in subject position because they are the most neutral referential expression for a first mentioned referent in subject position. Finally, in the third sentence, an ambiguous pronoun was introduced that could either be linked to the discourse referent introduced by the proper name in subject position (*Philip*) or the descriptive noun phrase in the direct object position (*the dirty owner*). Importantly, the pronoun can generally only be linked to a referent and not the concept of a descriptive noun phrase. In other words, at ambiguous pronoun encounter, hearers need to uniquely identify the referent associated with that pronoun.

Experimental items were constructed to create four conditions based on the manipulation of two factors: information status and uniqueness status. More specifically, referents in direct object position could be inferred and unique (*the dirty owner*), inferred and non-unique (*a dirty construction worker*), brand-new and unique (*the pedestrian at the fence*), or brand-new and non-unique (*a pedestrian at the fence*). We stress that within inferred referents, we used different referents for the definite (unique) and indefinite (non-unique) condition. This was done to preserve the naturalness of our stories. There is a strong tendency, if not a pragmatic constraint, to use a definite article for referents that provide a unique concept by their lexical material and the anchor concept. For example, in the context of a construction site, it seems infelicitous to speak of *an* owner rather than *the* owner, because there is usually only one owner at a construction site. In the same vein, provided that a construction worker is mentioned for the first time, it seems infelicitous to speak of *the* construction worker rather than *a* construction worker. This is because there is typically more than one worker at a construction site.

Furthermore, because object referents introduced in second sentences were always mentioned for the first time, we included additional descriptive material by modifiers for these referents to, again, preserve the naturalness of our items. This was particularly important for brand-new definites, because the uniqueness condition expressed by the definite article needs to be licensed by the descriptive material within the noun phrase. We thus added a locative prepositional phrase with all brand-new referents (e.g., *at the fence*; Table 1). Because a locative prepositional phrase sounds rather unnatural and triggers unwanted inferences with inferred and unique referent (*the owner at the fence* implies that there are multiple owners at the construction site), we modified inferred noun phrases by adjectives (e.g., *dirty*) rather than locative phrases. It is important to keep in mind that experimental materials only differed with respect to the noun phrase denoting the direct object in the second sentence. Any differences in the interpretation of the ambiguous pronoun in the final sentence are therefore likely to reflect differences in the information status and uniqueness status of preceding object referents.

In light of the many studies that showed that verb bias can affect referent processing and to avoid ceiling effects for looking time to the subject or the object referent (e.g., *impress* is strongly biased toward the subject and might therefore lead to particularly few looks to the object referent), we attempted to use verbs that were neither strongly biased toward the subject nor to the object. Judging from translations of verbs tested in Hartshorne and Snedeker (2012) and local normings, the mean object bias for the verbs in our materials was 42%. Finally, because we used different referents in the inferred conditions we conducted a control experiment to ensure that these referents (inferred/unique and inferred/non-unique) were equally strongly inferable from their contexts. We also ensured that referents of the brand-new conditions were in fact not or only weakly inferable from their contexts.

Typicality norming. Ninety-six students from the University of Cologne (monolingual speakers of German) rated how typical they believed a noun was in a given context. They received booklets of 42 sentences, each followed by one target noun provided on a separate line. Referents were never marked for uniqueness (i.e., they were presented without an article). Context sentences used for the ratings were the context sentences of the short stories used in the main experiment (e.g., sentence (1) in Table 1). Participants judged typicality of each referent

individually and based their judgment on a scale from 1 for “not typical at all” to 7 for “very typical.” Participants saw each context sentence and target noun only once, and conditions were counterbalanced across presentation lists.

As expected, nouns of the brand-new conditions were significantly less typical in their contexts than their inferred counterparts. Importantly, nouns of the inferred conditions (*owner* vs. *construction worker*) did not differ in typicality, regardless of whether the denoted referent was unique or non-unique. Nouns of the brand-new conditions (*pedestrian*) received a typicality score of 2.41 ($SD = .67$), nouns of the inferred/non-unique condition (*construction worker*) a score of 6.02 ($SD = 0.78$), and nouns of the inferred unique condition (*owner*) a score of 5.9 ($SD = 0.55$). Linear regressions showed that nouns of the brand-new conditions were significantly less typical in their contexts than nouns of the inferred conditions, $t_s > 17$, $p_s < .001$. Importantly, inferred/unique and inferred/non-unique nouns did not statistically differ, $\beta = -.11$, $SE = .20$, $t = -.58$, $p = .561$.

For the main experiment, materials were distributed across four presentation lists. Each list contained 24 experimental and 48 filler stories. Each list contained six items of each condition with no repetition of items within lists. Filler stories closely resembled experimental stories in structure and length but never contained any ambiguous pronouns. Because only male referents were used in the experiment, since the masculine gender morphologically distinguishes subject and object and because the singular pronoun *er* (*he*) requires two male antecedents to lead to an ambiguity, we also exclusively used male referents in our filler stories. In the same vein, because all final sentences of the experimental stories began with the subordinate conjunction *als* (*when*), the same was done for the filler items.

Three kinds of pictures were created. One set corresponded to the referents in subject position (*Philip*), one set to the referents in direct object position (*the dirty owner*), and one set to the objects that served as look-away distractors in our short stories (*dust*). An example display is provided in Figure 1. Words that corresponded to look-away objects were mentioned shortly before encounter of the ambiguous pronoun. Look-away objects were included to decrease the probability that participants were already fixating on one of the two target pictures (*Philip* or *the dirty owner*) at pronoun onset. Furthermore, while the picture of the look-away object appeared in the middle top of the screen, pictures corresponding to the two human referents were presented to the left and right of the screen beneath the look-away object (Figure 1). Positions of referents in subject and object position

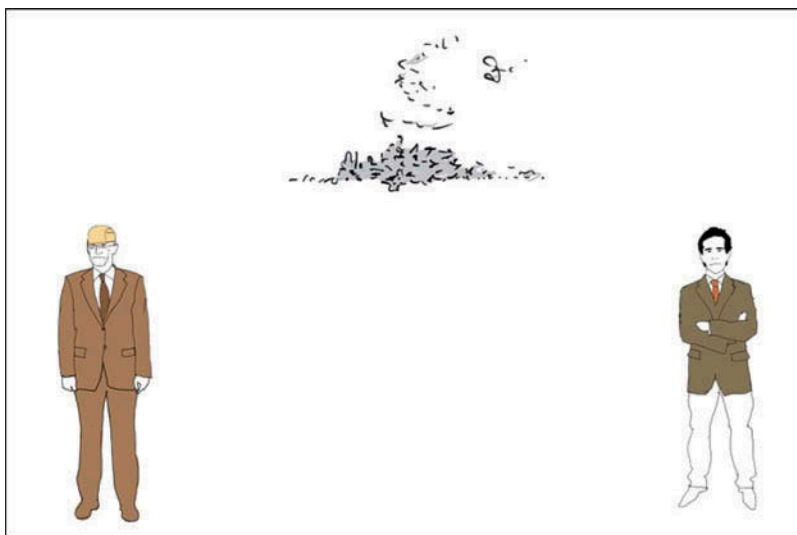


Figure 1. Example visual display for Experiment 1. The referent in subject position (*Philip*) is presented to the right, the referent in object position (*the dirty owner*) is presented to the left, and the look-away object (*dust*) is presented at the top.

were counterbalanced within and across lists such that both kinds of referents appeared on both sides of the screen equally often in each condition.

Finally, because we used proper names for referents in subject position (*Philip*) and because, unlike for referents in object position (*owner, construction worker, pedestrian*), proper names cannot be depicted and therefore not be identified via specific properties germane to the referent (i.e., there is no property that identifies a *Philip*), we introduced subject referents before they appeared in one of the subsequent stories. For the introduction of subject referents, we distributed the 72 trials across 12 blocks. Each block consisted of two experimental and four filler stories. Before each block, participants were familiarized with the referents that were to appear in one of the six following stories. Participants were given as much time as they needed to familiarize themselves with the subject referents and the corresponding pictures. However, they were told that they would never be asked questions about their physical appearance. Because referents in object position could be identified through particular visual features of their corresponding pictures, these referents did not require any familiarization. The order of presentation block and the order of trials within each block were randomized for each participant. Finally, each trial was followed by a yes or no comprehension question (half “yes,” half “no” responses).

Procedure

All stories were presented aurally over headphones. After participants indicated they were familiar with the subject referents of the current block, they initialized presentation of the first of six stories. At the beginning of each trial, the visual scene appeared onscreen (subject referent, object referent, look-away object). After 500 ms, auditory presentation of the story began. Participants were instructed to carefully listen to these stories and look at the pictures onscreen while listening. They were told that there was no correct or incorrect picture to look at and that the pictures might help them understand the story to which they were attending. To make sure that participants understood the task, four practice trials preceded the main experiment. Finally, participants were told that they would answer a yes or no comprehension question after each story.

Results

One participant was excluded from analysis due to comprehension accuracy lower than 80%. Average overall accuracy was 86%. An additional 8.8% of data points was excluded because of blinks (4.6%), fixations shorter than 80 ms (0.9%), or less than 60% of looks within the time frame of interest (1800 ms, see below) landed on any of the three picture onscreen (3.3%). For the analysis of the remaining fixation data and within a frame starting at 100 ms before ambiguous pronoun onset and ending at 1700 ms after pronoun onset, we divided fixation durations into a baseline measure (100 ms preceding pronoun onset to 200 ms post pronoun onset) and additional five time bins: 200 ms to 500 ms post pronoun onset, 500 ms to 800 ms post pronoun onset, 800 ms to 1,100 ms post pronoun onset, 1,100 ms to 1,400 ms post pronoun onset, and 1,400 to 1,700 ms post pronoun onset. We then determined for each millisecond within each bin where the participant was looking: subject referent, direct object referent, or look-away object. Note that the first time bin of interest started 200 ms post pronoun onset because it typically takes around 200 ms for a saccade and subsequent fixation to be programmed and executed (Matin, Shao, & Boff, 1993). We can therefore assume that fixations executed to resolve the ambiguity at pronoun encounter do not occur earlier than 200 ms postpronoun onset.

We calculated mean fixation times per participant, trial, and bin. Whenever a fixation within a bin landed on one of three pictures on the screen, the denoted referent received a score of 1, with the remaining two, nonfixated referents receiving a score of 0. Resulting means for subject and object referents with exclusion of all other fixations are provided in Figure 2. As can be seen, there was initially a slight advantage for the object over the subject referent that, starting at 800 ms post pronoun onset, turned into a slight advantage for the subject over the object referent. Because differences

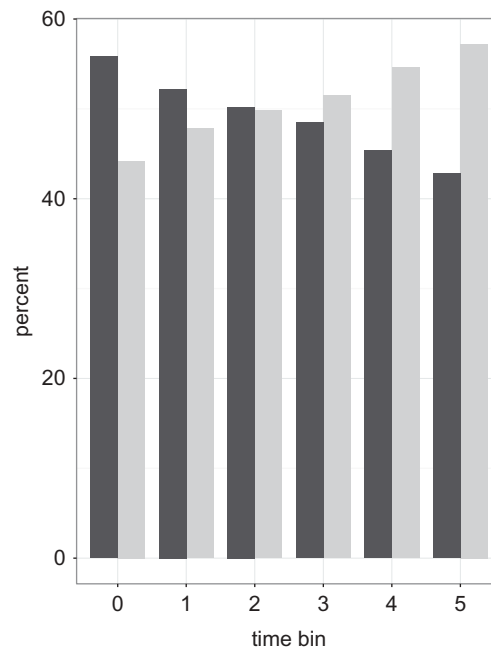


Figure 2. Proportion of looks (in %) to object referent (black bars) and subject referent (gray bars) across information status (inferred vs. brand-new referent) and uniqueness status (unique vs. non-unique referent), when excluding all other fixation times.

between subject and object referents were of minor interest to the perspectives of the current study, we did not further analyze them.

If information status and uniqueness status independently and additively contribute to a referent's availability at ambiguous pronoun encounter, we should observe main effects of information status and uniqueness status. If a referent's uniqueness status differently affects inferred and brand-new referents, we should find an Information Status \times Uniqueness Status interaction. The proportion of looks to the picture of the object referent together with the baseline means are plotted in Figure 3 as a function of bin (Bin 1 to Bin 5) and condition (inferred/unique, inferred/non-unique, brand-new/unique, brand-new/non-unique). For inferential statistics on average looking time to the object referent, we fitted generalized mixed-effects regression models with mean fixation times for the object and mean fixation times for all three pictures onscreen as dependent measure. That is, for each pairing of participant, bin, and condition, we created a vector that contained the mean looking time to the object referent and the sum of the mean looking time to object referent, subject referent, and look-away object. For example, when a participant fixated on the object referent for 200 ms, the subject referent for 70 ms, and the look-away object for 20 ms in Bin 1, the dependent measure for that data point would be a vector of (200, 290).

All models included information status (2: inferred or brand-new referent), uniqueness status (2: unique or non-unique referent), and their interaction as predictors, and all predictors were sum-coded before analyses. Furthermore, all models included random intercepts and slopes for participants and items. We followed Barr, Levy, Scheepers, and Tily (2013) in using maximally appropriate random slopes for subjects and items.

Results of all regression models are provided in Table 2. For the first two bins, we obtained no statistically reliable results. However, starting at 800 ms postpronoun onset (Bin 3), we observed a main effect of uniqueness status, with unique referents being fixated on longer than non-unique referents. Importantly, the main effect of uniqueness status was accompanied by a significant Information Status \times Uniqueness Status interaction in Bins 4 and 5. This interaction was due to

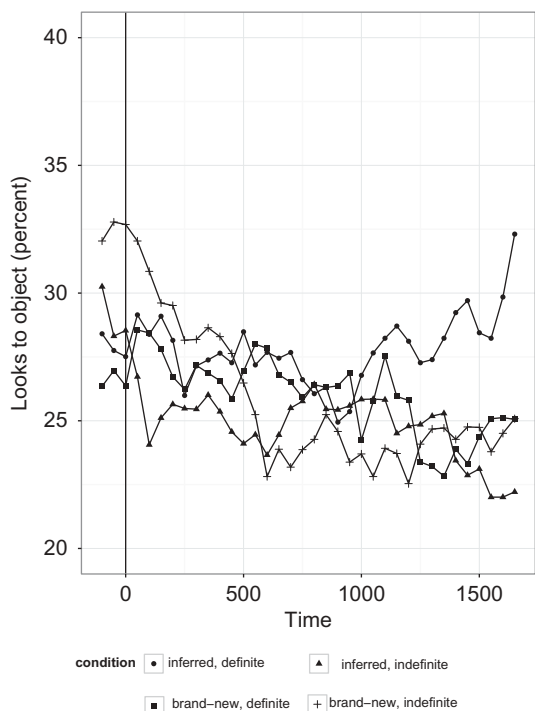


Figure 3. Looks to object referent divided by the sum of looks to object referent, subject referent, and look-away object. Proportions of looks (in %) are provided for each condition (inferred/unique, inferred/non-unique, brand-new/unique, brand-new/non-unique) and bin (Baseline to Bin 5) individually.

Table 2. Inferential statistics for mean fixation time data of Experiment 1.

Bin	Measure	Estimate	SE	z
1	Intercept	−1.60	.23	−7.07***
	Uniqueness Status	.57	.47	1.21
	Information Status	−.12	.41	−.29
	Uniqueness Status × Information Status	−.11	.93	−.12
2	Intercept	−1.86	.29	−6.38***
	Uniqueness Status	.70	.51	1.37
	Information Status	−.34	.43	−.79
	Uniqueness Status × Information Status	.76	.92	.82
3	Intercept	−2.77	.36	−7.69***
	Uniqueness Status	.70	.34	2.10*
	Information Status	.24	.43	.56
	Uniqueness Status × Information Status	.86	.66	1.29
4	Intercept	−2.38	.34	−6.95***
	Uniqueness Status	.62	.29	2.14*
	Information Status	.17	.35	.48
	Uniqueness Status × Information Status	.34	.02	14.64***
5	Intercept	−2.68	.40	−6.71***
	Uniqueness Status	.66	.28	2.37*
	Information Status	.75	.46	1.62
	Uniqueness Status × Information Status	.31	.03	12.40***

Bin 1 = 200 ms to 500 ms post pronoun onset, Bin 2 = 500 ms to 800 ms post pronoun onset, Bin 3: 800 ms to 1,100 ms post pronoun onset, Bin 4 = 1,100 ms to 1,400 ms post pronoun onset, Bin 5 = 1,400 ms to 1,700 ms post pronoun onset, Uniqueness Status = unique identifiability of referent, Information Status = object referent's information status. Significance levels: * $p < .05$, *** $p < .001$.

inferred/unique referents being fixated on significantly longer than inferred/non-unique referents, whereas there was no reliable difference between brand-new/unique and brand-new/non-unique referents.

Discussion

Results of Experiment 1 indicate that referents that can be uniquely identified are more readily interpreted as antecedent of an ambiguous pronoun than referents triggering a non-uniqueness implicature. Interestingly, the advantage for unique over non-unique referents, which is statistically reliable starting at 1,100 ms post pronoun onset, is restricted to referents that can be inferred from preceding context. For brand-new referents, unique identifiability had no observable effects.

Data from our comprehension experiment are not compatible with the view that information status and uniqueness status additively contribute to a referent's availability in online ambiguous pronoun resolution. Our data rather suggest that uniqueness status differently affects the availability of inferred and brand-new referents when an ambiguous referential expression is encountered. In line with Heim (1982), Kamp (1981), and Karttunen (1969), it seems that brand-new referents always function as introduction of a new referent into discourse, irrespective of its uniqueness status. In other words, unique identifiability does not make brand-new referents a better candidate for pronoun interpretation, whereas it does for referents for which an inference relation is available.

An interesting and rather unexpected result of Experiment 1 is the overall low availability of inferred/non-unique referents, in particular starting at 1,400 ms post pronoun onset. Although, just like for inferred definites, the associated concept of the inferred/non-unique referents is preactivated through an anchor in preceding context, the inference relation does not lead to increased availability when a referent needs to be assigned to an ambiguous pronoun.

In explaining the data pattern observed in Experiment 1, we propose that the introduction of new discourse referents involves two processes: concept activation and referent activation. In the first process, the concept of a referent is activated and, in the case of inferred referents, the activation already starts at the encounter of an anchor (i.e., before the referent is explicitly mentioned). This leads hearers/readers to expect some referents more than others. For example, when a hearer encounters *construction site*, she or he activates the concepts of and therefore expects the referents of both an owner and a construction worker. To explain the differences in ambiguous pronoun resolution between inferred/unique and inferred/non-unique referents we suggest that, for inferred/unique referents, referent activation (*the owner*) restricts the expected set of potential referents to one uniquely identifiable referent. When a pronoun is encountered, that referent is highly activated and can therefore quickly be linked to the pronoun. In contrast, for inferred/non-unique referents, the associated concept is preactivated and the referent expected, but due to the non-uniqueness implicature that is triggered by the indefinite article at referent activation, no particular referent is selected by the noun phrase. This means that referent activation is blocked or at least disrupted, leading to overall low availability for referent-to-pronoun assignment (if a referent is identified at all).

Finally, we should point out that the observed differences in pronoun resolution emerged rather late. We suspect that this observation is due to the specific instructions we gave to the participants. We stressed for each participant that there was no correct or incorrect picture to look and that the pictures onscreen might simply help following the story. A more language-specific task, such as matching stories with co-occurring pictures, might have resulted in earlier disambiguation effects. Indeed, evidence for our suspicion comes from a study by Altmann and Kamide (1999), who, using the same materials across two experiments, found earlier prediction effects with language-specific (matching of sentence with pictures) than language-unspecific instructions (sentences are ignored).

Experiment 2: Discourse production

Like for comprehension, few experimental studies have investigated effects of a referent's information status and uniqueness status on discourse planning (Arnold & MacDonald, 1999; Grosz, Aravind, & Weinstein, 1995; Strube & Hahn, 1999). On the theoretical side, Strube and Hahn (1999) proposed that inferred noun phrases are generally ranked higher than brand-new referents, in particular with respect to becoming (or remaining) the topic of a subsequent sentence. Furthermore, using a story continuation experiment, Arnold and MacDonald (1999) showed that a referent's uniqueness status (as in *I arrived at the café and discovered the waitress talking to a little boy*) affects the referential choice of a subsequent pronoun in the immediately following sentence. For discourse relations of the type elaboration (what they call "descriptions"), non-unique referents were more often mentioned again than unique referents. However, for discourse relations of the type narration (what they call "events"), there was no observable difference between unique and non-unique referents. Although Arnold and MacDonald's results clearly point to the importance of uniqueness status in discourse planning, their study cannot easily be compared with our Experiment 2. Arnold and MacDonald compared inferred/unique referents (*the waitress*) with brand-new/non-unique referents (*a little boy*). This makes it difficult to assess to what extent their data were driven by differences in information status and to what extent they were driven by differences in uniqueness status.

Nevertheless, Arnold and MacDonald's observation follows from a general principle of discourse planning: When a speaker or writer introduces a new and unexpected referent in a syntactically prominent position, this referent might seem particularly important, informative, or noteworthy and is, more often than not, mentioned again in subsequent discourse. Interestingly, this principle is often only informally described in the literature. Christophersen (1939) calls it the "introductory function" of the indefinite article, whereas Wright and Givón (1987) characterize it as the "pragmatically important function." Finally, Du Bois (1980) notes that the "opening of a new file with an *a*-form mention tends to raise the expectation that the file will continue to be used, as more information is added to it" (p. 221). Following Kamp (2015), we call this principle the Topic Saturation Principle.

However, it seems plausible that the Topic Saturation Principle is not restricted to noun phrases with an indefinite article. Indeed, there is no reason to believe that it does not also extend to other discourse-new referents. In other words, all referents that are newly introduced into a discourse potentially open a new file (in the metaphor of Heim's [1982] File Change Semantics), and considering that a large number of newly introduced referents are definite marked (Fraurud, 1990; Poesio & Vieira, 1998), this should also be true for unique referents.

Note that additional evidence in favor of the discourse planning principle sketched above comes from the use of the indefinite *this* in English and other languages (Ionin, 2006; MacLaran, 1982; Prince, 1981a). Indeed, relatedly and partially elaborating on previous work by Gernsbacher (Gernsbacher, 1989; Gernsbacher & Shroyer, 1989) and Chiriacescu and von Heusinger (Chiriacescu, 2014; Chiriacescu & von Heusinger, 2010; von Heusinger & Chiriacescu, 2013) showed that specially marked indefinite noun phrases, such as noun phrases introduced by *this* in English or *pe*-marked noun phrases in Romanian, show a higher rate of remention in subsequent discourse than their unmarked indefinite counterparts. The authors take their data as evidence that the morphological form of an indefinite noun phrase signals its introductory function, its pragmatic strength, and its discourse prominence in terms of planning the discourse. Likewise, Ionin (2006) assumes that indefinite *this* signals that the introduced referent is noteworthy and that more information is needed.

The goal of Experiment 2 was to address the various notions of a discourse function discussed above and to extend the results Experiment 1 to discourse planning. To that end, we used a multisentence story continuation task investigating whether the information status and uniqueness status of a referent in direct object position can affect a writer's choice to mention the referent again

and make it a topic. We used the same materials in Experiment 2 that were used in Experiment 1, with the exception that the final sentence (which includes the ambiguous pronoun) was removed. Thus, Experiment 2 was not about ambiguous pronoun resolution but rather about how information status and uniqueness status affect the noteworthiness of a referent and a participant's expectation that the referent will be mentioned again and/or made topic.

Predictions

Like for Experiment 1, we set out to test two competing hypotheses. If discourse planning mirrors discourse comprehension, we should replicate in Experiment 2 the results from Experiment 1: Inferred/unique referents (*the owner*) should be mentioned again and made a topic most often and inferred/non-unique referents (*a construction worker*) least often, with brand-new/unique (*the pedestrian*) and brand-new/non-unique referents (*a pedestrian*) falling in between. Thus, we should elicit an Information Status \times Uniqueness Status interaction. A second set of predictions follows from the assumption that story continuations involve the assessment of referent familiarity, similar to the planning principles described by Christophersen (1939), Wright and Givón (1987), Du Bois (1980), and Kamp (2015). If they do, we predict rates of next-mention and topic shift to stand in an inverse relation to referent expectedness: At first encounter, the less expected a referent is the more important or noteworthy that referent should seem and thus lead to some pressure to mention it again and make it a topic (see also Arnold & MacDonald, 1999). Inferred/unique referents should be most expected and therefore least noteworthy, inferred/non-unique and brand-new/unique referents should be less expected and therefore more noteworthy, and, finally, brand-new/non-unique referents should be least expected and therefore most noteworthy. Thus, the second set of predictions also expects an Information Status \times Uniqueness Status interaction but for different reasons than the first set of predictions.

We should note that, trivially, discourse planning in Experiment 2 involves both comprehension and production. That is, writers continue a story fragment based on their interpretation of that fragment. On the comprehension side, participants assess the familiarity of the introduced referents and how expected the referents are given the discourse. On the production side, participants use their assessment to complete the story.

Methods

Participants

One hundred one students of the University of Cologne participated in the experiment for course credit. All participants were monolingual speakers of German.

Materials

We used a subset of 16 short stories from Experiment 1. The only difference in materials was that for the story continuation task we removed the last sentence from each item, because in Experiment 2 we were not interested in how writers would interpret an ambiguous pronoun but rather how they would continue a story fragment that ended on a sentence introducing two human referents, one in subject and one in direct object position.

It is important to note that exclusion of eight items from the materials of Experiment 1 did not greatly change mean typicality scores. Brand-new referents had a typicality score of 2.53 ($SD = 0.71$), whereas inferred/non-unique and inferred/unique referents had a mean score of 5.95 ($SD = 0.72$) and 5.9 ($SD = 0.58$), respectively. Linear regressions confirmed that typicality scores for brand-new referents were reliably different from those of the two inferred conditions, $t_s > 14$, $p_s < .001$, and that typicality scores of inferred/non-unique referents were not statistically different from those of their unique counterparts, $\beta = -.07$, $SE = .24$, $t = -.28$, $p = .782$.

Materials were distributed across participants such that each participant saw each condition only once and no participant saw any item twice. Each participant received a booklet containing four two-sentence stories, one story per condition. Items were presented on separate pages and participants were asked not to switch back and forth between stories.

Procedure

We asked participants to carefully read each story fragment and continue it by providing five additional natural-sounding sentences. Participants were told there was no correct or incorrect way to continue a story and there was no connection between the different stories they encountered. However, we emphasized that participants should not be overly creative but continue each fragment in a plausible way.

Results

Five participants were excluded from analyses because of incomplete or incomprehensible continuations. For the remaining 96 participants, two independent judges, who were extensively trained on the task, coded each of the five continuation sentences provided by the participants for two measures: referential persistence and topic shift potential. Referential persistence expresses the potential of a referent to be mentioned again in the produced continuations. This measure was coded for subject and object referents and for other new referents, which were classified as “new.”

We annotated all referential expressions that were direct anaphoric expressions (i.e., coreferential expressions) to the subject referent and object referent and new referential expressions. We counted zero-pronouns (ellipses), personal pronouns (*er* ‘he’), demonstrative pronouns (*dieser* ‘this’), d-pronouns (*der*), proper names, demonstrative and definite noun phrases, possessive adjectives (*sein* ‘his’), and reflexives (*sich* ‘himself/herself’) that were syntactically free (i.e., replaceable by another referential expression) as instances of a referent. Topic shift potential expresses a referent’s potential to move from nontopic to aboutness topic position in a subsequent matrix clause (Dipper, Götze, & Skopeteas, 2007; Reinhart, 1981). Because subjects were already in topic position, the potential to shift topic was only coded and analyzed for object referents. Note that we considered the first instance in which an object referent was mentioned in topic position an instance of topic shift.

Although referential persistence and topic shift potential are closely related (what is being mentioned more often has a higher potential to become topic), it is important to keep in mind that the two measures express different dimensions of a referent’s discourse function. Referential persistence captures the textual property of a referent to be reused. The higher the persistence, the more essential the referent for the referential structure of the discourse. A referent’s topic shift potential, on the other hand, addresses a referent’s potential to become topic. It is therefore a referential element that one or more sentences are about. Topics in this sense are the main issues (or questions) in a discourse.

Finally, in response to a reviewer of an earlier version of this article, we also coded which type of referring expression participants used to refer back to the subject and object of story fragments. We did so for the first continuation sentence to better compare our results with related results in the field (Arnold, 1998; Kehler & Rohde, 2013; Rohde & Kehler, 2014; Stevenson et al., 1994, 2000). If, in Experiment 2, a participant decided to reuse a particular referent, she or he is likely to have chosen a referring expression that best matched her or his representation of the hearer’s knowledge as well as the syntactic structure as described in the Centering Theory (Brennan, 1995; Brennan et al., 1987; Gordon et al., 1993; Grosz et al., 1995). We believe, however, that the syntactic constraints described in the Centering Theory are likely to overwrite (parts of) the semantic parameters of information status and uniqueness status investigated in the materials of Experiment 2. This is why it is somewhat unclear what exactly to predict with respect to potential variations in type of referring expression.

Referential persistence. We calculated mean referential persistence scores for referents in direct object position relative to mean persistence scores for referents in subject position for each item, condition, and sentence individually. We did so for the first sentence (S1), the first three sentences (S1–S3), and all five sentences provided by the participants (S1–S5). Mean persistence scores and standard errors are presented in Table 3.

Inspection of Table 3 reveals that inferred/unique referents (*the owner*) were mentioned less often than their subject referent competitors throughout continuations (score below 50%; i.e., for S1, S1–S3, and S1–S5). Interestingly, in particular for the first sentences of continuations, the persistence disadvantage for inferred/unique referents was accompanied by a persistence advantage for object referents of the other three conditions. Furthermore, although the advantage for non-unique referents disappears starting at S1 to S3, regardless of their information status (*a construction worker*, *a pedestrian*), brand-new/unique referents remain at a high level of persistence throughout continuations (*the pedestrian*). When considering all five sentences of continuations, brand-new/unique referents were mentioned again more often than their subject referent competitors. Finally, starting at S3, there seems to be an overall increasing persistence advantage for brand-new referents over inferred referents.

Before turning to the statistical analyses, it is important to establish that the observed differences in subject and object persistence scores are not due to differences in the introduction of new referents, that is, referents that were not mentioned in the story fragments of the task. The total numbers of other new referents across continuation sentences were 106 for inferred/unique, 95 for inferred/non-unique, 108 for brand-new/unique, and 97 for brand-new/non-unique referents. These numbers render it unlikely that any observed differences in subject and object persistence scores are due to differences in new referent mentions.

We tested whether differences in referential persistence scores were statistically reliable. We conducted separate generalized linear mixed effects regression models. We fitted regression models that included vectors consisting of object and subject persistence scores as dependent measure, using a binomial distribution. For example, when, for a particular participant, a referent in object position of a particular item and condition was mentioned again four times and the referent in subject position was mentioned three times, these data points would contain the vector (4, 3). This kind of analysis allowed us to test whether the distributions of object versus subject persistence scores varied as a function of experimental condition, while considering slight differences in subject persistence between conditions.

Like for the analyses in Experiment 1, information status (2: inferred or brand-new referent), uniqueness status (2: unique or non-unique referent), and their interaction were entered into the models as predictors and were sum-coded before analysis. Because we can safely assume independence of observations for participants, as each participant saw each condition only once, we included in our model random slopes for items but not for participants.

Model outputs are summarized in Table 4. We found a significant Information Status × Uniqueness Status interaction for all three regions (S1, S1–S3, S1–S5). For first sentences this interaction is entirely driven by the observed object referent disadvantage for inferred/unique referents in contrast to the presence of an object referent advantage for referents of the remaining

Table 3. Mean referential persistence scores for direct object referents in Experiment 2.

	S1	S1–S3	S1–S5
Inferred/unique	43.8 (5.6)	43.5 (4.2)	41.4 (3.9)
Inferred/non-unique	59.5 (5.6)	51.0 (4.2)	47.2 (3.8)
Brand-new/unique	55.9 (6.1)	54.1 (4.8)	53.2 (4.0)
Brand-new/non-unique	54.5 (6.1)	50.0 (3.6)	48.7 (3.0)

Mean percentages for which the referent in direct object position was mentioned again relative to the subject referent in the first sentence (S1), in the first three sentences (S1–S3), and in all five sentences (S1–S5). Standard errors are presented in parentheses.

Table 4. Inferential statistics for mean referential persistence scores of Experiment 2.

Region	Measure	Estimate	SE	z
S1	Intercept	.07	.28	.25
	Uniqueness Status	-.41	.21	-1.94+
	Information Status	-.25	.24	-1.04
	Uniqueness Status \times Information Status	-1.11	.44	-2.50*
S1–S3	Intercept	.15	.29	.51
	Uniqueness Status	-.18	.20	-.89
	Information Status	-.50	.35	-1.45
	Uniqueness Status \times Information Status	-1.03	.44	-2.32*
S1–S5	Intercept	-.08	.28	-.30
	Uniqueness Status	-.10	.25	-.39
	Information Status	-.71	.32	-2.22*
	Uniqueness Status \times Information Status	-.41	.15	-3.07**

S1 = analysis on first sentences of continuations, S1–S3 = analysis on the first three sentences of continuations, S1–S5: analysis on all five sentences of continuations; Uniqueness Status = unique identifiability of referent Information Status = object referent's information status. Significance levels: + $p < .1$, * $p < .05$, ** $p < .01$.

three conditions. For regions S1 to S3 and S1 to S5, the Information Status \times Uniqueness Status interaction was due to the object referent disadvantage for inferred/unique referents and a simultaneous object referent advantage for brand-new/unique referents. Furthermore, the tendency for object referents to be mentioned again more often in the brand-new than in the inferred conditions was statistically reliable in the S1 to S5 region.

Topic shift potential. We calculated mean percentages of cases in which the object referent became the topic of a sentence by dividing the total number of occurrences in which the object was the aboutness topic of the sentence by the total number of continuations ($N = 96$). Thus, the higher the mean percentage score for an object is, the larger is its potential to become topic. Table 5 presents mean percentages and standard errors for the first sentence (S1), the first three sentences (S1–S3), and all five sentences of continuations (S1–S5). As would be expected given the referential persistence scores, object referents of the inferred/unique condition were, on average, made a topic least often in first sentences. This tendency persisted with inclusion of the first three sentences (S1–S3) as well as all five sentences of continuations (S1–S5). In addition, inferred referents were made a topic overall less often than their brand-new counterparts when analyzing all five sentences (S1–S5).

We tested for statistical reliability by performing logistic regressions for S1, S1 to S3, and S1 to S5 individually. Information status (2: inferred or brand-new referent), uniqueness Status (2: unique or non-unique referent), and their interaction were entered into the models as predictors and sum-coded before analysis. Like for referential persistence scores, we included random slopes for items but not participants. Note that scores of topic shift follow a binomial distribution, as direct objects can either be the topic of a sentence (coded as a score of 1) or not (coded as a score of 0).

Model outputs for the topic shift potential measure are summarized in Table 6. Most interestingly, and in line with the data from referential persistence, we found a significant Information Status \times Uniqueness Status interaction for all regions (S1, S1–S3, S1–S5). The additional main effect of information status statistically confirms the observation of an overall

Table 5. Mean topic shift potential scores for direct object referents in Experiment 2.

	S1	S1–S3	S1–S5
Inferred/unique	33.3 (4.8)	62.4 (5.9)	69.5 (5.5)
Inferred/non-unique	50.0 (7.0)	69.8 (5.9)	73.9 (6.3)
Brand-new/unique	49.0 (6.7)	70.8 (6.5)	81.3 (6.2)
Brand-new/non-unique	40.6 (7.0)	72.8 (6.4)	81.1 (5.0)

Mean percentage for which the referent in direct object position was made topic at least once in the first sentence (S1), in the first three sentences (S1–S3), and in all five sentences (S1–S5). Standard errors are presented in parentheses.

Table 6. Inferential statistics for mean topic shift potential scores of Experiment 2.

Region	Measure	Estimate	SE	z
S1	Intercept	−.36	.24	−1.52
	Uniqueness Status	−.23	.17	−1.39
	Information Status	−.15	.06	−2.73**
	Uniqueness Status × Information Status	−1.24	.11	−11.05***
S1–S3	Intercept	.59	.26	2.31*
	Uniqueness Status	.40	.08	4.83+
	Information Status	.53	.27	1.95***
	Uniqueness Status × Information Status	−.28	.12	−2.31*
S1–S5	Intercept	1.73	.33	5.22***
	Uniqueness Status	−.07	.29	−.23
	Information Status	−1.17	.46	−2.55*
	Uniqueness Status × Information Status	−.64	.15	−4.26***

S1 = analysis on first sentences of continuations, S1–S3 = analysis on the first three sentences of continuations, S1–S5: analysis on all five sentences of continuations; Uniqueness Status = unique identifiability of referent, Information Status = object referent's information status. Significance levels: * $p < .05$, ** $p < .05$, *** $p < .001$.

tendency for inferred referents to be made topic less often than brand-new referents, irrespective of their uniqueness status.

Type of referring expression. The typical finding in the literature is that writers/speakers use pronouns more often to establish coreference to a preceding subject referent than to establish coreference to a preceding object referent (Arnold, 1998; Crawley & Stevenson, 1990; Kehler & Rohde, 2013; Rohde & Kehler, 2014; see also the literature on Centering Theory: Brennan et al., 1987; Gordon et al., 1993; Grosz et al., 1995). This is also what we observe in our data. Although 12% of first continuation sentences did not mention any of the provided referents, 74% of the remaining data showed a personal pronoun (*er*) and 26% a full noun phrase when reference was established to the subject. When reference was established to the object, 25% showed a personal pronoun, 36% a demonstrative pronoun (*dieser, der*), and 39% a full noun phrase. Interestingly, although the distribution of pronouns versus full (definite) noun phrases was comparable between conditions, with brand-new/non-unique referents leading to the use of most full noun phrases, the distribution of personal versus demonstrative pronouns was not, as Table 7 reveals.

For inferred/non-unique, brand-new/unique, and brand-new/non-unique referents, there was a very similar distribution of personal pronouns and demonstrative pronouns, with slightly more demonstrative than personal pronouns. In contrast, for inferred/unique referents, many more demonstrative pronouns were used than personal pronouns. Unfortunately, a number of parameters were not controlled in our materials that are likely to have affected this result, which is why we refrain from any strong conclusions. First, the continuations provided by participants display different syntactic constructions for the anaphoric expression: It appears as subject in an intransitive sentence, as subject in a transitive sentence with the other referent as object, and as object in a transitive sentence with the other referent as subject. According to the Centering Theory, these syntactic constructions together with the type of the anaphoric expression to the subject provide different constraints on the type of anaphoric expression for the object. A preliminary analysis of type of referring expression together with syntactic constraint did not lead to any generalization.

Table 7. Types of referring expression for direct object referents in the first sentence in Experiment 2.

	Personal Pronoun	Demonstrative Pronoun	Full Noun Phrase
Inferred/unique	19	46	35
Inferred/non-unique	30	34	36
Brand-new/unique	26	35	39
Brand-new/non-unique	26	29	45

Mean percentages for the use of referring expressions.

Note that, as the experiment is, it is not clear how to control for syntactic constructions that participants produce.

Second, demonstrative pronouns (such as *dieser* and *der* in German) are anaphorically linked to nontopical or nonsubject antecedents (Bosch & Umbach, 2007). In Experiment 2 (proper name subject first and direct object noun phrase second), this function overlaps with the generally observed function of definite noun phrases to anaphorically refer to the direct object. This, in turn, makes demonstrative pronouns a good competitor to definite noun phrases rather than to personal pronouns. In short, it is not clear whether to group demonstrative noun phrases with full noun phrases, due to a mutual bias to refer to the preceding nonsubject noun phrase, or with personal pronouns, due to a mutual reduction in morphological form.

Third, Sidner (1979) argues that the English demonstrative *this* signals a referential shift to the main topic and *that* signals a secondary topic (“focus,” in her terminology). Demonstrative pronouns in German seem to have a similar forward looking function, namely to focus or center the interest towards the referent (Ahrenholz, 2007). We therefore checked for the second sentence of continuations whether the referent of a demonstrative pronoun became a topic more often than the referent of a personal pronoun. We could not find any effect of the use of demonstratives towards topic shift.

Discussion

Results of Experiment 2 are broadly in line with the claim that referent management in discourse planning involves the assessment of a referent’s expectedness, providing some estimate of a referent’s importance or noteworthiness. Importantly, we found that the expectedness of a referent is partially influenced by both information status and uniqueness status. Inferred referents that were unique (i.e., referents that were highly expected in their contexts) were mentioned again least often. For referential persistence, this finding was particularly robust for first sentences of continuations. Not surprisingly, a referent’s potential to move from nontopic to topic position generally matches the data pattern observed for referential persistence. For first sentences and first three sentences of continuations, inferred/unique referents were used as a topic less often than referents of the other three conditions. Interestingly, in most measures the least expected referents (i.e., brand-new/non-unique referents) patterned together with referents that could either be uniquely identified and referents that could be inferred. This indicates that the expectedness of a referent can be significantly increased by providing an inference relation and making the referent uniquely identifiable. However, inference relations and uniqueness per se did not greatly increase a referent’s expectedness.

Taken together, results from Experiment 2 support the Discourse Saturation Principle and the Topic Saturation Principle both of which involve two steps. First, given a specific context, a speaker/writer assesses the discourse structure with respect to the (un)expectedness of introduced discourse referents, and the more expected a referent is, the less noteworthy that referent seems for the discourse. Second, the story continuation provided by a speaker/writer reflects the assessment of the provided discourse structure. To that end, we assume that the less expected and more noteworthy a referent is the more likely it is that a speaker/writer will continue the discourse in a way to elaborate on that referent. We further assume that a referent’s information status and uniqueness status signal a referent’s (un)expectedness and noteworthiness.

General discussion

In the present study we set out to bridge theoretical and empirical work on concept activation and referent activation and asked to what extent these two parameters affect referent management in discourse comprehension and discourse planning. We manipulated concept activation through a referent’s information status and referent activation through a referent’s uniqueness status. Data from Experiment 1, a visual-world eye-tracking study investigating ambiguous pronoun resolution, show that inferred/unique referents (*construction site... the owner*) are more available to a hearer at

pronoun encounter than inferred/non-unique referents (*construction site... a construction worker*). Furthermore, whereas brand-new/unique (*construction site... the pedestrian*) and brand-new/non-unique referents (*construction site... a pedestrian*) did not differ, brand-new referents were generally stronger candidates for ambiguous pronoun resolution than inferred/non-unique referents.

Data from Experiment 2, a multisentence story continuation task exploring discourse planning principles by means of referential persistence and topic shift, show that it is the inferred/unique referents that are least likely to be mentioned again and appear as the aboutness topic in discourse. Inferred/non-unique and brand-new referents, irrespective of their uniqueness status, did not greatly differ.

Taken together, our data provide evidence that information status (i.e., concept activation) and uniqueness status (i.e., referent activation) affect whether or not a referent is considered a potential antecedent of an ambiguous referential expression, its potential to be mentioned again, and its potential to move from nontopic to topic position. Interestingly, our data suggest that the two parameters have opposite effects on discourse comprehension and discourse planning. In what follows, we propose the Dual-Process Activation Model that might account for the comprehension and planning data.

With respect to the comprehension data, we suggest that the observed difference between inferred/unique and inferred/non-unique referents can be explained by differences in the interaction of two distinct components of the noun phrases. First, a concept denoted by the descriptive material is preactivated by a conceptual frame provided by previous discourse (i.e., the anchor). For example, a construction site activates the concepts of OWNER, CONSTRUCTION WORKERS, DUST, BARRIER TAPE, and so on. Therefore, when a hearer or reader encounters *construction site*, she or he expects a number of concepts or roles associated with that scene or frame (Barsalou, 1992; Fillmore, 1975; Löbner, 1985, 1998; Minsky, 1977) to take part in the discourse. As Minsky (1977) points out, frames provide information of “what one can expect to happen next” (p. 355). So, when we encounter the noun phrase (or anchor) *construction site* in a text, we have a good understanding of what persons and what entities may become part of the discourse, such as an owner, construction worker, engineer, dust, barrier, and so on. We then propose that one process of referent introduction crucially involves the preactivation of concepts and the expectation of related referents when an anchor is encountered in a discourse. The second process of referent introduction involves the activation or selection of particular referents associated with the concepts that have been activated by the anchor. This process restricts the set of potential candidates (owner, construction worker, engineer, dust, barrier, etc.) to those referents or entities that do in fact participate in the present discourse.

Zooming in the data presented in this study, we propose that in the first process of the Dual-Process Activation Model, inferred/unique and inferred/non-unique referents behave very similarly. Concepts associated with either referent are similarly activated by the concept of a construction site and the associated referents therefore equally expected by the hearer. However, in the second process of the model (i.e., the process initiated when referents are explicitly introduced into the discourse), the definite article restricts the set of potential candidate referents to one uniquely identifiable referent (*the owner*) but remains with the general concept or kind when the noun phrase is indefinite marked (*a construction worker*).

With respect to the brand-new referents, we suggest that these referents always function as genuine introduction of new discourse referents, as these referents are brand-new and associated with unfamiliar concepts. This observation fits nicely with the assumption in the theoretical literature, in particular within dynamic semantics (Heim, 1982; Kamp, 1981; Karttunen, 1969), that both definite and indefinite noun phrases introduce discourse referents into a discourse and that the introduction of a new referent by a descriptive noun phrase proceeds in two steps. First, the descriptive material introduces a concept, and, second, a referent is assigned to that concept, which is brand-new and therefore unfamiliar to the hearer.

The Dual-Process Activation Model put forward here is compatible with data on discourse comprehension reported by Schumacher (2009; see also Burkhardt, 2006). The author found that inferred referents were accessed more easily than brand-new referents. In our model this difference is predicted and follows from the first process, concept activation: Concepts that can be inferred from related concepts in the preceding context are activated before the noun phrase of the referent is encountered. This preactivation makes inferred referents more easily accessible when the associated noun phrase is mentioned than referents that cannot be inferred. Our model also explains the stronger frontal negativity for unique than non-unique referents. In our model this difference is explained by differences in the restriction of an expected set of referents in the second process, referent activation: The definite but not the indefinite article sufficiently restricts the set of potential referent candidates to exactly one referent, making that referent uniquely identifiable. One possibility is that the identification of a unique referent is more costly than retrieving and integrating a non-unique referent, which does not force unique identifiability.

Turning to the data from Experiment 2, we first note that unlike for ambiguous pronoun resolution in comprehension, in discourse planning a speaker has some time to plan the discourse and therefore most likely uses principles that go beyond a referent's availability when a pronoun needs to be interpreted. One such principle seems to be that when a referent is unexpected in a discourse, this referent seems particularly important or noteworthy. This, in turn, shapes the goals of a writer or speaker when continuing the discourse: The more noteworthy a referent is the more likely it is that the referent remains part of the discourse and that it will be elaborated on further (Topic Saturation Principle). Generally, this principle is closely associated with indefinites (i.e., with non-unique referents). However, our data show that it also holds for brand-new referents that can be uniquely identified (containing definites, unfamiliar definites; cf. Du Bois, 1980; Ionin, 2006; Kamp, 2015).

More specifically, we propose that a writer's or speaker's choice to mention a referent again in discourse and use it as a topic is informed by two general discourse planning principles, which we refer to as Discourse Saturation Principle and Topic Saturation Principle of discourse planning. We suggest that the rate with which a referent is mentioned again correlates negatively with its overall noteworthiness, based on an assessment of expected versus unexpected referents. The more expected a referent is at the point of its first mention, the less noteworthy it is and the less often it will be mentioned again. Similarly, the less expected a referent is, the more noteworthy it is and the more often it will be mentioned again in the subsequent discourse. Thus, just like for discourse comprehension, we propose that discourse planning is linked to expectation. When a writer/speaker is presented with a discourse (fragment) she or he assesses how expected the referents of a discourse are, thereby evaluating their noteworthiness. When producing further text, the writer/speaker addresses the noteworthiness of the referents by moving less expected referents more into focus of the discourse than expected referents (e.g., by rementioning them and/or making them a topic).

The Discourse Saturation and Topic Saturation Principle most straightforwardly generalize previous work and observations on indefinite noun phrases (Christophersen, 1939; Du Bois, 1980; Ionin, 2006; Kamp, 2015; Wright & Givón, 1987) and are clearly independent of activation-driven principles discussed in the literature on the Centering Theory (Brennan et al., 1987; Gordon et al., 1993; Grosz et al., 1995; Strube & Hahn, 1999) or cognitive approaches like Gundel et al. (1993) and Ariel (1988).

In conclusion, our data on referent management in ambiguous pronoun resolution and discourse planning provide good evidence that the possibility to infer a referent from preceding context and the uniqueness status of a referent can affect a referent's availability when a referring expression needs to be interpreted as well as the way a discourse is structured in planning. Most critically, our results point to a complex interaction between the two parameters (information status and uniqueness status) and, additionally, to a modulation of this interaction by type of processing (discourse comprehension vs. discourse planning). We propose that separately analyzing concept activation and referent activation, both of which are directly linked

to the introduction of new discourse referents, best captures the complex data pattern we have observed in the present study. As Arnold (2001) states: “I am assuming that language use is a dynamic process, whereby discourse referents become more or less accessible as the result of various sources of information” (p. 153). The Dual-Process Activation Model proposed in the present study is one approach to address this dynamicity in referent management.

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Appendix A

Sample materials in German along with their English translations are shown. The complete set of materials can be obtained upon request from the first author. The first story of each item is the brand-new/non-unique condition, the second story the brand-new/unique condition, the third story the inferred/non-unique condition, and the fourth story the inferred/unique condition.

Item	German	English Translation
1	a. Die Party in der Wohnung war schon in vollem Gange. Oskar bemerkte den sympathischen Gastgeber. Als die Musik stoppte, ging er in die Küche und holte sich ein neues Glas Wein.	The house party was in full action already. Oskar noticed the friendly host. When the music stopped, he went to the kitchen and got himself a new glass of wine.
	b. Die Party in der Wohnung war schon in vollem Gange. Oskar bemerkte einen sympathischen Gast. Als die Musik stoppte, ging er in die Küche und holte sich ein neues Glas Wein.	The house party was in full action already. Oskar noticed a friendly guest. When the music stopped, he went to the kitchen and got himself a new glass of wine.
	c. Die Party in der Wohnung war schon in vollem Gange. Oskar bemerkte den Architekten an der Tür. Als die Musik stoppte, ging er in die Küche und holte sich ein neues Glas Wein.	The house party was in full action already. Oskar noticed an architect at the door. When the music stopped, he went to the kitchen and got himself a new glass of wine.
	d. Die Party in der Wohnung war schon in vollem Gange. Oskar bemerkte einen Architekten an der Tür. Als die Musik stoppte, ging er in die Küche und holte sich ein neues Glas Wein.	The house party was in full action already. Oskar noticed the architect at the door. When the music stopped, he went to the kitchen and got himself a new glass of wine.

(Continued)

(Continued).

Item	German	English Translation
2	<p>a. In Köln fand an diesem Abend ein beliebtes Open-Air Rockkonzert statt. Benjamin sah den muskulösen Schlagzeuger. Als plötzlich ein Gewitter aufkam, zog er sich eine Regenjacke an und setzte die Kapuze auf.</p> <p>b. In Köln fand an diesem Abend ein beliebtes Open-Air Rockkonzert statt. Benjamin sah einen muskulösen Ordner. Als plötzlich ein Gewitter aufkam, zog er sich eine Regenjacke an und setzte die Kapuze auf.</p> <p>c. In Köln fand an diesem Abend ein beliebtes Open-Air Rockkonzert statt. Benjamin sah den Schüler hinter dem Dixiklo. Als plötzlich ein Gewitter aufkam, zog er sich eine Regenjacke an und setzte die Kapuze auf.</p> <p>d. In Köln fand an diesem Abend ein beliebtes Open-Air Rockkonzert statt. Benjamin sah den Schüler hinter dem Dixiklo. Als plötzlich ein Gewitter aufkam, zog er sich eine Regenjacke an und setzte die Kapuze auf.</p>	<p>A popular open air rock concert was taking place in Cologne this evening. Benjamin saw the muscle-packed drummer. When a storm approached, he put on a raincoat and put on the hood.</p> <p>A popular open air rock concert was taking place in Cologne this evening. Benjamin saw a muscle-packed security agent. When a storm approached, he put on a raincoat and put on the hood.</p> <p>A popular open air rock concert was taking place in Cologne this evening. Benjamin saw a student behind the portable toilet. When a storm approached, he put on a raincoat and put on the hood.</p> <p>A popular open air rock concert was taking place in Cologne this evening. Benjamin saw the student behind the portable toilet. When a storm approached, he put on a raincoat and put on the hood.</p>
3	<p>a. In der Urologie war die Renovierung des Aufenthaltsraums fast fertig. Christian beobachtete den dünnen Chefchirurgen. Als ein Farbtopf umkippte, drehte er sich um und schüttelte den Kopf.</p> <p>b. In der Urologie war die Renovierung des Aufenthaltsraums fast fertig. Christian beobachtete einen dünnen Patienten. Als ein Farbtopf umkippte, drehte er sich um und schüttelte den Kopf.</p> <p>c. In der Urologie war die Renovierung des Aufenthaltsraums fast fertig. Christian beobachtete den Rollstuhlfahrer am Kaffeeautomaten. Als ein Farbtopf umkippte, drehte er sich um und schüttelte den Kopf.</p> <p>d. In der Urologie war die Renovierung des Aufenthaltsraums fast fertig. Christian beobachtete einen Rollstuhlfahrer am Kaffeeautomaten. Als ein Farbtopf umkippte, drehte er sich um und schüttelte den Kopf.</p>	<p>The renovation work at the waiting room of the urology department was almost finished. Christian observed the skinny head surgeon. When a bucket of paint fell over, he turned around and shook his head.</p> <p>The renovation work at the waiting room of the urology department was almost finished. Christian observed a skinny patient. When a bucket of paint fell over, he turned around and shook his head.</p> <p>The renovation work at the waiting room of the urology department was almost finished. Christian observed a person in a wheelchair at the vending machine. When a bucket of paint fell over, he turned around and shook his head.</p> <p>The renovation work at the waiting room of the urology department was almost finished. Christian observed the person in a wheelchair at the vending machine. When a bucket of paint fell over, he turned around and shook his head.</p>
4	<p>a. Die neue Baustelle auf dem Nachbargrundstück war laut und staubig. Philip starrte den verdreckten Bauherren an. Als der Staub aufwirbelte, trat er einige Schritte zurück und rieb sich die Augen.</p> <p>b. Die neue Baustelle auf dem Nachbargrundstück war laut und staubig. Philip starrte einen verdreckten Bauarbeiter an. Als der Staub aufwirbelte, trat er einige Schritte zurück und rieb sich die Augen.</p> <p>c. Die neue Baustelle auf dem Nachbargrundstück war laut und staubig. Philip starrte den Passanten am Bauzaun an. Als der Staub aufwirbelte, trat er einige Schritte zurück und rieb sich die Augen.</p> <p>d. Die neue Baustelle auf dem Nachbargrundstück war laut und staubig. Philip starrte einen Passanten am Bauzaun an. Als der Staub aufwirbelte, trat er einige Schritte zurück und rieb sich die Augen.</p>	<p>The construction site at the neighbor's was loud and dusty. Philip stared at the dirty owner. When the dust dispensed, he stepped back and rubbed his eyes.</p> <p>The construction site at the neighbor's was loud and dusty. Philip stared at a dirty construction worker. When the dust dispensed, he stepped back and rubbed his eyes.</p> <p>The construction site at the neighbor's was loud and dusty. Philip stared at a pedestrian at the corner. When the dust dispensed, he stepped back and rubbed his eyes.</p> <p>The construction site at the neighbor's was loud and dusty. Philip stared at the pedestrian at the corner. When the dust dispensed, he stepped back and rubbed his eyes.</p>