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1   Introduction

1.1   Overview

A ban on pronoun reference to word-internal elements (so-called *outbound anaphora*) was first proposed by Postal (1969). This ban accounts for the unacceptable nature of examples like (1), wherein the pronoun *him* is reported not to be able to refer to *McCarthy*.

(1)   *$**McCarthy**_i$ites are now puzzled by $**his**_i$ intentions.

At issue in the current study is pronoun reference to non-head elements of compounds in English, e.g., *truck* in (2). Because these are word-internal elements, such referential dependencies should be ruled out by any general ban on outbound anaphora.

(2)   *He is a $**truck**_i$ driver who takes good care of $**them**_i$. (Iordachioaia et al., 2017)

Since Postal's proposal, however, evidence has accumulated in the literature against a categorical ban on outbound anaphora (see discussion of Ward et al. (1991) below). It has still been commonly assumed, however, that anaphoric reference to word-internal elements, and therefore to non-heads of compounds, is degraded in many circumstances.

A parallel debate has surfaced in the theoretical morphology-syntax literature on the status of proper names in the grammar. This debate has implications for the predictions regarding pronoun reference to proper names as non-head elements of compounds. If proper names are like common nouns in their syntax (Borer, 2005; Matushansky, 2008), then reference to proper names in compounds by a subsequent pronoun should be as restricted as it would be for common nouns. If, however, proper names are referring expressions (Longobardi, 1994), then their status could make them more accessible for subsequent pronoun reference.

We investigate these predictions in three self-paced reading experiments and one naturalness rating study. Our results are quite surprising in that we find little evidence for a ban on reference to non-heads in compounds. Only in naturalness judgments do we find evidence that reference to non-heads in compounds is degraded, and only for common noun items. Before reporting our experiments in full, we will introduce the background literature on proper names and outbound anaphora to motivate our study.

1.2   Proper name compounds

The morpho-syntactic status of proper names has been debated in the theoretical literature. Two competing views have emerged: Proper names have been proposed to be predicates in all of their occurrences (see Matushansky, 2008), or alternatively referring expressions (Longobardi, 1994). It has been pointed out in the literature that in English and other Germanic languages (see e.g., Schlücker (2013) for German, and Breban (2017) for English), proper names may appear as the non-head of a compound, but only if the referent of the proper name is recognizable as unique (a person or group) within the speech community (Koptjevskaja-Tamm,

2009). For example, based on our intuitions, *Hillary* has a unique salient referent but *John* does not.

(3)   Mary was a Kerry/Clinton/#John/Hillary supporter.

To explain this restriction, Alexiadou (2018) builds on two ingredients. In the work of Matushansky (2006), proper names in English undergo D-N m-(orphological) merger. According to Matushanksy (2006: 296), "m-merger is a strictly cyclic morphological operation that takes two syntactic heads in a certain configuration and returns one syntactic head. It is subject to strict locality: nothing may intervene between [the two heads]: neither a Spec nor a modifier." In the case of English proper names, m-merger takes D and N and yields a syntactic head where D is realized as an affix on N. The second ingredient is the analysis of synthetic compounding in English put forth in Iordachioaia et al. (2017) who propose that in English, non-heads in compounds are independent words (basically NPs). If NPs that have undergone D-N mergers are included in English synthetic compounds, we expect that they should be accessible for subsequent pronoun reference.

1.3   Reference to non-heads in compounds: Outbound anaphora

Several lines of inquiry have examined the putative ungrammaticality of reference to sublexical items, as defined by Postal (1969). For example, Garnham and Oakhill (1988) found that reference to the noun corresponding to a verb (e.g., *fight*$_n$ in *Young Toby **fights** every playtime, but **they** never lead to injuries*) in an antecedent sentence can be acceptable, but takes longer to process in a speeded acceptability judgment task. Such results call into question the modelling of outbound anaphora as categorically ruled out by the grammar.

With respect to the empirical domain of interest in the current studies, Ward et al. (1991) examined the processing of pronoun reference to non-heads of compounds. To call into question the putative ban on outbound anaphora, Ward et al. (1991) present attested examples, such as (4), due to Judith Levi, and (5), due to a column by Mike Royko in the *Chicago Tribune* on May 22, 1989 (and originally cited by James McCawley). Such attested examples further show that reference to a non-head in a compound may be acceptable in some circumstances.

(4)   For a **syntax** slot, I'd rather see someone with more intensive coursework in **it**.

(5)   Millions of **Oprah Winfrey** fans were thoroughly confused last week when, during **her** show, **she** emotionally denied and denounced a vile rumor about herself.

These examples led Ward et al. (1991) to hypothesize that outbound anaphora are not banned in the grammar, but rather the acceptability of outbound anaphora may depend on the *accessibility* of the referent during the processing of the pronoun. Accessibility of an element in a current discourse depends on many variables, including lexical/conceptual, grammatical and discourse structure-based factors. Accessibility has been shown to influence sentence production (see e.g., Bock & Warren, 1985; Arnold, 2010). Ward et al. report the results of studies by McKoon et al. (1990) examining whether pragmatic factors that are known to influence the accessibility of a potential referent in general would systematically affect the possibility of reference to a non-head of a compound. McKoon et al. (1990) tested the hypothesis that a non-head of a compound would be more accessible as the referent of a pronoun if it was set up as topical by a preceding context passage. As such, McKoon et al. (1990) presented participants with context paragraphs that either did or did not set up an intended referent as a topic. At the end of each context passage, the intended referent (e.g., *deer*) was introduced in the form of a compound (*Lately, he's taken up deer hunting*) or a corresponding Verb Phrase (*Lately, he's taken up hunting deer*). The critical pronoun *they* then appeared in a target sentence (*And he thinks that they are really exciting to track*). Overall, McKoon et al. (1990) found that target sentences were read faster when the intended referent was topical in the preceding text. Reading times on the target sentence were also longer when the referent was part

of a compound than when it was part of a Verb Phrase, but crucially this difference only emerged when the referent was not a topic in the current discourse. Ward et al. (1991) interpret this result as meaning that by making the intended referent the topic of a preceding discourse, assignment of the referent was facilitated to a degree that overcame the lack of structural accessibility. They then use this finding as support for their claim that outbound anaphora are grammatical, and not a case of *acceptable ungrammaticality* (see e.g., Arregui et al., 2006; Frazier, 2015), because outbound anaphora are sensitive to the same pragmatic influences as other uncontroversially grammatical anaphoric relationships.

Ward et al. (1991), citing the McKoon et al. studies) showed that the discourse status of the referent can influence the processing of outbound anaphora. There are further claims that in addition to discourse status, the morphosyntactic status of the intended referent can affect the acceptability of outbound anaphora. Koptjevskaja-Tamm (2009) observes that proper names in compounds can serve as the referent of a subsequent pronoun, as in the attested example (6) from Swedish (attributed to Marcus Boldemann in the newspaper *Dagens Nyheter, Kultur*, January 22nd 2005).

(6)   *År*   *2006*   *är*   *åter*   *ett*   *Mozart+år,*   *nämligen*   *hans*   *250:de*
     Year   2006   is   again   a:N   Mozart_year   namely   his   250:th

     födelsedag.
     birthday.

     '2006 is once again a Mozart year, more precisely his 250th birthday.'

<div align="right">(Koptjevskaja-Tamm, 2009: 1)</div>

If indeed proper names are more accessible as pronoun referents, this may be telling about the status of proper names in the grammar. This is the question we examine in our experiments.

1.4   Predictions for the current study

Previous results show that the processing of a pronoun varies according to at least some facets of the accessibility of its word-internal referent. We predict that if proper names are referring expressions (Longobardi, 1994), and therefore syntactically DPs, these will be more accessible as referents to a subsequent pronoun than common nouns in the same structural position. However, if proper names are merely NPs, then we would not expect any difference based on structure between proper names and common nouns as word-internal referents. Furthermore, if proper names are NPs that have undergone D-N merger, then again we expect them to be more accessible as referents to a subsequent pronoun. These predictions are summarized in Table 1. We test these competing hypotheses in three self-paced reading studies, presented as Experiment 1a-b, which had very similar experimental items but differed with respect to whether the pronoun reference dependency was within or across sentences, and Experiment 2, which had a modified item set. In addition to the predictions based on proper name status, we may also expect differences based on pragmatic factors. We will return to this possibility in the discussion.

Table 1. Predictions for accessibility of proper names vs. common nouns as non-heads of compounds

Hypothesis	Trump$_i$ supporter… he$_i$	boat$_i$ maker… they$_i$
Proper names are DPs	*more accessible*	*less accessible*
Proper names are NPs	*equal accessibility*	
Proper names undergo D-N merger	*more accessible*	*less accessible*

2   Experiment 1

2.1   Rationale

We conducted two related self-paced reading studies testing pronoun reference to non-heads of compounds, which we present here as Experiments 1a and 1b. In Experiment 1a, the critical pronoun referred to the non-head of a compound (or corresponding element of a phrase) in a previous clause within the same sentence. In Experiment 1b, reference was across a sentence boundary. We tested both of these configurations because there is evidence that pronoun resolution works differently within versus between sentences, which may also be interpreted as Discourse Units (see Miltsakaki, 2002). For example, Colonna et al. (2015) found that the focusing effect of clefting increased pronominal reference to the clefted element across sentences, but not necessarily within sentences. De la Fuente et al. (2016) further extend and specify the differences between inter- and intra-sentential reference. If the ban on reference to non-heads of compounds is a syntactic restriction, we might expect that such a ban would be more prominent within the same sentence than across sentences.

2.2   Method

Participants Participants were recruited via Amazon's Mechanical Turk and completed the study over the web using the Ibex Farm platform (Drummond, http://spellout.net/ibexfarm/). For Experiment 1a, data from 90 participants are reported. For Experiment 1b, data from 102 participants are reported. Additional participants took part in each experiment but were excluded on the basis of self-reported non-native speaker status, participating more than once (despite instructions not to do so), low question accuracy or having a large proportion of reading times that were too fast to represent true processing. All participants included in analyses were self-reported native speakers of English with IP addresses within the United States.

Materials Twenty-four items were constructed such that the non-head of a compound (or the corresponding element in a phrasal version) was referred to by a pronoun in a subsequent clause (see Table 2 for example items). The NOUN TYPE factor (proper name vs. common noun) was manipulated between items, with 12 items in each condition. STRUCTURE (compound vs. phrase) was manipulated within items. For Experiment 1a, the compound/phrase and the pronoun were always separated by three presentation regions to avoid any spillover effects on the critical pronoun. Due to our experimental design, the critical pronouns were necessarily different between the proper name items, which used *he/she/his/her*, and the common noun items, which used *it* or *they*. For a list of all item sets from this paper, please refer to our online appendix at http://grant-psycholinguistics.com/propernames/.

Table 2. Sample items with presentation regions (/), Experiment 1. Compound/Phrase conditions shown in {}. Critical pronouns shown in bold (but were not bolded during the experiment)

Exp.		
Exp. 1a	Proper name	The elderly woman/ is/ {a Trump supporter/ a supporter of Trump}/ but/ on/ occasion/ **he**/ tweets/ criticisms/ that she doesn't like./
	Common noun	The retired man / was/ {a boat maker/ a maker of boats}/ but/ at/ the end/ **they**/ were/ too much work/ for him to complete./
Exp. 1b	Proper name	The elderly woman/ has been/ {a Trump supporter/ a supporter of Trump}/ since 2015./ Although often/ **he**/ tweets/ criticisms/ that she doesn't like./
	Common noun	The retired man / was/ {a boat maker/ a maker of boats}/ for decades./ Eventually/ **they**/ became/ too much work/ for him to complete./

Procedure Participants read the experimental sentences piece by piece (presentation regions shown in Table 2), pressing a button to advance to the next portion of the sentence. The regions of the sentence were presented centred on the screen to avoid any differences in line breaks across conditions. Materials from Experiments 1a and 1b were intermixed with filler items from unrelated experiments (98 in Experiment 1a and 91 in Experiment 1b).

2.3   Results

Prior to statistical analysis, data were trimmed such that values between 100 and 2000ms were excluded (less than 1 % of observations for each experiment) because they are unlikely to represent reading comprehension, and such that values more than 2.5 standard deviations from the subsequent participant/region mean were excluded (approximately 3 % of observations in each experiment).

We analysed log reading times for each region of text using linear mixed-effects models implemented in the lme4 package (Bates et al., 2015) in R (R Core Team, 2018), but show raw reading times in Figure 1 for the reader's ease. Fixed effects were sum-coded with contrasts for NOUN TYPE (common noun: -0.5, proper name: 0.5) and STRUCTURE (compound: -0.5, phrase: 0.5). Random intercepts for participants and items were included in the models. Random slopes for STRUCTURE and NOUN TYPE were included for participants. Only random slopes for STRUCTURE were included by items (without correlation parameters) as NOUN TYPE was a between-items manipulation. Random slopes for the interaction between fixed effects were not included due to model convergence issues. We report p-values based on output from the lmerTest package (Kuznetsova et al., 2017).

Reading Times, Experiment 1a For our one-sentence materials, analysis of the third sentence region, which contained the compound or phrase, revealed a significant interaction (*Estimate* = -0.085 (± 0.035), t = -2.398, p < .05) such that common noun compounds were read the fastest out of all conditions. The predictors NOUN TYPE (*Estimate* = 0.085 (± 0.028), t = 3.003, p < .01) and STRUCTURE (*Estimate* = 0.070 (± 0.018), t = 3.783, p < .05) were also significant, but these appear to be driven by the fast reading times for common-noun compounds. Follow-up models showed that the difference based on STRUCTURE was significant for common nouns (*Estimate* = 0.111 (± 0.026), t = 4.333, p < .05) but not for proper names (*Estimate* = 0.027 ((± 0.027), t = 1.03, p = .33). On the region containing the critical pronoun, there were no significant effects of any factor.[1] The subsequent region also showed no significant differences between conditions. The final two regions showed a numerical difference such that items with common nouns were read slower than items with proper names (417 ms vs. 395 ms on average for region 9, two regions post-pronoun), but this difference was non-significant in statistical analyses.

Reading Times, Experiment 1b For two-sentence materials, analysis of the third sentence region containing the critical compound or phrase revealed significant effects of NOUN TYPE (*Estimate* = 0.110 (± 0.032), t = 3.436, p < .05) and STRUCTURE (*Estimate* = 0.069 (± 0.015), t = 4.661, p < .001). These effects indicate that proper name items were read more slowly than common noun items at this region, and that phrases were read more slowly than compounds. While common noun compounds were still numerically fastest on this region, the interaction between factors that we found in Experiment 1a was not significant here (*Estimate* = -0.023 (± 0.026), t = -0.874, p = .38). As in Experiment 1a, there were no significant effects on the pronoun region itself. Also like Experiment 1a, subsequent regions of text showed a numerical penalty for common noun items. Again, this difference did not reach significance.

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[1] Analyses of raw reading times did find a marginal interaction between NOUN TYPE and STRUCTURE.

2.4   Discussion

Experiments 1a-b find no evidence for a ban on reference to non-heads in compounds, whether proper names or common nouns. The only hint of a difference following the critical pronoun was a penalty for common noun items in general (see Figure 1). However, it is difficult to interpret this difference, if indeed it is reliable, given that NOUN TYPE is a between-items manipulation, and therefore common noun and proper name items differed in their lexical content.
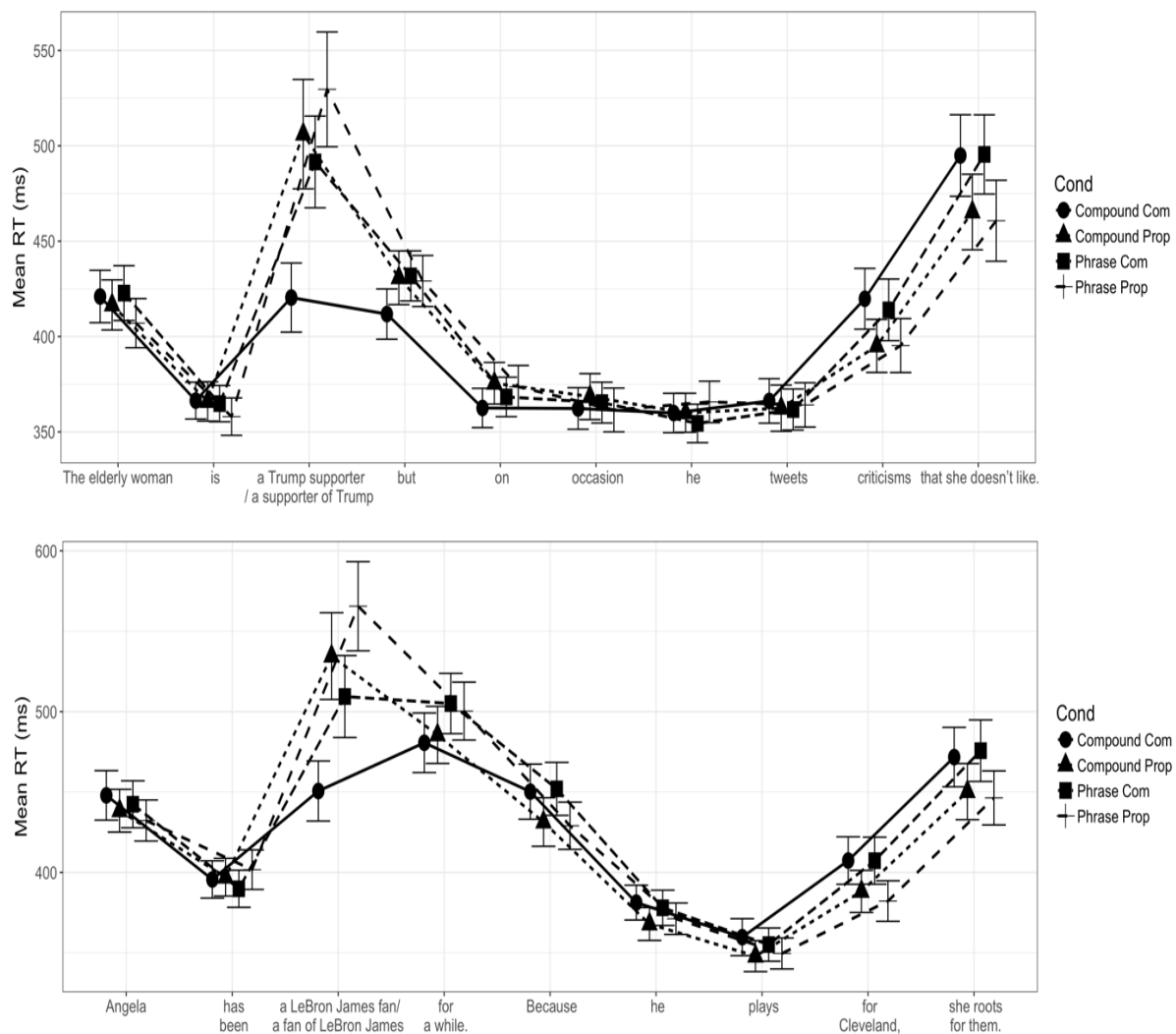

Figure 1. Mean reading times (ms) by participants, Experiment 1. Experiment 1a is shown in the top frame and 1b in the bottom frame. Examples shown are from the proper name condition. Bars indicate standard errors.

If we entertain the possibility that the difference between common noun and proper name items was not merely due to lexical variation between the item sets, one possibility that could have made common noun items more difficult to process is the presence of the pronoun *they* in some items. Take for example the sample item in Table 2. Here the pronoun *they* is used to refer to the boats that the boat maker produced, rather than the singular *it*, assuming that a boat maker makes a number of boats over the course of his or her career. This seems like a fair assumption in this case (a boat maker is un-likely to make only one boat in his or her lifetime), but it could be true that participants did not immediately connect the pronoun *they* with what we intended to be its only possible referent earlier in the item. There is also a possibility that *they* could be taken to refer to the main clause subject plus a larger group, say boat makers more generally. Due to the small number of items involved, nothing conclusive about the

effect of *they*-items vs. *it*-items can be said from our current data. However, there was a trend such that items with *they* had numerically longer reading times on the spillover regions discussed than items with *it*. To determine whether this was masking any underlying effects related to proper names, we eliminated *they* from our items in the next experiment.

3 Experiment 2

3.1 Rationale

Experiment 2 sought to further replicate Experiment 1a, and to further test whether the results of Experiments 1a-b were unduly influenced by the presence of *they* in the common noun condition. The design was the same as Experiment 1a, with NOUN TYPE manipulated between items and STRUCTURE manipulated within items. Because we did not find differences between within- and across-sentence references in Experiment 1, Experiment 2 only tests reference relationships within a sentence.

3.2 Method

Participants Data from 70 participants recruited via Prolific Academic (https://prolific.ac) are reported. A total of 76 participants completed the experiment, but six were excluded prior to data analysis based on the same criteria described above for Experiment 1a-b. Participants were self-reported native speakers of English currently residing in the United States.

Materials In Experiment 2, we used common-noun compounds with non-heads that were either mass nouns (e.g., *red wine* in *red wine drinker)* or pragmatically likely to be singular (e.g., *certificate* in *certificate holder*, where we believe that a single certificate is likely to be salient). We also increased the number of items to 32, with 16 proper name and 16 common noun items. Table 3 shows sample items from the proper name and common noun sets.

Table 3. Sample items with presentation regions (/), Experiment 2. Compound/Phrase conditions shown in {}. Critical pronouns shown in bold (but were not bolded during the experiment)

Proper name	Larry/ is/ {an Oprah follower/a follower of Oprah}, and/ often/ when/ **she**/ recommends/ a product,/ he buys it.
Common noun	Albert/ is/ {a certificate holder/ a holder of a certificate}/ and/ when/ occasionally/ **it/** falls off/ the wall/ he re-hangs it./

Prior to conducting our self-paced reading study, we collected naturalness ratings on a scale from 1 ('completely unnatural') to 7 ('completely natural') from a separate group of participants ($N_{participants}$ = 30, one additional participant removed due to self-reported non-native speaker status). Table 4 shows the mean naturalness ratings in each experimental condition.

Table 4. Mean naturalness ratings from 1-7, by participants (standard errors)

	Common noun	Proper name
Compound	5.31 (0.20)	5.55 (0.18)
Phrase	5.60 (0.19)	5.50 (0.19)

We ran a cumulative-link mixed effects model using the ordinal package (Christensen, 2018) in R (R Core Team, 2018) on the naturalness ratings to determine statistical reliability. The overall model showed only a marginal interaction (*Estimate* = -0.452 (± 0.252), z = -1.791, p = .07). Following up on this interaction, the only significant pairwise difference was between the common noun, compound condition and the common noun, phrase condition such that for common noun items, the conditions wherein a pronoun referred to the non-head of a

compound were rated as less natural than condition wherein the pronoun referred to an element of a phrase (*Estimate* = 0.441 (±0.181), *z* = 2.442, *p* < .05). Naturalness ratings, therefore, show a small tendency toward less-natural status for reference to non-heads in compounds when those compounds include a common noun.

Procedure The procedure for Experiment 2 was identical to that for Experiment 1a-b. Our experimental items were intermixed with 88 unrelated filler items.

3.3 Results

Prior to statistical analysis, data were trimmed such that values between 100 and 2000 ms were excluded (approximately 1 % of observations) and such that values more than 2.5 standard deviations from the subsequent participant/region mean were excluded (approximately 3 % of observations). Due to a coding error, one item was removed from analyses. Figure 2 shows raw reading times across the sentence regions for Experiment 2. We analysed log reading times for each region using the same approach used in Experiment 1a-b and using the same contrast codes for each factor of interest (see Figure 2).

On the region containing an article plus the compound or phrase (a Madonna fan/a fan of Madonna), we find that STRUCTURE significantly predicts (log) reading times (*Estimate* = 0.096 (± 0.018), *t* = 5.286, *p* < .001). While visual inspection of the raw reading times in Figure 2 suggests that there could be an interaction, such that for compounds, proper name items were read longer than common noun items, the interaction is not significant in our analyses (*Estimate* = -0.048 (±0.036), *t* = -1.331, *p* = .195) nor is the effect of NOUN TYPE (*Estimate* = 0.032 (±0.043), *t* = 0.742, *p* = .464). On the region containing the critical pronoun, we find only a marginal effect of STRUCTURE (*Estimate* = 0.016 (±0.008), *t* = 1.957, *p* = .060) with no other predictors reading significance. The subsequent region reveals a marginal effect of NOUN TYPE (*Estimate* = -0.030 (± 0.015), *t* = -2.018, *p* = .053) such that common noun items showed longer reading times than proper name items on this region, with no other significant predictors. This difference remains marginal on the subsequent region of text (two downstream from the critical pronoun) as well (*Estimate* = -0.077 (± 0.040), *t* = -1.896, *p* = 0.068).
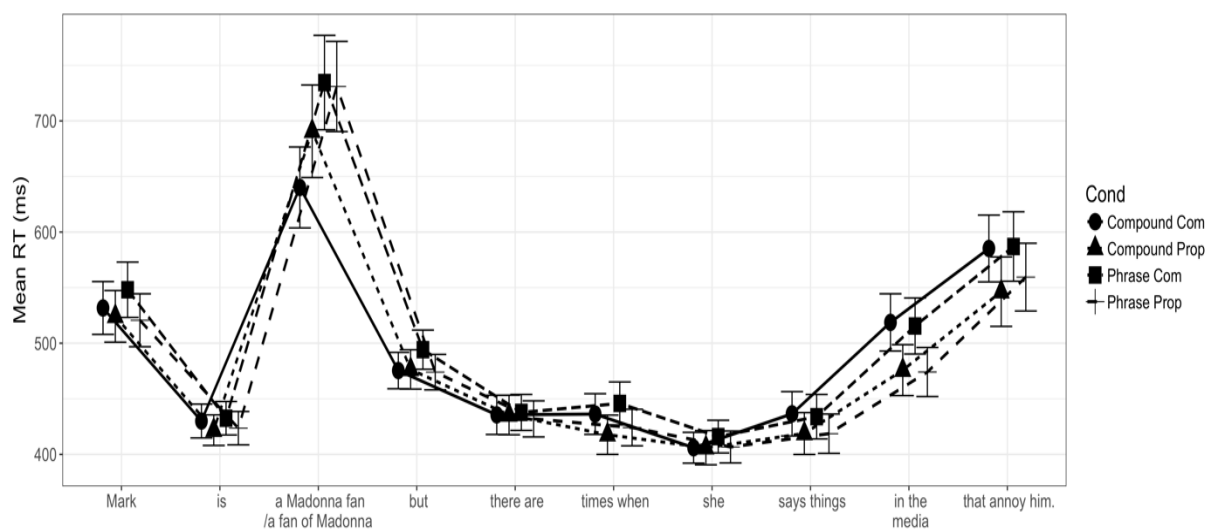

Figure 2. Mean reading times (ms) by-participants, Experiment 2. Bars indicate standard errors

3.4 Discussion

Like Experiments 1a-b, Experiment 2 provides little evidence for a general ban on outbound anaphora. In our naturalness pre-test, common noun items showed a degraded status for a referent within a compound as compared to a referent within a phrase. In fact, this is the only evidence for a ban on outbound anaphora in our results, although the difference does not

straightforwardly suggest a difference in grammaticality in our interpretation. Our real-time processing results again only show a marginal between-items split such that common noun items took longer to read in the regions following the critical pronoun, but without a difference based on the hypothesized accessibility of the referent.

One could criticize the design of Experiment 2 in a parallel to Experiment 1 with respect to the common noun items. Specifically, perhaps upon processing a compound like *bulldog owner*, the reader assumes that there is more than one bulldog in the discourse representation, thereby making it strange to refer to a single bulldog later on with *it*. However, if this were the case, we would predict a difference between the compound and phrasal conditions with common nouns. While we do find such a difference in end-of-sentence naturalness judgments, there is little suggestion of such an effect in self-paced reading times.

4   General discussion

The experiments presented here tested whether reference to a non-head in a compound is facilitated when that non-head is a proper name. However, we find no suggestion of a penalty in processing for reference to these elements even without a proper name. Of course we must be careful in how we interpret null results. There is certainly a possibility that our experimental designs were not sensitive enough to detect a penalty for outbound anaphora. However, in none of our three reading-time experiments do we find that pronouns with referents within a phrase are easier to process than those with compound-internal referents.

From our results, it is difficult to make conclusions about the syntactic status of proper names. The fact that reference to proper names in compounds is not degraded in acceptability judgments, in contrast to reference to common nouns, does point toward a facilitatory effect of the proper name when the entire sentence can be considered at once. Such facilitation could be due to a more accessible grammatical status for proper names (DPs as compared to NPs). However, considering the results of Ward et al. (1991), another likely explanation is that the celebrity names used in our proper name condition were particularly salient in the discourse representation, and were therefore particularly accessible as referents of the critical pronoun no matter what structural position they appeared in. We believe that this likely possibility, paired with the theoretical arguments in Alexiadou (2018), among others, is reason to maintain the hypothesis that proper names are NPs that have undergone D-N merger.

5   Conclusions

In this paper, we report the results of three self-paced reading experiments and one naturalness judgment task testing pronoun reference to compound-internal elements. Such referential dependencies had previously been modelled as ungrammatical (Postal, 1969). Taken together, our experiments provide further evidence that reference to non-heads of compounds in English is not categorically banned by the grammar. While our results do not allow us to make straightforward conclusions about the morpho-syntactic status of proper names, as they are compatible with both a DP and D-N merger hypothesis. However, we believe that the theoretical motivation for the analysis that proper names are NPs that have undergone D-N merger make this the best hypothesis moving forward.

Acknowledgments

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