Antecedent accessibility and exceptional covariation:
Evidence from Norwegian Donkey Pronouns

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Abstract. It is generally assumed that interpreting a co-referential or a syntactically-bound pronoun requires retrieving a representation of its antecedent from memory. Donkey pronouns (e.g., Geach 1962) are pronouns that co-vary in interpretation with non-c-commanding indefinite QPs in apparent violation of structural constraints on QP-pronoun relations (Reinhart 1976). Recent research (Moulton & Han 2018) has hypothesized that the real-time processing of donkey pronouns may not involve retrieval of the co-varying indefinite QP as an antecedent, because non-c-commanding QPs are assumed to be inaccessible to retrieval. We tested this hypothesis with a self-paced reading study that compared the processing of standard co-referential pronouns and donkey pronouns in Norwegian. Contrary to the hypothesis, our results indicate that donkey pronouns retrieve a feature-matching antecedent from memory in a manner analogous to how co-referential pronouns retrieve a referential antecedent. Our findings imply that retrieval of a feature-matching antecedent is a necessary step in the processing of all pronouns, irrespective of their ultimate interpretation. Moreover, retrieval does not uniformly ignore non-referential NPs that fail to c-command a pronoun. We briefly discuss the implications of these findings for psycholinguistic models of anaphora resolution and formal theories of donkey pronouns.

Keywords: pronouns; antecedent retrieval; donkey anaphora; c-command; sentence processing; Norwegian

1   Introduction

Pronouns can be interpreted in various ways. *Co-referential* pronouns point to entities in a discourse model: *it* in (1) refers to the unique object that its antecedent NP *the medal* denotes.

(1)   **The medal** was given to the skier after the host shined **it**.

Syntactically bound pronouns do not refer to entities, but *co-vary* in interpretation with the value of their antecedent. In (2) the quantificational phrase (QP) *every medal* is said to bind the pronoun *it*. The pronoun does not pick out a unique medal, as it does in (1), but rather stands in for each medal in the relevant set denoted by the QP.

(2)   **Every medal** was given to the skier after the host shined **it**.

The availability of syntactically bound readings is subject to constraints that do not govern co-reference. In (3a) the QP *every/no medal* fails to bind the pronoun *it* from within the relative clause (RC), but co-reference between the pronoun and a referential NP in the same position is acceptable (3b).

(3)   a.   *The skier [$_{RC}$ who won **every/no medal$_i$**]   proudly wore **it$_i$** home.

       b.   The skier [$_{RC}$ who won **the medal$_i$**]   proudly wore **it$_i$** home.

The constraint that blocks binding in (3a) is often stated in terms of the *c-command* relation (Reinhart 1976; 1983). Informally, X c-commands Y if Y is contained within X's sister in the syntactic tree. With this definition and the assumption that an antecedent must c-command a pronoun that it binds (Reinhart 1976; 1983 though see Barker 2012; Safir 2004), binding in (3a) can be ruled out because the QP *every/no medal* does not c-command *it* from inside the RC.

Despite the rather tight correlation between c-command and co-variation via syntactic binding, there are exceptional cases where pronouns appear to co-vary with non-c-commanding phrases (see, e.g., Barker 2012; Poesio & Zucchi 1992). In this short paper we focus on one case of exceptional co-variation: so-called *donkey pronouns* (Geach 1962; Evans 1980; Heim 1982; 1990; Neale 1990; Elbourne 2001; 2005, a.o.). The pronoun *it* in (4) is a donkey pronoun that is most naturally interpreted as co-varying with a phrase, *a medal*, that does not c-command the pronoun.

(4) Every skier [$_{RC}$ who won **a medal**$_i$] proudly wore **it**$_i$ home to Norway.

{Haga wore her gold medal, Klæbo wore his gold medal, Falla wore her silver medal …}

Because donkey anaphora can neither be interpreted as standard co-referential or syntactically-bound pronouns, some formal theories assume that donkey pronouns require a distinct semantic analysis from their conventional cousins. Under some of these theories (Cooper 1979; Heim 1990; Neale 1990), the pronoun does not take the indefinite phrase as its antecedent.

Our goal is to compare the initial processing of donkey pronouns to the initial processing of more commonly-studied pronouns. More specifically, our experiment was intended to determine whether the early memory processes associated with pronoun resolution treat the indefinite phrase in constructions like (4) as an antecedent in a manner comparable to how the referential NP in (1) and QP in (3) are treated.

Memory-based models of pronoun interpretation posit that resolution begins with an *antecedent retrieval* stage, in which the parser identifies a candidate antecedent representation from a set of previously-seen items in memory (McKoon & Ratcliff 1980; Gordon & Hendrick 1998; Sanford & Garrod 1989; 2005; Duffy & Rayner 1990; Almor & Nair 2007; but see Cunnings, Patterson & Felser 2014; Kush, Johns & Van Dyke 2018). It is generally assumed, for example, that interpreting the co-referential pronoun in (1) involves first retrieving an antecedent representation corresponding to *the medal*. Likewise for the bound pronoun in (2), antecedent retrieval has access to the QP *every medal*. We investigated whether the processing of donkey pronouns similarly requires the retrieval of the indefinite phrase *a medal*. Our investigation is motivated by the suggestion made by Moulton and colleagues (Moulton 2017; Moulton & Han 2018) that the processing of exceptionally-covariant pronouns does not involve retrieval of the feature-matching phrase with which the pronoun appears to co-vary. To preview our results, we find evidence that language users appear to access the indefinite NP as the antecedent of a donkey pronoun.

1.1 Antecedent accessibility and grammatical sensitivity

It is often assumed that candidate antecedents are identified by their morphological features (e.g. Carreiras et al. 1996; Arnold et al. 2000; Rigalleau, Caplan & Baudiffier 2004; Chow, Lewis & Phillips 2014). For example, when the parser first comes across the pronoun *it* in (1) and (2), many models hold that the it should probe recent memory for an eligible antecedent with 3rd-person, singular, inanimate features.[1] As the NPs *the medal* and *every medal* match those features, their representations should be retrieved.

Morphologically-driven retrieval is a rapid way of finding potential antecedents, but a naïve version of the mechanism is susceptible to error if it ignores the structural position of matching phrases vis-à-vis the pronoun. In addition to identifying acceptable potential antecedents, such a mechanism is liable to identify matching NPs that are disqualified from antecedence by structural constraints. For example, the QP *every medal* in (3a) would be identified as a potential antecedent for the pronoun *it*, even though it is not allowed to grammatically bind the pronoun due to lack of c-command.

Recent studies have investigated whether antecedent retrieval erroneously accesses structurally illicit phrases as potential antecedents based on morphological feature-match (Chow, Lewis & Phillips 2014; Cunnings, Patterson & Felser 2015; Kush, Lidz & Phillips 2015; 2017; but see Badecker & Straub 2002). The results of these studies suggest that retrieval does not access matching NPs in grammatically unacceptable positions.

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[1] We remain agnostic as to whether initial retrieval recalls the antecedent's lexical entry, lemma, or a memory trace at some other level of representation (see Lago et al. 2017 for discussion), but we assume that retrieval reconstitutes at least enough morphological and lexical content to evaluate whether the candidate antecedent matches or mismatches the pronoun.

Kush et al. (2015) tested whether non-c-commanding QPs are accessed as antecedents for pronouns that they are grammatically prohibited from binding. In one experiment the authors had participants read sentences like those in (5), which contained a potential antecedent phrase (*scout*) inside a relative clause and a critical pronoun (*him*) in the matrix clause. The design manipulated the gender of the potential antecedent (*boy/girl scout*) such that it either matched or mismatched a critical pronoun. The design also manipulated whether the potential antecedent was referential (5a) or quantification (5b).

(5) a. The troopleaders [that **the boy/#girl** *scout* had no respect for] scolded **him** …

   b. #The troopleaders [that **no boy/girl scout** had any respect for] scolded **him** …

The authors found a *gender-mismatch effect* at the critical pronoun in (5a): participants had more difficulty reading the pronoun when it mismatched the referential NP than when it matched. The effect was interpreted as evidence that participants could access the matching referential antecedent and had trouble when there was no matching antecedent. Gender-match did not, however, affect the processing of the pronoun when the potential antecedent was a QP (5b). Kush and colleagues concluded that the asymmetry in gender-mismatch effects indicated that antecedent retrieval does not access non-c-commanding QPs that are not acceptable antecedents (see also Cunnings et al. 2015).

Moulton and Han (2018) pointed out that the inaccessibility of the non-c-commanding QPs in the above studies is compatible with two interpretations. The first

interpretation is that retrieval uniformly ignores non-referential phrases that do not c-command a pronoun. The alternate possibility is that retrieval simply ignores non-referential phrases that are not acceptable antecedents for a pronoun, without direct reference to c-command. Under this interpretation accessibility would not be narrowly determined by syntactic scope (c-command), but rather *semantic scope* (see Barker 2015; Ruys & Winter 2011 for discussion of semantic scope).

Moulton & Han (2018) tested the processing of exceptional covariation dependencies to tease these two possibilities apart. The authors tested the accessibility of QPs in constructions like (6a), where a pronoun (*he*) co-varies with a QP (*each boy*), even though the QP does not c-command the pronoun from within the fronted temporal adjunct. Two self-paced reading experiments compared the processing of such exceptionally co-varying pronouns to standard bound and co-referential pronouns. Both experiments varied gender-match between a critical pronoun *he/she* and an antecedent phrase (*each/the boy*). Experiment 1 compared exceptionally-co-varying pronouns in (6a) to (6b), where *each boy* c-commanded the pronoun and syntactic binding was possible. Experiment 2 compared (6a) to (6c), in which co-reference between *the boy* and *he* was possible.

(6) a.   CO-VARIATION WITHOUT C-COMMAND

[After **each boy** brought fresh water from the kitchen quickly], it seems that

{he/she} went on an early break.

b.   SYNTACTIC BINDING UNDER C-COMMAND

It seems that *each boy* brought fresh water from the kitchen quickly right

[before **{he/she}** went on an early break].

c. CO-REFERENCE

[After **the boy** brought fresh water from the kitchen quickly], it seems that

{he/she} went on an early break.

Gender-mismatch effects were found at the syntactically bound (6b) and co-referential

(6c) pronoun, but not on the exceptionally co-varying pronouns (6a). Based on the

absence of a gender-mismatch effect in (6a), Moulton and Han concluded that the non-c-

commanding QP was inaccessible to antecedent retrieval and that the general

accessibility of non-referential antecedents was strictly governed by syntactic scope/c-

command rather than semantic scope. In this regard, the co-varying QP was not treated as

the *true* antecedent, as the pronoun did not establish a direct anaphoric dependency with

the phrase. Co-variation was assumed to arise via a different route (e.g. via establishing a

relationship with an alternative mediating situation variable, as proposed by Moulton

2017).

Moulton and Han (2018) speculated that a similar processing profile should be

observed with other exceptionally co-variant dependencies, such as donkey pronouns. If

this prediction is correct, then the indefinite phrase with which the donkey pronoun co-

varies should not be accessible to antecedent retrieval. We tested this possibility.

2   Self-paced reading experiment

We ran a self-paced reading experiment that compared the effects of gender-mismatch on

the resolution of co-referential and donkey pronouns. Following previous studies (Chow

et al. 2014; Cunnings et al. 2014; 2015; Kush et al. 2015; Moulton and Han 2018), we expected a gender-mismatch effect to emerge at or immediately after the pronoun in co-referential sentences. We were interested in determining whether a comparable gender-mismatch effect would be observed with donkey pronouns.

2.1 Participants

32 native-speakers of Norwegian (23 Female, mean age = 30.5) from the greater Trondheim community participated in the study. Participants were compensated with a gift certificate good for one movie ticket.

2.2 Materials

Test sentences contained a critical object pronoun and an indefinite NP that was a *potential antecedent* for the pronoun. Critical pronouns were either the masculine human-denoting object pronoun *ham* 'him' or the feminine object pronoun *henne* 'her' (Faarlund et al. 1997). Critical pronouns immediately followed the main verb. Antecedent NPs were human-denoting NPs (e.g. *ei datter* 'a daughter' in Table 1). Antecedent NPs were embedded within a relative clause (RC) attached to the main clause subject.

24 sets of experimental sentences were created in accordance with a 2 × 2 factorial design that crossed the factors GENDERMATCH and DEPENDENCYTYPE. An example item is given in Table 1 and a full set of materials can be found at the project's OSF page: https://osf.io/g5u48/. GENDERMATCH controlled whether the critical pronoun matched the indefinite antecedent NP in grammatical gender. The gender of the critical pronoun was counter-balanced across items. DEPENDENCYTYPE determined whether the

indefinite antecedent NP could license a co-referential or a donkey reading of the pronoun. DEPENDENCYTYPE was controlled by varying whether the main subject NP was quantificational (*Hver far* 'every father' in Table 1) or referential (*Faren* 'the father').[2] The main subject was two words in the quantificational conditions, but only one word in the referential conditions. This difference reflects the fact that the definite article in simple NPs is a bound morpheme that suffixes to the head noun. The suffix takes different forms depending on the number and gender of the noun (Julien 2005).

When the subject NP was quantificational, the antecedent NP could license a donkey reading of the pronoun. When it was referential, the antecedent NP could only establish co-reference with the pronoun.

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[2] A reviewer asked whether it is possible to give the definite RC in the referential conditions a quantificational or generic interpretation, akin to *a/every father who has a daughter*[…] Informants suggest that such a reading is highly marked, if possible at all, thus we assume that it is unlikely that participants considered such readings during the experiment.

Donkey

Hver far/	som/	hadde/	ei datter/	i fotballiga-en/	måtte/	kjøre/	henne|#ham/	til/	kamper/	…
every dad	that	had	a_{FEM} daughter	in soccer.league-DEF	had.INF	drive	her|#him/	to	games	…

Referential

Far-en/	som/	hadde/	ei datter/	i fotballiga-en/	måtte/	kjøre/	henne|#ham/	til/	kamper/	…
dad-DEF	that	had	a_{FEM} daughter	in soccer.league-DEF	had.INF	drive	her/#him	to	games	…

Table 1. Sample item from the self-paced reading experiment.

We wished to avoid the possibility that the post-verbal position of the pronoun would allow participants to anticipate features of a likely object based on the semantics or selectional properties of the main verb. Under such a scenario, it would be difficult to attribute gender-mismatch effects to retrieval, rather than violations of a prediction. In order to minimize this possibility we chose main verbs that were not close semantic associates of the antecedent NP and that did not strongly predict reference to the potential antecedent NP. We used main verbs that could take a diverse range of direct objects (e.g., *få* 'get') or verbs whose canonical object was not the antecedent NP (e.g., *kjøre* 'drive' in Table 1).

Materials were written in *Bokmål*, one of the two official standardized forms of written Norwegian (alongside *Nynorsk;* Venås 1993; Vikør 1995). Bokmål is the preferred written standard for an estimated 85-90% of the total population, and all students in Norwegian schools receive instruction in both standards (Staalesen 2014).

Test sentences were distributed in a Latin Square design across 4 separate lists containing 78 additional sentences for a total of 102 sentences. 54 of these sentences were fillers of varying length and complexity. 24 were sentences from an unrelated experiment on the processing of relative clauses. All sentences were followed by a yes-no comprehension question to encourage participants to read carefully. One item was removed from analysis due to a typo in the pre-critical region.

2.3 Procedure

Participants were run on a desktop PC using the Linger software package (Doug Rohde, MIT) in a self-paced phrase-by-phrase moving window paradigm (Just, Carpenter

& Woolley 1982). Phrases for presentation consisted of one or two words, as demarcated with slashes in Table 1. Each trial began with a sentence masked by dashes appearing on the screen. Letters and punctuation marks were masked. Spaces were not masked, leaving word-boundaries visible. As the participant pressed the spacebar, a new word appeared on the screen and the previous word was re-masked. All sentences were followed by a yes/no comprehension question.

2.4 Analysis

Reaction times (RTs) below 100ms were removed, affecting less than 0.1% of all data. RTs were subsequently log-transformed and the resulting logRTs were used as the dependent variable in analysis.

Analysis was restricted to two regions of interest: the critical pronoun and the region immediately following the pronoun (henceforth the *post-pronoun* region). The composition of the post-pronoun region varied across items, but in most items it contained either a lone preposition (e.g. *til* 'to') or a preposition plus an infinitival marker (e.g., *om å*) presented simultaneously. Statistical analysis was conducted using linear mixed effects models estimated using the lme4 package (Bates, Maechler & Bolker 2011) in R (R Core Development Team 2014). Models included simple-difference sum-coded fixed effects of DEPENDENCYTYPE (*Donkey*: 0.5, *Referential*: -0.5) and GENDERMATCH (*Mismatch*: 0.5, *Match*: -0.5). Instead of using models with "maximal" random effects structures, we determined the "parsimonious" random effects structure for each individual model according to the model selection procedure described in Matuschek et al. (2017; see also Bates et al. 2015; Baayen et al. 2017) using the *RePsychLing* package. All models

contained random intercepts for participants and items. The parsimonious model used for analysis of reading times in the pronoun region also contained a random slope for DEPENDENCYTYPE by item. The model used for analysis of the post-pronoun region contained by-subject and by-item random slopes for DEPENDENCYTYPE and GENDERMATCH, and a by-item random slope for their interaction. Estimated *p*-values were calculated using the Satterthwaite approximation implemented in the *lmerTest* package (Kuznetsova, Brockhoff & Christensen 2015).

2.5 Results and discussion

2.5.1 Comprehension question accuracy

Average accuracy on the comprehension questions across conditions was 0.91. Logistic regression showed that accuracy was significantly higher in *Match* sentences than *Mismatch* sentences (0.93 v. 0.89; z = -2.18, p < .05). There were no other significant effects.

2.5.2 Reading times

Log-transformed reading times are plotted in Figure 1. A summary of statistical effects for the critical and post-pronoun region are in Table 2.

[INSERT FIGURE 1 ABOUT HERE]

	Pronoun Region				Post-Pronoun Region			
	Beta	SE	*t*		Beta	SE	*t*	
DEPENDENCYTYPE	-0.01	0.03	-0.39		-0.01	0.03	-0.23	
GENDERMATCH	0.08	0.02	3.14	**	0.20	0.03	6.34	***
TYPE:MATCH	0.01	0.05	0.25		0.03	0.06	0.48	

Table 2. Summary of statistical effects for the Pronoun and Post-pronoun regions. **, *** indicate significance at p < .01, .001, respectively.

Clear and sustained gender-mismatch effects began at the pronoun and continued throughout the remainder of the sentence for both donkey and co-referential sentences. Statistical analysis confirms that the gender-mismatch effect was significant at the critical pronoun ($t = 3.14$, $p < .01$). Matching pronouns were read more quickly than mismatching pronouns (average raw RT difference = 32ms). There was no sign of a DEPENDENCYTYPE X GENDERMATCH interaction, indicating that the gender-mismatch effects were comparable across the donkey and the co-referential sentences. The gender-mismatch effect was even larger in the post-pronoun region ($t = 6.34$, average raw RT difference = 85ms). Again, the absence of an interaction suggested that there were no differences in the magnitude of the effect across different sentence types.

Keir Moulton (personal communication) asked whether the pairwise differences that we observe could perhaps stem from a confound unrelated to gender-mismatch: In a subset of our materials the pronoun in the mismatch sentences was the same gender as the matrix subject (e.g. *Hver far/Faren* 'every/the father' and *ham* 'him' in the example in Table 1). If the critical pronoun were to retrieve the matrix subject in the mismatch condition, then the difficulty that we labeled a gender-mismatch effect could alternatively be attributed to a violation of Principle B. Instead of slowing down because the pronoun failed to match any accessible NPs in the sentence, participants might have slowed down under this interpretation because they recognized they attempted to link the pronoun to the local subject and then recognized that such a dependency would be grammatically illicit.

We consider this alternative explanation unlikely because most recent reading experiments suggest that participants do not consider a matching local subject as an

antecedent for an otherwise unheralded object pronoun in violation of Principle B (Lee & Williams 2008; Chow, Lewis & Phillips 2015; though see Kennison 2003). Nevertheless, we conducted a post-hoc analysis to determine whether the supposed confound could account for our results.

We identified experimental items in which the mismatching pronoun and the matrix subject were the same gender. Of our set of 24 items, there were 10 items that conservatively fit the description. Six of the ten items had matrix subjects with definitional gender (*father, princess, man, woman*) that matched the gender of the critical pronoun. The matrix subjects of the other four items were nouns that were not male or female by definition, but which may have been biased towards the matching gender (e.g., *student, school kid, officer*).

We removed the ten items from our data set and reran the analysis above. If the mismatch effect had been due to the proposed confound, we would expect the pairwise effect of gender-mismatch at the pronoun and the spill-over region to disappear with the subset of items. This is not what we observed. Even with the reduced power, we still observe significant gender-mismatch effects in the pronoun and spillover regions ($t = 2.08, 4.46$; ps $< .05, .001$, respectively). Thus, we conclude that difficulty in the mismatch conditions can safely be apportioned to gender-mismatch.

3 General discussion

Donkey pronouns belong to a class of exceptional pronominal dependencies that allow co-variation between a pronoun and a non-c-commanding, non-referential QP. Recent research has suggested that although there is apparent covariation between the non-c-commanding phrase and the pronoun, the non-c-commanding phrase may nevertheless be

inaccessible to initial antecedent retrieval (Moulton & Han 2018). If non-c-commanding QPs are inaccessible to retrieval, then donkey pronouns do not, in fact, use the matching indefinites with which they co-vary as true antecedents, but are rather interpreted via relation to some other (covert) item in the linguistic representation. In response to this suggestion, we tested whether the processing of a donkey pronoun involves retrieval of the non-c-commanding indefinite NP as its antecedent.

In a self-paced reading experiment we compared the effects of a gender-mismatch manipulation on the processing of donkey pronouns to co-referential pronouns in Norwegian. Our experiment manipulated the gender match between the animate pronouns *ham* and *henne* ('him' and 'her' respectively) and an indefinite phrase that preceded, but did not c-command the pronoun. We observed a small, but reliable gender-mismatch effect immediately at the critical pronoun in both the co-referential and donkey sentences: reading times were faster when the pronoun matched the antecedent NP in grammatical gender than when the pronoun mismatched the antecedent. At the post-pronoun spill-over region there were large gender-mismatch effects in both co-reference and donkey sentences. Gender-mismatch effects were analogous for both pronoun types; at no point did they differ in either time-course or magnitude.

The simultaneous gender-mismatch effects provide evidence that participants readily access a feature-matching indefinite NP when resolving donkey pronouns, on par with the processing of standard co-referential pronouns. Our findings disconfirm Moulton & Han's (2018) broad prediction that non-referential phrases that do not c-command a pronoun are uniformly inaccessible to retrieval.

Our results are in line with relatively common, though often tacit, assumption in many psycholinguistic models of anaphor resolution that the parser employs a *uniform retrieval procedure* to access phrases of different types as potential antecedents for a pronoun (e.g., Gordon & Hendrick 1998; Kush 2013; Chow, Lewis & Phillips 2014; Cunnings, Patterson & Felser 2014; Kush, Lidz & Phillips 2015). In these models the primary function of antecedent retrieval is to identify a potential antecedent phrase *before* processes of resolution and integration begin (Sanford & Garrod 1989; Duffy & Rayner 1990; Almor & Nair 2007; Kush 2013; Kush, Lidz & Phillips 2015). The type of the anaphoric dependency that an antecedent phrase may ultimately license with a pronoun is immaterial to the early access process.

For concreteness we illustrate how uniform retrieval is implemented in a cue-based framework with a proposal from Kush and colleagues (Kush 2013; Kush et al. 2015) and discuss how uniform retrieval could be extended to cover donkey pronouns within the framework.

Kush and colleagues proposed that referential NP and quantificational NP antecedents are identified in and retrieved from memory via the same morpho-syntactic cues. The challenge associated with using such a simple, uniform retrieval mechanism lies in distinguishing feature-matching NPs and QPs that are potential grammatical antecedents from those that are not, particularly because the conditions that determine accessibility vary by antecedent type. Kush and colleagues proposed to solve this challenge with a "book-keeping" feature, [ACCESSIBLE], that provided a feature-based analogue of maintaining a "pre-sorted" set of potential antecedents: Phrases marked as

[ACCESSIBLE] are visible to retrieval, while those that do not have the feature are invisible to retrieval.

The proposal captured the fact that the set of potential antecedents may change over the course of incremental parsing by allowing the parser to dynamically update [ACCESSIBLE]-marking on phrases in memory. Dynamic update accounts for how the accessibility of non-c-commanding referential NPs (*the fan* in 7) and non-c-commanding QPs (*no fan*) that occupy the same structural position can depend on the relative position of a pronoun. Consider (7). So long as the parser is still building the relative clause, both the NP and the QP should be marked [ACCESSIBLE]. This reflects their ability to antecede the pronoun *his* inside the relative clause (7a). At the right-edge of the relative clause (demarcated by the matrix verb *waved*), the parser should revoke [ACCESSIBLE]-marking on the QP, because the end of its c-command domain has been reached. [ACCESSIBLE] should remain on the referential NP. Thus, only the referential NP should be accessible to antecedent retrieval for the later pronoun *him* (7b v. 7c).

(7)　　a.　The skier [that {*the|no man*}[ACCESSIBLE] saw from *his* seat] …

　　　　b.　The skier [that *the man*[ACCESSIBLE] saw from his seat] waved to *him*

　　　　c.　#The skier [that *no man*[ACCESSIBLE] saw from his seat] waved to *him*

Kush and colleagues' original proposal was only offered as an account of standard co-referential and syntactic binding dependencies, but the spirit of uniform retrieval is that it should apply to all dependencies. We show how to extend it to donkey anaphora.

Indefinite phrases in donkey configurations are accessible to antecede a pronoun that they do not c-command, which entails that they should stay [ACCESSIBLE] beyond their c-command domain. This sets them in contrast to other QPs. This would not be allowed under Kush and colleagues' original rigid update procedure. To accommodate the phenomenon one could modify update procedure to align better with the descriptive generalization: an individual QP can remain [ACCESSIBLE] beyond its c-command domain, *if the processor deems that the QP could potentially – or is likely to – license exceptional covariation later in the sentence*. Thus, the modification brings the interpretation of [ACCESSIBLE] marking on a QP in line with [ACCESSIBLE] marking on a referential NP: it simply marks whether the phrase corresponds to an antecedent that can license an anaphoric dependency *of some kind* with a subsequent pronoun (be that dependency syntactic binding, semantic binding, or coreference).

The parser must determine whether to maintain [ACCESSIBLE] marking on the basis of contextual cues. Cues could be drawn from a variety of sources: surface syntactic cues like c-command, semantic constraints, or more subtle and complex semantic and pragmatic factors.

At least some of the cues that would influence whether a parser would let an indefinite keep its [ACCESSIBLE] feature are easily identifiable. On the one hand, if the semantics of the local context forces, or biases towards a referential reading of the indefinite, its [ACCESSIBLE] marking should not be revoked. Quantificational indefinites should almost always retain their [ACCESSIBLE] feature, except for example, in

downward-entailing environments like those in (8).[3] In such cases, the feature should be revoked at the end of the indefinite's c-command domain.

(8)   a. *After no one found **a medal$_i$,** Hilda polished **it$_i$**.

        b. *The man [that didn't get **a medal$_i$**] desperately wanted **it$_i$**.

For other cases of exceptional covariation the exact factors that govern the decision to keep a QP accessible will necessarily vary as a function of QP-type and properties of the local context.

3.1 Relation to formal analyses of Donkey Anaphora

Insofar as gender-mismatch effects reliably diagnose antecedent retrieval – and there is some degree of parser-grammar isomorphism (Boland 2005; Marantz 2005; Kush & Dillon to appear) – our results suggest that donkey pronouns enter into a dependency with the indefinite phrase. We briefly discuss how this finding aligns with the different formal analyses of donkey pronouns. As we discuss below, the idea that the indefinite serves as an antecedent is, in principle, compatible with variants of both of the dominant semantic approaches to donkey pronouns. Thus, our goal is not to use our results to adjudicate between the two theoretical accounts.[4] Instead, we wish to point out how the

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[3] Essentially, any indefinite that does not introduce a discourse referent, as defined in dynamic theories, should lose the feature at the end of its c-command domain.
[4] For previous work that has used experimental evidence to argue for or against a particular class of formal analyses see Conway & Crain (1995); Guerts (2002); Foppolo (2009); Grosz et al. (2015).

results could be accommodated under each theory and in which cases alignment is harder than in others.

Broadly speaking, there are two approaches to interpreting donkey pronouns. *Covert definite* (sometimes called *e-type* or *D-type*) accounts hold that donkey pronouns are interpreted as *covert definite descriptions,* where apparent covariation between the indefinite and the pronoun does not occur via binding by the indefinite phrase (Cooper 1979; Evans 1980; Heim 1990; Elbourne 2001; 2005; a.o.). Instead covariation requires quantification over a separate hidden variable, the identity of which differs by theory: some (e.g. Cooper 1979) posit an individual variable bound by the QP *every skier* as in (9a), while others (Heim 1990; Elbourne 2001) invoke covert quantification over *situation variables*, as in (9b).

(9) a. $\forall x.$ *x* is a skier & *x* won a medal & *x* wore **the medal *x* won** home.

　　b. For every pair (*x,s*), such that *x* is an individual and *s* is a minimal situation in which *x* is a skier who won a medal in *s,* there is an extension of *s, s',* such that in s' *x* wore the medal from *s.*

In contrast to covert definite accounts, *Dynamic* accounts reject a formal distinction between donkey, traditional bound, and co-referential pronouns, treating them all as instances of *semantically* bound *individual-denoting* variables (Kamp 1981; Heim 1982; Gronendijk & Stokhof 1991; Brasoveanu & Dotlacil 2016; a.o.). Pronouns are identified with *discourse referents* introduced by quantificational and non-quantificational noun phrases alike. Discourse referents "live" – i.e. can serve as antecedents – as long as their corresponding phrase has *semantic scope*. Under this interpretation, the [ACCESSIBLE] feature would correspond directly to semantic scope.

The finding that donkey pronouns directly retrieve indefinites as antecedents can be reconciled with covert definite accounts if retrieval functions to provide the *content* of the covert description (rather than supplying an individual or binder). The finding is perhaps most difficult to reconcile with models such as Cooper (1979), where the content of the definite description is supplied by a "contextually-salient" relation that is available to the semantics and not via connection to the indefinite itself. By contrast, Elbourne's (2002; 2005) D-Type analysis of donkey anaphora is relatively easy to align with the assumption. Elbourne proposes that donkey pronouns are definite descriptions whose nominal content has been *elided.* The content of the elided noun must be recovered under identity with the indefinite antecedent as shown in (8).

(8)   Every skier who won a medal proudly wore [*the* ~~medal~~] home

If donkey pronouns use the indefinite to provide content for a definite description (and co-referential and syntactically bound pronouns are not interpreted as covert definite descriptions), then the purpose of retrieval varies as a function of dependency. However, the fact that different dependencies are computed does not threaten the assumption that the same antecedent retrieval mechanism underlies the processing of all pronouns.

 Squaring the uniform retrieval hypothesis with dynamic accounts is relatively trivial, as the default assumption of dynamic accounts is that the same mechanisms that underlie co-reference and syntactic binding support the interpretation of donkey anaphora. Insofar as the processing of other pronoun types involves antecedent retrieval –

which corresponds, in this case to the retrieval of a discourse referent – then so too should the processing of donkey pronouns.[5]

3.2 Reconciling present and past results: Other cases of exceptional covariation

We close by considering the differences between our findings and those of Moulton and Han (2018) in light of the uniform retrieval hypothesis. All else equal, uniform retrieval holds that if a pronoun co-varies with an overt QP, then processing that pronoun involves retrieving the QP (or some chunk in memory corresponding to the QP). Insofar as reliable gender-mismatch effects index successful retrieval, Moulton and Han's results suggest that the non-c-commanding QPs in their items were inaccessible to antecedent retrieval even though they seem to license exceptional covariation.

As the c-commanding QPs were not accessible in Moulton & Han's non-c-commanding QP sentences, the question arises of how participants interpreted pronouns in these sentences. Under the uniform retrieval hypothesis, the absence of a reliable gender-mismatch effect entails that the pronouns were initially interpreted *as lacking an explicit antecedent.* The alternative, endorsed by Moulton and Han, is that the pronouns immediately retrieve an antecedent, but that that antecedent does not correspond to the

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[5] To our knowledge there is only one dynamic account that predicts a potential processing distinction between donkey pronouns and all others. Geurts (2011) proposes that antecedents that license donkey interpretations are not immediately accessible, but must be linked to pronouns via a two-step process involving a *bridging inference* grounded in semantic entailment. Insofar as the bridging inference responsible for the process (i) is a *backward* inference first triggered upon encountering the pronoun (Haviland & Clark 1974; Garrod & Sanford 1981), and (ii) exacts a detectable cost, our results are incompatible with Geurts (2011), since we saw no distinction between the time-course or magnitude of the gender-mismatch effect for co-referential or donkey pronouns in our experiment.

QP: it is instead a "situation binder". The absence of the gender-mismatch effects supposedly follows from the fact that situation binders lack gender features, unlike nominal antecedents.

Moulton and Han concluded matching pronouns in the non-c-commanding condition immediately find an antecedent based on two pieces of evidence: First, when participants were asked to choose a possible reading of matching test pronouns in an untimed interpretation task, they chose the co-varying reading in the non-c-commanding condition roughly as often as they chose binding under c-command or co-reference in other test sentences. The authors inferred therefore that participants in the self-paced reading task immediately resolve the pronoun as covariant with the non-c-commanding QP. Second, the average RT for the matching pronoun in the non-c-commanding QP condition was comparable to RTs for matching bound or co-referential pronouns. If antecedent-less pronouns are always read more slowly than pronouns with antecedents, then the absence of a pairwise difference between the matching pronouns is consistent with the assumption that matching pronouns in the non-c-commanding QP condition immediately find an antecedent.

There are reasons, however, to question this conclusion: First, participants' offline preferences do not offer a direct window onto immediate incremental processing. The offline results are equally compatible with the interpretation that participants do not access the non-c-commanding QP during initial antecedent retrieval, but eventually recognize that covariation may be possible when given more time to reflect. Second, the similarity in average RTs between the matching pronoun in the non-c-commanding QP condition and matching pronoun in the syntactic binding (or co-reference) condition is

only informative if mismatching pronouns in the non-c-commanding QP condition were more difficult than matching pronouns. However, there were not reliable differences between the matching and mismatching pronouns in the non-c-commanding QP condition. As such, we cannot conclude that matching pronouns were easier to process than pronouns that did not have a sentence-internal antecedent.

We therefore take the lack of a reliable gender-mismatch effect in the non-c-commanding QP conditions to indicate that participants tended to interpret the matching pronoun as though it lacked a sentence-internal antecedent. What remains to be explained, under this interpretation, is why the QP would be treated as inaccessible to antecedent retrieval during incremental processing, given its apparent ability to license exceptional covariation in Moulton & Han's offline task.

Following our conjecture from above: the accessibility of QPs in fronted adjuncts depends on participants' unconscious assessment of whether exceptional covariation is likely in, or supported by, the context. If cues in the sentence or context lead participants to judge a QP unlikely to license exceptional covariation, then that QP will not be kept accessible beyond its c-command domain. We suspect that this is what happened in Moulton & Han's (2018) items: the test sentences contained enough cues to discourage participants from keeping the QP accessible up to the pronoun.

Providing a deterministic account, as we did for indefinites, of how to assess whether adjunct-internal QPs are likely to license exceptional covariation is not trivial. It is known that the availability of exceptional covariation is governed by extra-syntactic (e.g. semantic, pragmatic) conditions (e.g., Poesio & Zucchi 2002; Anderssen 2011; Barker 2012), but the conditions are not exhaustively determined by a single feature of

the local syntactic context, such as whether the QP is in the scope of a downward-entailing quantifier. Instead, the availability of the readings is tied to subtler, less deterministic cues of the local and non-local context.

Although we do not have a formal analysis of why participants treated the QPs as inaccessible in Moulton and Han's sentences, we can point to some of the cues that might have influenced their assessments. Intuitions suggest that extending the non-c-commanding QP's accessibility beyond a fronted adjunct depends on how easy it is to adopt a *quantificational, distributive,* or *multiple-event* reading of the fronted adjunct. Such readings feel rather unnatural in examples such as those below (taken from the appendix in Moulton & Han 2018).

(9)
    a. When - each old woman - came quickly - out of the house - down the road, - it seems - that s**he/he** - yelled mean - things loudly - for hours.
    b. After - each little boy - came home - late - from a long day at school, - it seems - that **he/she** – practiced playing - the piano - for half an hour.

Features such as tense-marking, predicate choice, and even the presence of the intervening raising predicate *it seems* also appear to influence what readings participants consider likely. The infelicity of a mismatching pronoun is intuitively more pronounced in sentences like (10), which have present tense, an additional indefinite, which lack an intervening raising predicate, and which are easily interpreted as following a *script* (Poesio & Zucchi 1992):

(10) After *each nun* gets a new habit, *she/#he* is given special instructions for its care.

We suspect that when participants read sentences like (9), they judged exceptional scope to be unlikely and marked the QP inaccessible either at the edge of the adjunct or shortly thereafter. Thus, matching and mismatching pronouns are treated alike in those sentences. In sentences like (10), however, we expect that participants would keep the QP accessible beyond the adjunct and a gender-mismatch effect would arise at the pronoun. We encourage future researchers to test this prediction.

Finally, since the availability of exceptional scope is governed by multiple, less-than-deterministic cues, we speculate that the decision to extend a QP's accessibility past its c-command domain may best be modelled as *probabilistic* in certain configurations. Thus, the decision to treat a QP as licensing exceptional co-variation may vary item-by-item (and perhaps speaker-by-speaker). We think that this explanation provides a promising avenue for interpreting some of Moulton & Han's secondary findings. If participants *inconsistently* extended the scope of the QP beyond the fronted adjunct across items, then we would predict a mixture of trials where the QP was accessible to retrieval and trials where it was not accessible to retrieval.[6] Thus, the average response pattern observed in the average region-by-region reading times would similarly reflect a mixture across inconsistent trials, yielding an attenuated gender-mismatch effect in the non-c-commanding QP conditions relative to other conditions with consistently accessible antecedents. Such a behavioral response, in fact, is what Moulton and Han (2018) observed in their Experiment 3: a non-significant trend towards a gender-

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[6] For items (or trials) where the QP was accessible, the processing of the matching pronoun would be facilitated relative to a non-matching pronoun, resulting in a standard gender-mismatch effect. For items and trials where the QP was inaccessible, the matching pronoun would not be facilitated and no gender-mismatch effect would be observed.

mismatch effect was observed in the non-c-commanding QP sentences at the post-pronoun region and a marginally significant gender-mismatch effect was observed in the following region (t = -1.79, p < .10). This marginal gender-mismatch effect is consistent with our interpretation that non-c-commanding QPs were actually accessible on a subset of trials.

4   Conclusion

We tested whether the processing of Norwegian donkey pronouns triggers antecedent retrieval of a co-varying indefinite NP. We found that donkey pronouns retrieve a co-varying indefinite NP as quickly and with the same ease as co-referential pronouns retrieve a referential antecedent. Our findings imply that retrieval of a feature-matching NP is a necessary step in the processing of all pronouns, irrespective of their ultimate interpretation. Retrieval does not uniformly ignore non-referential NPs that fail to c-command a pronoun.

Abbreviations

DEF = Definite suffix, FEM = Feminine, INF = Infinitive

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Competing interests

The authors have no competing interests to declare.

References

Alcocer, Pedro & Colin Phillips, C. 2012. Using Relational Syntactic Constraints in Content-Addressable Memory Architectures for Sentence Parsing. *Unpublished manuscript. Available online at: http://www. colinphillips. net/wp-content/uploads/2014/08/alcocer_phillips2012_v2. pdf*.

Almor, Amit & Veena A. Nair. 2007. The form of referential expressions in discourse. *Language and Linguistics Compass* 1. 84-99. https://doi.org/10.1111/j.1749-818X.2007.00009.x

Badecker, W. & Kathleen Straub. 2002. The processing role of structural constraints on interpretation of pronouns and anaphors. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 28. 748-769. https://doi.org/10.1037/0278-7393.28.4.748

Boland, Julie E. 2005. Cognitive mechanisms and syntactic theory: Arguments against adjuncts in the lexicon. In Anne Cutler (ed.), *Twenty-first Century Psycholinguistics: Four Cornerstones*, 23-42. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Bates, Douglas, Martin Maechler, Ben Bolker & Steve Walker. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67. 1-48. https://doi.org/10.18637/jss.v067.i01

Barker, Chris. 2012. Quantificational binding does not require c-command. *Linguistic Inquiry* 43(4). 614-633.

Barr, Dale. J., Roger Levy, Christoph Scheepers, & Harry J. Tily. 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language* 68(3). 255-278. https://doi.org/10.1016/j.jml.2012.11.001

Chow, Wing-Yee, Shevaun Lewis & Colin Phillips. 2014. Immediate sensitivity to structural constraints in pronoun resolution. *Frontiers in Psychology* 5. 630. https://doi.org/10.3389/fpsyg.2014.00630

Cooper, Robin. H. 1979. The interpretation of pronouns. In Frank Heny & Helmut S. Schnelle (eds.), *Syntax and semantics 10: Selections from the third Gröningen Round Table*, 61–92. New York, NY: Academic Press.

Cunnings, Ian, Clare Patterson & Claudia Felser. 2014. Variable binding and coreference in sentence comprehension: Evidence from eye movements. *Journal of Memory and Language* 71(1). 39-56. https://doi.org/10.1016/j.jml.2013.10.001

Cunnings, Ian, Clare Patterson & Claudia Felser. 2015. Structural constraints on pronoun binding and coreference: evidence from eye movements during reading. *Frontiers in Psychology* 6. 840. https://doi.org/10.3389/fpsyg.2015.00840

Duffy, Susan A. & Keith Rayner. 1990. Eye movements and anaphor resolution: Effects of antecedent typicality and distance. *Language and Speech* 33(2). 103-119. https://doi.org/10.1177/002383099003300201

Elbourne, Paul D. 2001. E-type anaphora as NP-deletion. *Natural Language Semantics* 9(3). 241-288. https://doi.org/10.1023/A:1014290323028

Elbourne, Paul D. 2005. *Situations and individuals*. Cambridge, MA: MIT Press.

Elbourne, Paul D. 2008. The interpretation of pronouns. *Language and Linguistics Compass* 2(1). 119-150. https://doi.org/10.1111/j.1749-818X.2007.00041.x

Evans, Gareth. 1980. Pronouns. *Linguistic Inquiry* 11(2). 337-362.

Faarlund, Jan Terje, Svein Lie & Kjell Ivar Vannebo. (eds.). 1997. *Norsk referansegrammatikk*. New York: Columbia University Press.

Foraker, Stefani & Brian McElree. 2007. The role of prominence in pronoun resolution: Active versus passive representations. *Journal of Memory and Language* 56(3). 357-383. http://dx.doi.org/10.1016/j.jml.2006.07.004

Groenendijk, Jeroen & Martin Stokhof. 1991. Dynamic predicate logic. *Linguistics and Philosophy* 14(1). 39-100. https://doi.org/10.1007/BF00628304

Grosz, Patrick. G., Pritty Patel-Grosz, Evelina Fedorenko. & Edward Gibson. 2014. Constraints on donkey pronouns. *Journal of Semantics* 32(4). 619-648. https://doi.org/10.1093/jos/ffu009

Geurts, Bart. 2002. Donkey Business. *Linguistics and Philosoph*y 25. 129–156. https://doi.org/10.1023/A:1014624331450

Geurts, Bart. 2011. Accessibility and anaphora. In Klaus von Heusinger, Claudia Maienborn & Paul Portner (eds.), *Semantics: An international handbook of natural language meaning* 2, 1988-2011. Berlin: De Gruyter Mouton.

Gordon, Peter. C. & Randall Hendrick. 1998. The representation and processing of coreference in discourse. *Cognitive Science* 22(4). 389-424. https://doi.org/10.1016/S0364-0213(99)80045-7

Heim, Irene. 1982. The semantics of definite and indefinite noun phrases. Amherst, MA: University of Massachusetts dissertation.

Heim, Irene. 1990. E-type pronouns and donkey anaphora. *Linguistics and Philosophy* 13(2). 137-177. https://doi.org/10.1007/BF00630732

Kamp, Hans. 1981. A theory of truth and semantic representation. In Jeroen Groenendijk, Theo Janssen and Martin. Stokhof (eds.), *Formal methods in the study of languages*, 277–322. Amsterdam: Mathematical Centre.

Kratzer, Angelika & Irene Heim. 1998. *Semantics in generative grammar*. Oxford: Blackwell.

Julien, Marit. 2005. *Nominal phrases from a Scandinavian perspective*. Amsterdam: John Benjamins Publishing.

Just, Marcel A., Patricia A. Carpenter & Jacqueline D. Woolley. 1982. Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General* 111(2). 228-238. https://doi.org/10.1037/0096-3445.111.2.228

Kush, Dave, Clinton L. Johns, & Julie Van Dyke. 2018. Prominence-sensitive pronoun resolution: New evidence from the speed-accuracy tradeoff procedure. *Journal of Experimental Psychology. Learning, Memory, and Cognition* 45(7). 1234-1251. https://doi.org/10.1037/xlm0000646

Kush, Dave, Jeffrey Lidz & Colin Phillips. 2015. Relation-sensitive retrieval: evidence from bound variable pronouns. *Journal of Memory and Language*, *82*, 18-40. https://doi.org/10.1016/j.jml.2015.02.003

Kush, Dave, Jeffrey Lidz & Colin Phillips. 2017. Looking forwards and backwards: The real-time processing of Strong and Weak Crossover. *Glossa: A Journal of General Linguistics* 2(1). 70. http://doi.org/10.5334/gjgl.280

Kuznetsova, Alexandra, Per B. Brockhoff & Rune H. B. Christensen. 2017. lmerTest package: tests in linear mixed effects models. *Journal of Statistical Software* 82(13). 1-26. https://10.18637/jss.v082.i13

Lago, Sol, Shayne Sloggett, Zoe Schlueter, Wing-Yee Chow, Alexander Williams, Ellen Lau & Colin Phillips. 2017. Coreference and antecedent representation across languages. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 43(5). 795-817. https://doi.org/10.1037/xlm0000343

Lewis, Richard. L., Shravan Vasishth & Julie A. Van Dyke. 2006. Computational principles of working memory in sentence comprehension. *Trends in Cognitive Sciences* 10. 447-454. https://doi.org/10.1016/j.tics.2006.08.007

Marantz, Alec. 2005. Generative linguistics within the cognitive neuroscience of language. *The Linguistic Review* 22. 429-445. https://doi.org/10.1515/tlir.2005.22.2-4.429

McKoon, Gail. & Roger Ratcliff. 1980. The comprehension processes and memory structures involved in anaphoric reference. *Journal of Memory and Language* 19(6). 668-682. https://doi.org/10.1016/S0022-5371(80)90355-2

Moulton, K. 2017. Retrieving antecedents in processing: Binder indices and Φ-Features. In Wm G. Bennett, Lindsay Hracs & Dennis Ryan (eds.), *Proceedings of the West Coast Conference on Formal Linguistics* 35, 30-40. Somerville, MA: Cascadilla Proceedings Project.

Moulton, Keir. & Chung-Hye Han. 2018. C-command vs. scope: An experimental assessment of bound-variable pronouns. *Language* 94(1). 191-219. https://doi.org/10.1353/lan.2018.0005

Neale, Stephen. 1990. Descriptive pronouns and donkey anaphora. *The Journal of Philosophy* 87(3). 113-150. https://doi.org/10.2307/2026632

Poesio, Massimo. & Alessandro Zucchi. 1992. On telescoping. In Chris Barker & David Dowty (eds.)*, Proceedings of Semantics and Linguistic Theory* 2, 347-366. Columbus, OH: Ohio State University Working Papers in Linguistics.

Reinhart, Tanya. 1976. *The syntactic domain of anaphora*. Cambridge, MA: Massachusetts Institute of Technology dissertation.

Reinhart, Tanya. 1983. Coreference and bound anaphora: A restatement of the anaphora questions. *Linguistics and Philosophy* 6(1). 47-88. https://doi.org/10.1007/BF00868090

Rigalleau, François., David Caplan & Vanessa Baudiffier. 2004. New arguments in favour of an automatic gender pronominal process. *The Quarterly Journal of Experimental Psychology Section A* 57(5). 893-933. https://doi.org/10.1080/02724980343000549

Ruys, Eddy G. & Yoad Winter. 2011. Quantifier scope in formal linguistics, in Dov M. Gabbay & Franz Guenthner (eds.), *Handbook of Philosophical Logic*, 159–225. Dordrecht: Springer.

Safir, Kenneth J. 2004. *The syntax of anaphora*. Oxford: Oxford University Press.

Sanford, Anthony. J. & Simon C. Garrod. 1989. What, when, and how?: Questions of immediacy in anaphoric reference resolution. Language and Cognitive Processes 4. SI235–SI262. https://doi.org/10.1080/01690968908406369

Sanford, Anthony. J. & Simon C. Garrod. 2005. Memory-based approaches and beyond. *Discourse Processes* 39. 205-224. https://doi.org/10.1080/0163853X.2005.9651680

Staalesen, Pia Dybvik. 2014. *Undersøkelse av nynorsk som hovedmål*; *Rapport 2014-07*. Oslo: Proba samfunnsanalyse.

Van Dyke, Julie A. & Brian McElree. 2006. Retrieval interference in sentence comprehension. *Journal of Memory and Language* 55(2), 157-166. https://doi.org/10.1016/j.jml.2006.03.007

Venås, Kjell. 1993. On the choice between two written standards in Norway. In Ernst H. Jahr (ed.), *Language Conflict and Language Planning*, 263–278. Berlin: Mouton de Gruyter.

Vikør, Lars S. 1995. *The Nordic Languages: Their Status and Interrelations. Nordic Language Secretariat Publication*, no. 14. Oslo: Novus Press.
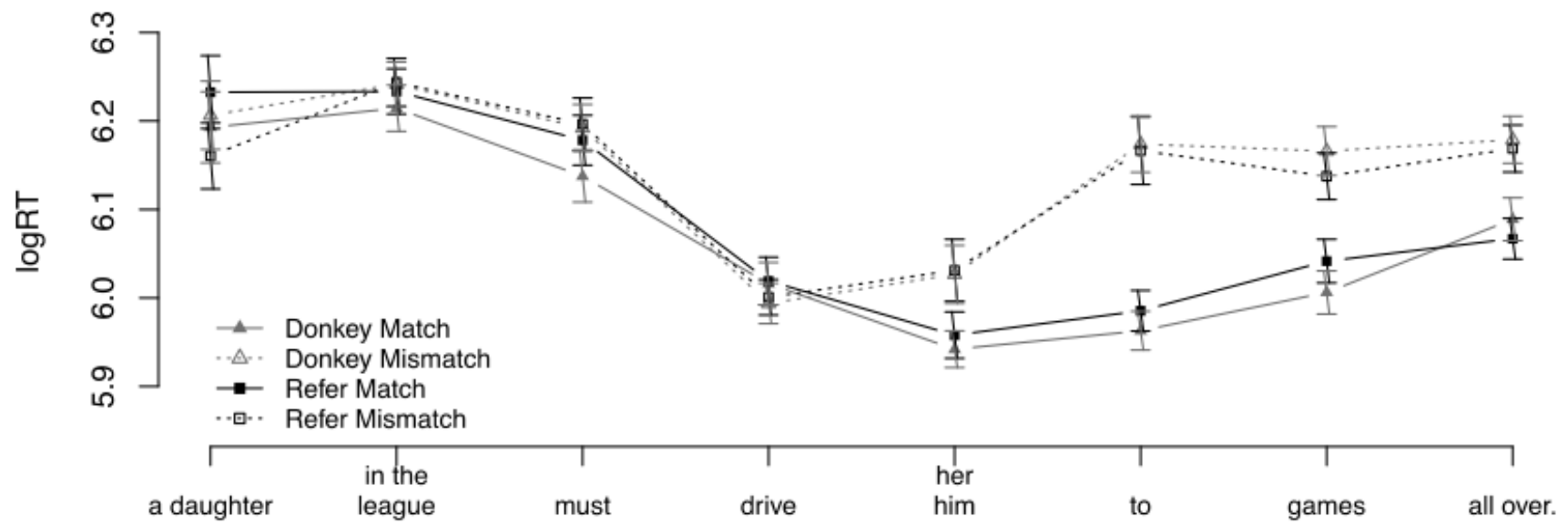
Figure 1. Region-by-region log-transformed reading times beginning from the antecedent NP. Error bars indicate standard errors of the mean.