Processing Reflexives and Pronouns in Picture Noun Phrases

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Abstract

Binding theory (e.g., Chomsky, 1981) has played a central role in both syntactic theory and models of language processing. Its constraints are designed to predict that the referential domains of pronouns and reflexives are nonoverlapping, that is, are complementary; these constraints are also thought to play a role in online reference resolution. The predictions of binding theory and its role in sentence processing were tested in four experiments that monitored participants’ eye movements as they followed spoken instructions to have a doll touch a picture belonging to another doll. The instructions used pronouns and reflexives embedded in picture noun phrases (PNPs) containing possessor phrases (e.g., Pick up Ken. Have Ken touch Harry’s picture of himself). Although the interpretations assigned to pronouns were generally consistent with binding theory, reflexives were frequently assigned interpretations that violated binding theory. In addition, the timing and pattern of eye movements were inconsistent with models of language processing that assume that binding theory acts as an early filter to restrict the referential domain. The interpretations assigned to reflexives in PNPs with possessors suggest that they are binding-theory-exempt logophors, a conclusion that unifies the treatment of reflexives in PNPs.

Keywords: Binding theory; Sentence processing; Reflexives; Pronouns; Early filter; Multiple constraints; Logophors; Picture noun phrases; Eye tracking

1. Introduction

English pronouns (e.g., him) and reflexives (e.g., himself) have a nearly complementary distribution; that is, their referential domains are nearly completely nonoverlapping. This observation has played a central role in syntactic theory since the 1960s when generative linguists began to formulate the structural conditions that now form the basis of current theories of “binding” (e.g., Chomsky, 1980, 1981, 1986, 1995; see Lasnik, 1989, for an overview). By the
late 1960s researchers had recognized that the hierarchical arrangement of phrases in a sentence was relevant to the distribution of pronouns and reflexives (Langacker, 1969; Ross, 1969), and research in the 1970s further clarified these syntactic conditions (Chomsky, 1980; Lasnik, 1976; Reinhart, 1976), leading to the classic binding theory of Chomsky (1981). The binding theory continues to play a prominent role in current syntactic theory, and the patterns of distribution for pronouns and reflexives are used to diagnose and argue for syntactic structure (Belletti & Rizzi, 1988; Chomsky, 1995; Larson, 1988).

Recently, psycholinguists have begun to investigate how readers and listeners integrate the structural constraints described by binding theory as they process sentences with pronouns and reflexives (Badecker & Straub, 2002; Clifton, Kennison, & Albrecht, 1997; Kennison, 2003; Nicol & Swinney, 1989; Sturt, 2003). The binding theory is assumed to correctly characterize structural constraints on the interpretation of pronouns and reflexives. Processing issues are framed as questions about the time course with which these constraints are used with respect to putative stages in reference resolution. For example, are binding theory constraints used at an early stage in processing to circumscribe the initial referential domain? Or, alternatively, are they used to filter potential referents at a later stage in processing?

The research presented here has two goals. The first is to evaluate the assumption that reflexives and pronouns have nonoverlapping referential domains by examining the interpretations that listeners assign to these forms. The second is to investigate which potential referents are considered as the pronoun and reflexives are being processed. We focus on picture noun phrases (PNPs) with possessors (e.g., Harry’s picture of him/himself)—a construction that is generally assumed to be constrained by structural binding theory. We monitored eye movements to a task-relevant visual display as participants followed spoken instructions (Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995); these instructions contained pronouns and reflexives (e.g., Pick up Ken. Have Ken touch Harry’s picture of him/himself). The choices made by participants provide implicit judgments about how the pronouns and reflexives are interpreted. These judgments can be used to evaluate the predictions made by binding theory, which addresses our first goal. The pattern and timing of eye movements to potential referents provide time-course information about which referents are being considered and whether the referential domain varies as a function of the participant’s interpretation. These data provide information about how the structural constraints described by binding theory affect the online processing of reflexives and pronouns, which addresses our second goal.

The data we present demonstrate that whereas the binding theory correctly predicts the interpretation of pronouns in PNPs containing possessors, it is frequently violated for reflexives. Moreover, participants’ choices of referents for reflexives, in conjunction with the overlap in choices of referents for pronouns and reflexives, make it difficult to maintain the standard view that reflexives and pronouns have nonoverlapping referential domains in PNPs containing possessors. This brings into question the claim that these reflexives are subject to binding theory. As an alternative, we propose that all reflexives in PNPs—both those with and those without possessor phrases—are “logophors,” a type of anaphor exempt from binding theory. In addition, we show that binding-theory-incompatible referents are not excluded from consideration early on in reference resolution. We do this by examining the case of pronouns that, unlike reflexives in PNPs with possessors, do appear ultimately to be constrained by binding theory.
This finding has important implications for the theoretical discussion of the role of binding theory constraints in sentence processing.

The remainder of the article is structured as follows: Section 2 reviews the basic facts about binding theory, highlighting evidence from the linguistics literature that calls into question a strict complementarity between reflexives and pronouns and summarizes proposals about how binding theory constraints are used in sentence processing. Section 3 motivates and presents an overview of five eye-tracking experiments that investigate the processing of pronouns and reflexives in sentences with PNPs with possessors. Section 4 presents the methods and results for each of these experiments. Section 5 concludes with a summary and implications.

2. Background

2.1. Binding theory

Any analysis of the constraints on coreference among different types of noun phrases (NPs) must account for the following basic facts: The referential domains for pronouns and reflexives seem to be nonoverlapping, as illustrated in Phrase 1a versus Phrase 1b. This means that pronouns and reflexives in the same structural position will have complementary sets of potential referents, and in particular, a reflexive must find a local antecedent, as in Phrase 2a (Billj, not Johni), but a pronoun cannot have a local antecedent, as in Phrase 2b (Johni, not Billj).

Chomsky’s (1981, 1986) binding theory is probably the best-known approach to accounting for these generalizations. The binding theory states a condition constraining reflexives and a condition constraining pronouns. The reflexive constraint (called Condition A) states that a reflexive must find an antecedent within some local structural domain; the pronoun constraint (Condition B) states that a pronoun must not find an antecedent within that same domain. This connection between the antecedent and a pronoun or reflexive is called binding. The binding theory thus partitions the referential domain into two separate sets of referents available to reflexives and to pronouns. Furthermore, these sets of referents do not overlap. In this way the binding theory can account for the observation that pronouns and reflexives have nonoverlapping referential domains, that is, that they are in complementary distribution.

2.2. Challenges to classic binding theory

Since the earliest days of research on binding there have been certain classes of examples that do not fit the generalizations just noted as accurately as expected. The most famous cases come from examples containing PNPs. PNPs are NPs headed by a “representational” noun, such as picture, photograph, story, opinion, and so on. Superficially, PNPs appear to follow the
basic pattern predicted by the binding theory, as in Phrase 3: Reflexives and pronouns are in complementary distribution, and the presence of a local antecedent is relevant.

3. John, saw [a picture of him / himself].

However, the literature is replete with examples involving reflexives in PNPs that do not find a local antecedent in the expected structural configuration, as in Phrase 4, from Pollard and Sag (1992). All of the binding-theory-violating examples involve a PNP lacking a possessor phrase, in contrast to the examples previously discussed in Phrase 2:

4. John said that there was [a picture of himself] in the post office.

Three facts have led some researchers to argue that reflexives in PNPs lacking a possessor (which we will refer to simply as PNPs) are different from the reflexives discussed in the overview in Phrases 1 and 2. First, as just noted, in examples such as Phrase 4, a reflexive need not find a strictly local antecedent. Examples of this type abound, and also extend to examples in which the antecedent is not even in the same sentence as the reflexive, such as Phrase 5 (also from Pollard & Sag, 1992).

5. John was going to get even with Mary. That picture of himself in the paper would really annoy her, as would the other stunts he had planned.

Second, binding by an antecedent is not always predictable from structural prominence. For example, in the following Phrase 6, a reflexive is bound by a structurally less prominent antecedent, contrary to the predictions of binding theory (Pollard & Sag, 1992).

6. That picture of himself in Newsweek dominated John’s thoughts.

Third, as discussed in detail in Kuno (1987), pragmatic and discourse factors ranging from (among others) “point of view” (compare Phrase 5 with Phrase 7, both from Pollard & Sag, 1994) to “awareness” to “focus” (cf. Phrases 8 and 9, both from Kuno, 1987) are relevant for determining the appropriate antecedent for a reflexive in a PNP.

7. Mary was quite taken aback by the publicity John was receiving. *That picture of himself in the paper would really annoy her, as would the other stunts he had planned.

8. a. John knows that there is a picture of himself in the morning paper.
   b. *John still doesn’t know that there is a picture of himself in the morning paper.

9. a. John didn’t tell MARY that there was a picture of himself in the post office; he told SAM.
   b. *JOHN didn’t tell Mary that there was a picture of himself in the post office; SAM did.

Two prominent approaches have been proposed to account for the behavior of the binding-theory-violating reflexives in PNPs such as the ones seen in Phrases 4 to 9. One of these approaches preserves classic binding theory, but still accounts for the apparent violations within PNPs. The proposal entails that a PNP lacking an overt possessor phrase instead contains a null pronominal possessor (PRO) in the NP (cf. Chomsky, 1986, and more recently, Davies & Dubinsky, 2003). This null PRO, like other pronominal forms, could be the
source of the apparent sensitivity to discourse factors. For example, a sentence such as Phrase 10a would have a structure like that in Phrase 10b, interpreted roughly as shown in Phrase 10c:

10. a. Johni told a story about himselfi.
    b. Johni told [PROi’s story about himselfi].
    c. Johni told hisi story about himselfi.

The reflexive would be locally bound by the PRO in NP, as predicted by binding theory. The null PRO would in turn receive its reference from the discourse, and thus be susceptible to discourse–pragmatic factors, as is typical for pronominals. The virtue of this account is that it treats all reflexives in PNPs alike: They are all structural reflexives, constrained by binding theory to take the (null or overt) possessor as antecedent. We call this the \textit{PRO-in-NP} approach to PNP reflexives.

The second approach has been developed independently by Pollard and Sag, and by Reinhart and Reuland (Pollard & Sag, 1992; Reinhart & Reuland, 1993). In Pollard and Sag’s (1992, 1994) binding theory, the constraint on reflexives (principle A), requires that a reflexive that has a structurally more prominent coargument must be bound by that argument or another more prominent coargument. Crucially, however, a reflexive that lacks a more prominent coargument does not come under the purview of binding theory. Pollard and Sag called these reflexives “binding-theory-exempt anaphors.” They argued that the distribution of these anaphors is constrained by certain pragmatic and discourse factors—such as point of view (building on Kuno, 1987). For example, in an example such as, “Ken saw a snake near him/himself,” the reflexive (the object of the preposition \textit{near}) has no coarguments (the preposition has only the reflexive argument); as such, it is an exempt anaphor. Kuno suggested that the use of a reflexive in this construction is licensed only if the speaker has taken the participant’s point of view; otherwise, the pronoun is used. Pollard and Sag’s claim is that just the reflexives that appear in structural contexts such as this will be binding theory exempt, and instead sensitive to discourse factors such as point of view.

Reinhart and Reuland’s (1993) approach is similar to Pollard and Sag’s (1992, 1994) in that their binding theory is also sensitive to predicate-argument structure. In their view, true reflexives appear in reflexive predicates, which by definition involve two coindexed arguments. Thus, if a predicate does not have two arguments, it cannot be reflexive. Therefore, in cases such as “Ken saw a snake near him/himself,” the reflexive cannot be part of a reflexive predicate because it is the only argument of the preposition \textit{near}. Reinhart and Reuland also argued that such nonreflexivizing reflexives, which they termed logophors, are sensitive to pragmatic and discourse factors. In the work presented here, we follow Reinhart and Reuland’s terminology and refer to binding-exempt reflexives as logophors.\textsuperscript{5}

In both the Pollard and Sag and Reinhart and the Reuland accounts, which we call the logophor approach to PNP reflexives, true argument reflexives (such as those in Phrases 1 and 2) are subject to structural binding theory constraints and, therefore, are in complementary distribution with pronouns. However, reflexives in (simple) PNPs (as in Phrases 4–9) are logophors, and are not strictly sensitive to structure alone. The virtue of this proposal is that the distinction between two types of reflexive allows one to explain the logophoric behavior of reflexives in PNPs (i.e., sensitivity to pragmatic factors thought to be relevant to logophors, such as “point of view” and “awareness” (see Phrases 4–9) and at the same time preserves the struc-
tural conditions that apply to pronouns and reflexives in all other environments (see Phrases 1 and 2). The PRO-in-NP and the logophor approaches differ in the following way: The PRO-in-NP approach treats all reflexives in PNPs—including those with and without a possessor phrase—as structural reflexives constrained by binding theory; in contrast, the logophor approach treats reflexives in PNPs containing a possessor phrase as structural reflexives that are constrained by binding theory, but reflexives in PNPs lacking a possessor are considered logophors and are not constrained by structural binding theory.

Both approaches agree that a reflexive in a PNP containing a possessor (e.g., “Joe’s picture of himself”) is obligatorily bound to that possessor. Furthermore, both approaches attribute this to the binding theory. Indeed, the basic facts of binding within possessed PNPs do seem to be in accordance with this standard assumption: A pronoun must not be bound by the local (possessor) NP, and a reflexive must be bound by that same NP, as in Phrases 11a and 11b (see also, Phrase 2).

11. a. Keni saw Joej’s picture of himi/*j/*k.
   b. Keni saw Joej’s picture of himselfi/*j/*k.

The judgments typically found in the literature are that the pronoun can take as its antecedent the sentence subject (Keni) or some sentence-external antecedent (indicated by the index k), but not the possessor (Joej). The reflexive must take the possessor (Joej) of the PNP as its antecedent; it may not take the subject of the sentence (Keni) or any other antecedent. Thus, according to binding theory, the PNP in (Phrase 11a) could refer to Joe’s picture of Ken or Joe’s picture of somebody else, but crucially may not refer to Joe’s picture of Joe; the PNP in Phrase 11b could refer only to Joe’s picture of Joe, according to binding theory, and not Joe’s picture of Ken or of anyone else.

Despite the fact that binding theory was developed to account for the judgments indicated in Phrases 11a and 11b, examples have occasionally appeared in the literature that would seem to indicate that reflexives in PNPs containing a possessor may not in fact be restricted to taking the possessor of the PNP as antecedent. Kuno (1987) and Reinhart and Reuland (1993) provided Phrases 12 and 13, respectively, noting some speaker variability. In each of these examples, these authors reported that for some speakers it is possible for the reflexive in the PNP to take the subject of the whole sentence as its antecedent, in lieu of the intervening possessor:

12. a. Maryi isn’t interested in anybody’s opinion of herselfi.
   b. ok/*Maryi isn’t interested in John’s opinion of herselfi.
13. */?Luciei liked your picture of herselfi.

In addition, Keller and Asudeh (2001) specifically tested the extent of speaker variability in an online (Web-based) questionnaire using the Magnitude Estimation technique. In their study, they found that participants accepted sentences such as Phrase 14 in which not only could a pronoun in a PNP containing a possessor take the sentence subject as antecedent, but the reflexive could equally as well.

14. Hanna, found Peter’s picture of heri /herselfi.
Again, binding theory predicts nonoverlapping referential domains for reflexives and pronouns, but Keller and Asudeh (2001) found that participants in their study allowed both the pronoun and the reflexive to take the subject of the sentence as antecedent. Although the pronoun reference was in accord with the predictions of binding theory, the reflexive reference consistently violated binding theory.

Finally, we believe that there is an unexpected contrast if binding theory is indeed implicated for reflexives in PNPs containing possessors. It is clear that a true (non-PNP) reflexive cannot be bound by an antecedent outside of its sentence, as illustrated in Phrase 15a. However, there is certainly a contrast between that situation (in Phrase 15a) and one in which the reflexive is bound by the sentence subject outside of a PNP containing a possessor, as in Phrase 15b; although Phrase 15b may be marginal for some, it is much more acceptable than in Phrase 15a.

15. a. *John said that Bill likes himself.
   b. ?John liked Bill’s photograph of himself.

Thus, there is concern that some of the basic judgments that the binding theory was constructed to explain may not represent the full range of data.

It becomes crucial, then, to clarify the data concerning reflexives and pronouns in PNPs containing possessor phrases. If they are indeed in complementary distribution, this would be evidence in favor of an account where binding theory constrains referential interpretation in possessed PNPs. If they are not in complementary distribution (e.g., if the reflexives can consistently take the subject of the sentence instead of the possessor phrase as referent as hinted at in Phrases 12–15), it would call into question both the PRO-in-NP approach and the logophor approach to reflexives in PNPs as they stand. The PRO-in-NP’s account for reflexives in PNPs lacking possessors depends on the claim that reflexives in PNPs containing possessors are constrained by binding theory; if this in fact turns out not to be the case, then any motivation for a null PRO-in-NP is lost. The logophor approach’s account for reflexives in PNPs posits two types of reflexives: the logophors in PNPs lacking a possessor and the structural reflexives constrained by binding theory in PNPs containing possessors. If the latter class of reflexives turns out not to be subject to binding theory constraints, then the logophor approach would have to be re-examined.

The examples in Phrases 12 to 15 suggest a third possible analysis for PNP reflexives—which as far as we are aware has not been proposed before—that all reflexives in PNPs are logophors, those in PNPs lacking a possessor as well as those in PNPs containing a possessor. This proposal would straightforwardly account for the logophor-type behavior of reflexives in PNPs such as those in Phrases 4 to 9. In addition, it would be able to explain the possibility that a reflexive in a PNP containing a possessor may under certain circumstances be able to take an antecedent that is not the local possessor phrase itself. This account would provide a unified analysis of PNP reflexives, treating them all as logophors. We will call this the unified approach to PNP reflexives. It is the unified approach that we suggest is correct. Table 1 outlines the three approaches we are comparing and the roles binding theory and logophors play in each.
Determining the binding facts for reflexives in PNPs containing possessors is crucial to testing the predictions of these three approaches. Furthermore, in cases where reflexives do not act as if constrained by binding theory, it is critical to determine whether they act like logophors.

In the experiments presented here, we investigate the binding of reflexives and pronouns in PNPs containing overt possessor phrases by using a participant’s choice of referents to test the contrasting predictions of these three approaches. We tested whether pronouns and reflexives in PNPs containing a possessor are in complementary distribution and whether a reflexive in a PNP containing a possessor behaved like a logophor.

2.3. Binding theory constraints and sentence processing

The binding theory was developed as a set of structural constraints on the interpretation of pronouns and reflexives. It is not intended to be a theory of how these constraints are used in language processing. However, computational linguists and psycholinguists have generally assumed that the constraints provided by classic binding theory (Chomsky, 1981, 1986) are incorporated into reference resolution. In computational linguistics, this has resulted in algorithms for reference resolution that generally treat binding constraints as “hard” structural constraints restricting the referential domain for pronouns and reflexives (see Hobbs, 1978, for an early approach; and Tetreault, 2001, and Tetreault & Allen, 2004, for more recent accounts; Gordon & Hendrick, 1997, provided experimental evidence for the generalizability of the binding theory). Within the sentence-processing literature, psycholinguists have adopted binding theory as a predefined set of hard constraints. This work generally assumes that reference resolution proceeds in two or more sequential processing stages. Given this assumption, the question becomes At which stage or stages of processing do binding constraints apply? This section outlines this line of research.

One of the first proposals regarding the role of binding theory in sentence processing is the early filter proposal, introduced by Nicol and Swinney (1989). This work reported results from a cross-modal lexical priming study in which participants heard sentences similar to those in Phrase 16. On test trials, a probe that was either an unrelated word or an associate of one of the potential antecedents (the boxer, the doctor, or the swimmer) was presented for lexical decision.

16. a. The boxer told the swimmer that the doctor for the team would blame him [probe] for the recent injury.

b. The boxer told the swimmer that the doctor for the team would blame himself [probe] for the recent injury.
Nicol and Swinney (1989) reported facilitation for words related to the two binding-theory-compatible antecedents, but not for antecedents that would violate binding theory. This pattern of results suggests that on hearing a pronoun or reflexive, only binding-theory-licensed antecedent possibilities are activated. Nicol and Swinney interpreted these results as evidence that binding theory acts as an initial filter on online reference resolution, excluding from consideration potential referents that are not allowed by binding theory.

Clifton et al. (1997) reached a similar conclusion in interpreting the results of a self-paced reading experiment, using sentences such as those in Phrase 17:

17. a. The supervisors paid his assistant to finish typing the manuscript.
   b. The supervisor paid his assistant to finish typing the manuscript.
   c. The supervisors paid him yesterday to finish typing the manuscript.
   d. The supervisor paid him yesterday to finish typing the manuscript.

When the possessive pronoun *his* did not match the number of the subject NP (e.g., Phrase 17a), the immediately following regions showed longer reading times compared to when the possessive pronoun matched the number of the subject NP (e.g., Phrase 17b). Clifton et al. (1997) reasoned that this increase in reading times for mismatching possessives was the result of a failed attempt to establish coreference between the plural subject NP and the singular possessive. If participants attempt to bind the pronoun *him* to the subject NP in Phrases 17c and 17d, a similar mismatch effect between reading times in the postpronoun regions of these two sentences would be expected. However, no such effect was found. This failure to consider the binding-theory-inappropriate subject as an antecedent is precisely the result predicted by the early filter hypothesis. However, a later experiment by Kennison (2003) did not replicate these results.

Badecker and Straub (2002) failed to find support for the early filter hypothesis in a study that combined self-paced reading with a postsentential recognition probe (participants had to indicate whether the word had appeared in the sentence). They varied the number and binding-theory compatibility of antecedents for several different NP types, including pronouns and reflexives, using sentence such as those in Phrases 18 and 19.

18. a. John thought that Bill owed him another opportunity to solve the problem.
   b. John thought that Beth owed him another opportunity to solve the problem.
19. a. Jane thought that Bill owed himself another opportunity to solve the problem.
   b. John thought that Bill owed himself another opportunity to solve the problem.

According to binding theory, of the NPs introduced in the sentence, only the subject of the main clause is a licensed binder for the pronoun, and only the subject of the embedded clause is a licensed binder for the reflexive. Thus manipulations of the embedded subject should have no effect on pronouns, and conversely, manipulations of the matrix subject should have no effect on reflexives. However, for both the pronoun and reflexive conditions, reading times for the region following the pronoun/reflexive were significantly longer when both the subject of the embedded clause and the subject of the sentence were of the same gender. This result is contrary to the predictions of the early filter hypothesis, which would predict that only features relevant to the binding-theory-compatible referents are considered. Thus, Badecker and Straub...
(2002) suggested that multiple constraints—both binding theory constraints and other discourse constraints—must be operative simultaneously.

In response to this series of conflicting results, Sturt (2003) suggested that the confusion surrounding the role of binding theory in sentence processing might be due to methodological problems. He argued that the measures used in the previously mentioned experiments (namely, self-paced reading times and priming–lexical decision tasks) might not have the temporal resolution necessary to truly pinpoint the time frame when binding theory constraints dictate reference choices. To address this concern, Sturt examined participants’ eye movements as they read sentences such as

20. a. Jonathan was pretty worried at the hospital. He remembered that the surgeon had pricked himself with a used syringe needle.
   b. Jennifer was pretty worried at the hospital. She remembered that the surgeon had pricked himself with a used syringe needle.

21. a. Jonathan was pretty worried at the hospital. He remembered that the surgeon had pricked herself with a used syringe needle.
   b. Jennifer was pretty worried at the hospital. She remembered that the surgeon had pricked herself with a used syringe needle.

Sturt took advantage of the fact that eye movements during reading can be divided into “early” measurements, such as first-pass fixation time and first fixations, and “late” measurements, such as second-pass reading times. He found that the measurements associated with early processing reflected differences consistent with binding theory constraints. First fixations and first-pass reading times were longer to the reflexive when the stereotypical gender of the NP “the surgeon” did not match the gender of the reflexive (Phrase 21b). However, a mismatch in gender between the reflexive and the binding-theory-inaccessible subject of the sentence had no effect on these measures. For measures associated with later processing, the gender of the binding-theory-inaccessible subject did have an effect, observable in a significant interaction between the match in gender of the accessible and inaccessible referents. Sturt concluded that these results support a model of processing where binding theory constraints have an immediate influence on referent choice, but at later stages of processing they may be violated in favor of other considerations.

In a self-paced reading time experiment examining the role of binding theory in the processing of pronouns, Kennison (2003) found that the longest reading times for the disambiguating region of sentences such as Phrase 22 were associated with cases where the gender and number of the subject NP matched the gender and number of the direct object pronoun (as in Phrase 22a). Intermediate reading times were associated with disambiguating regions where the subject NP matched the direct object in number but not in gender (as in Phrase 22b), and fast reading times were obtained when the subject NP did not match the direct object in number (Phrase 22c).

22. a. Susan/watched/her/yesterday/during/the open rehearsals/of the/school play.
   b. Carl/watched/her/yesterday/during/the open rehearsals/of the/school play.
   c. They/watched/her/yesterday/during/the open rehearsals/of the/school play.
Kennison (2003) further established that when a salient discourse referent was provided for the direct object pronoun (as in Phrase 23), the matching or mismatching of the subject NP had no effect (see Phrase 24).

23. Lucy complained about having a stomach ache.
24. a. Laura/watched/er/closely throughout/the/day.
   b. Michael/watched/her/closely throughout/the/day.
   c. They/watched/er/closely throughout/the/day.

In light of this pattern of data, Kennison (2003) built on proposals by Sanford, Garrod, and colleagues (e.g., Sanford, Garrod, Lucas, & Henderson, 1983), which posited two stages for anaphora resolution: bonding and resolution. Bonding creates a link between an anaphor (pronoun, reflexive, etc.) and a set of possible candidates. Resolution evaluates each link and either integrates it into the semantic representation or recomputes it if it is found to be implausible. Kennison suggested that in addition, a decision stage should be posited for cases where no link is found or when none of the links can be integrated successfully. At this point, the comprehender continues to process, either inferring an antecedent or maintaining multiple possible interpretations until later context supports one or the other.

According to Kennison (2003), the initial candidate set of possible antecedents is generated, regardless of binding theory compatibility. At the bonding stage, binding theory is used to guide the linking between anaphors and potential antecedents, which are then evaluated at the resolution stage. If a highly salient antecedent is available (as in Phrases 23 and 24), the link is quickly integrated into the semantic representation. If no such antecedent is available (as in Phrase 22), at the later decision stage the comprehender can terminate antecedent search and infer an antecedent. Kennison suggested that the way to compare her results and Sturt’s (2003) results is to divide bonding into an early and late stage. The early bonding stage is guided by binding theory (as indicated by Sturt’s early measures), whereas the later bonding stage may be influenced by other factors (as indicated by Sturt’s late measures). In Kennison’s view we might expect initial violations of binding theory, followed by binding-theory-compatible interpretations during early bonding, possibly then followed by additional binding-theory-incompatible interpretations during late bonding.

In sum then, with the exception of Badecker and Straub (2002), who assume a multiple-constraints view, approaches to the role of binding theory in reference resolution have assumed some form of a multistage model: an early stage involving one set of constraints, followed by later stages involving different or additional constraints. Existing data have been used to argue for binding theory as an early filter (Clifton et al., 1997; Nicol & Swinney, 1989), binding theory as an early but defeasible filter (Sturt, 2003), and binding theory as a set of constraints applying to an initial candidate set during bonding (Kennison, 2003). In addition, (again with the exception of Badecker & Straub, 2002), most research has focused on only one of the two anaphors constrained by binding theory: A study may test either reflexives or pronouns, but rarely both. The behavior of that one type of anaphor is then used to argue for how binding theory in general interacts with sentence processing. Because binding theory ultimately seeks to explain the behavior of both pronouns and reflexives, it would be informative to compare both, using the same structures.
The experiments presented here test both pronouns and reflexives. To examine which potential referents participants consider as they hear each of these forms, we monitored eye movements as participants followed spoken instructions with reflexives and pronouns in PNPs with possessors. Participants were seated in front of a display containing three male dolls (Ken, Joe, and Harry), each with distinct facial features, as illustrated in Fig. 1. Digitized pictures of the dolls’ faces were mounted in a column on a board directly above each individual doll. The participant was told that each doll “owned” the set of pictures directly above him; that is, the three pictures in the column above Joe were Joe’s pictures, and so on. Because every doll has a picture of every other doll above him, the display supports all possible interpretations of the PNPs used in the instructions.

The logic linking eye movements to reference resolution is based on the fact that attentional shifts to objects in the visual field are typically accompanied by a saccadic eye movement. Eye movements can be used to evaluate the time course of reference resolution because when participants hear spoken instructions in task-relevant visual contexts, eye movements to potential referents and objects relevant to establishing reference are closely time-locked to the input (Cooper, 1974; Tanenhaus et al., 1995). The time course of looks to potential referents in the display are closely time-locked to the point in the utterance where the word, phrase, or anaphor denoting the referent is disambiguated (Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000; Chambers, Tanenhaus, Eberhard, Filip, & Carlson, 2002; Eberhard, Spivey-Knowlton, Sedivy, & Tanenhaus, 1995; Hanna, Tanenhaus, & Trueswell, 2003; Jarvikivi, van Gompel, Hyona, & Bertram, 2005). In addition, potential referents are fixated in proportion to the likelihood of that referent being the intended target of the spoken materials (Allopenna, Magnuson, & Tanenhaus, 1998). Thus, the proportion of looks to potential referents during the moments when the pronoun or reflexive is being heard can be used to infer the likelihood that the listener was considering that referent. The timing and pattern of looks to potential referents provide information about which alternative referents were considered as well as when they were considered. More specifically, we can determine if participants consider potential referents that are inconsistent with those that are sanctioned by binding theory. If unsanctioned referents are considered, we can determine whether they are considered relatively late in processing as predicted (for example) by Sturt’s two-stage model, or early in processing as predicted by multiple-constraints models. We can also use interpretation-contingent analyses to examine the ear-
liest moments of processing for a particular interpretation to determine whether potential referents were considered on trials in which participants did or did not perform actions consistent with classic binding theory. For example, it is possible that participants rarely consider binding-theory-incompatible referents on those trials where they chose a binding-theory-compatible referent. This result would be compatible with early filter models because it would suggest that looks to binding-theory-incompatible referents could reflect performance errors in applying binding theory constraints. In contrast, looks to binding-theory-inappropriate referents on trials in which the binding-theory-appropriate referent was chosen would be problematic for models in which binding theory constraints are used to filter out inappropriate referents.

3. Overview of experiments

In the experiments we present here, participants’ eye movements are monitored as they follow instructions containing pronouns and reflexives in PNPs. This paradigm provides two types of data: choice of referent and fixations to potential referents. Participants’ choices reveal the referent they assigned to a pronoun or a reflexive in a PNP. These data can be used to evaluate whether participants’ interpretations conform to predictions made by different versions of binding theory. Participants’ eye movements can be used to infer which potential referents were considered as they heard the pronoun and reflexive. These data can in turn be used to evaluate hypotheses about the time course with which the binding theory constraints are used in real-time reference resolution.

Experiment 1 sought to validate this methodology using sentences with reflexives and pronouns where the predictions of classic binding theory are clear and uncontroversial. The results of Experiment 1 confirmed that this methodology can be used to further test the predictions of binding theory. Experiment 2 explored the claim that the possessor (e.g., “Ken”) in a PNP such as “Ken’s picture of himself” is obligatorily the antecedent of the reflexive and excluded as a potential referent of a pronoun. The results of this experiment called into question the standard assumption that the referential domains for the two anaphors are nonoverlapping. In addition, the pattern and timing of eye movements was inconsistent with claims that binding theory is used as an early filter. From the earliest moments of processing, binding-theory-compatible and incompatible referents were under consideration. Experiment 3 addressed the possibility that the form of the instructions (which were recorded by one of the experimenters) might have somehow biased the results against binding theory. Therefore Experiment 3 replicated Experiment 2 using instructions generated by naive participants who read the instruction after seeing the (binding-theory-compatible) action that the instruction was intended to elicit. Experiment 3 also focused in more detail on pronouns to address the early filter hypothesis under conditions where binding theory constraints hold. Even with pronouns that otherwise appear to be constrained by binding theory, participants made early fixations to binding-theory-incompatible potential antecedents. The results of Experiments 2 and 3 together suggest that reflexives in PNPs containing possessors are logophors that are not subject to binding theory. Experiment 4 presented a preliminary test of this hypothesis by examining reflexives in constructions involving ellipses. The results suggest that reflexives in PNPs
containing possessors can behave like coreferential anaphora, a characteristic thought to hold for logophors but not for structural reflexives.

4. Experiments

4.1. Experiment 1

Experiment 1 was conducted to establish that the basic binding facts gathered from standard native-speaker judgments could be replicated as participant choices within our experimental paradigm.

Participants were seated in front of the display illustrated in Fig. 1. The participant was told that each doll “owned” the set of pictures directly above him; that is, the three pictures in the column above Joe were Joe’s pictures, the three pictures above Ken were Ken’s, and so on. Each trial contained two types of sentence: a lead-in phrase in which the participant was told to look at one of the dolls (e.g., “Look at Ken”), followed by an action sentence in which the participant was instructed to have that doll or another doll touch one of the dolls or a picture of one of the dolls. The action sentence contained either a pronoun or a reflexive. Experiment 1A used simple NPs. Experiment 1B used PNPs without possessors.

The predictions of binding theory are clear-cut. For pronouns, participants should have the doll performing the action touch the doll mentioned in the lead-in sentence. For reflexives, participants should have the doll touch (a picture of) himself.

4.1.1. Method

4.1.2. Experiment 1A

4.1.2.1. Participants. Participants were 19 members of the University of Rochester community, all of whom were native speakers of English; one participant’s results were excluded (see Section 4.1.4). They received $7.50 in compensation.

4.1.2.2. Materials. Participants heard two instructions. The “lead-in” instructed them to look at one of the dolls; the “action” sentence told them to have one of the dolls touch something. In this experiment, the action sentence contained the verb touch, and the direct object was either a pronoun or a reflexive NP (see Table 2 for full set of materials).


4.1.2.3. Procedure. Three versions of each instruction were constructed, varying which of the three dolls was mentioned in the lead-in and action sentences, giving a total of 6 trials. Experiment 1A and Experiment 2 (see Subsection 4.2) were conducted together; that is, along with the 6 experimental trials of Experiment 1A; 24 other instructions involving the pictures of the dolls were included (the experimental trials of Experiment 2). In addition, there were 30 filler trials containing full NPs in place of the pronouns and reflexives, for a total of 60 trials.
The instructions were counterbalanced and organized into three blocks. In addition, placement of the dolls on the table was randomized so that each order was equally represented across all of the participants.

4.1.3. Experiment 1B

4.1.3.1. Participants. Participants were 16 members of the University of Rochester community; two participants’ results were excluded (see Subsection 4.1.4).

4.1.3.2. Materials. The materials were similar to those used in Experiment 1A, except that the pronoun or reflexive occurred within a PNP (see Table 3 for full set of materials).


4.1.3.3. Procedure. Three versions of each instruction were constructed using the same procedure as in Experiment 1A, resulting in a total of 6 trials. Experiment 1B and Experiment 1 of Runner, Sussman, and Tanenhaus (2003) were conducted together; thus, in addition to the 6 experimental trials for Experiment 1A, there were an additional 24 instructions of a different syntactic form (the experimental trials for Experiment 1 of Runner et al., 2003), for a total of 30 trials (see Table 3). The materials and display were counterbalanced as in Experiment 1A.

Instructions were recorded using neutral prosody and no unusual pitch accents or stress on the pronouns and reflexives; they were then digitized for presentation using PsyScope experimental-control software (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants were first familiarized with the dolls and the display by following instructions containing full NPs. They performed the task by picking up the relevant doll and using it to touch a picture or a doll. A head-mounted eye tracker (ISCAN EC-501 [ISCAN Inc., Burlington, Massachusetts]) for Experiment 1A and ASL Series 5000 for Experiment 1B [Applied Science Laboratories, Bedford, Massachusetts]) was used to monitor eye movements. The system software superim-

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Experiment 1A sample materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lead-In Phrase(s)</td>
</tr>
<tr>
<td>Experiment 1A</td>
<td>Look at Joe.</td>
</tr>
<tr>
<td>Experiment 2 trials</td>
<td>Look at Joe. Pick up Ken.</td>
</tr>
<tr>
<td>Fillers</td>
<td>Look at Joe. Pick up Ken.</td>
</tr>
</tbody>
</table>

(see Table 2).
posed the fixations on a video recorded from a scene camera mounted on the tracker headband. A VCR recorded the instructions and scene for analysis (Sony DSR-30 digital editing for Experiment 1A, Sony Hi8 EVO-9650 for Experiment 1B [Sony Corporation, New York, New York]).

4.1.4. Results and discussion

The data were coded manually by the experimenters and trained research assistants. One participant’s data in Experiment 1A and two participants’ data in Experiment 1B were discarded because they made 30% or more responses incompatible with the instructions (e.g., picking up the wrong doll). Because the primary goal of Experiments 1A and 1B was to see whether participant choices would reflect standard judgments, we report only target-choice data. Participants’ target choices showed the pattern of complementary distribution predicted by binding theory, with pronouns taking a nonlocal antecedent and reflexives taking a local antecedent. For Experiment 1A, on 100% of the pronoun trials, participants chose the lead-in as the target, whereas on 100% of the reflexive trials, they chose the subject of the sentence as the target. For Experiment 1B, on 95.2% of the pronoun trials, participants chose a picture of the lead-in as the target, whereas they chose a picture of the subject as the referent on 97.6% of the reflexive trials. A 2 × 2 analysis of variance (ANOVA), with Anaphor type (pronoun or reflexive) and proportion of Binding-theory-compatible responses as independent factors, showed a main effect of compatibility for both Experiment 1A, $F(1, 17) = 1633.22$, mean square error $[\text{MSE}] = 16.37$, $p < .01$, and Experiment 1B, $F(1, 13) = 1071.12$, $\text{MSE} = 12.07$, $p < .01$, and no interaction with type of Anaphor, $F < 1.0$ for both experiments. The goal of these two initial experiments was to confirm that the action-based tasks used here can be used to replicate judgment data on binding. Our results do just this. In these clearly unambiguous contexts the final target choices are identical to the standard binding judgments.

4.2. Experiment 2

4.2.1. Background

This experiment tested the predictions of binding theory for PNPs containing possessors (e.g., “Harry’s picture of him/himself”). As outlined in Subsection 2.2, most versions of binding theory (e.g., Chomsky, 1981, 1986; Pollard & Sag, 1992; Reinhart & Reuland, 1993) predict that a PNP containing a possessor creates a domain for binding in which a reflexive must find an antecedent and a pronoun must not. However, as pointed out previously, there have been some hints in the literature that the data may not completely conform to these predictions (Keller & Asudeh, 2001; Kuno, 1987, pp. 168–169; Reinhart & Reuland, 1993, p. 683); in some cases it appeared that the reflexive could take an NP other than the possessor as its antecedent. A confirmation of these observations would call into question both the PRO-in-NP approach and the logophor approach to reflexives in PNPs. Recall that the PRO-in-NP’s account for reflexives in PNPs lacking possessors depends on the claim that reflexives in PNPs containing possessors are constrained by binding theory; if that turns out not to be the case, then any motivation for the null PRO-in-NP is lost. The logophor approach’s account for reflexives in PNPs is that there are two types of reflexives: the logophors in PNPs lacking a possessor and the structural reflexives constrained by binding theory in PNPs containing possessors. If the
latter assumption turns out to be false, then the dual approach to reflexives would have to be re-examined.

Further, if the results of this experiment confirm that a reflexive in a PNP containing a possessor can take an antecedent other than the possessor, a new analysis of such reflexives will be needed, because virtually all accounts assume these reflexives are subject to standard binding theory. We outlined such a unified account at the end of Subsection 2.2. On this account, all reflexives in PNPs—both those with and those lacking possessors—would be treated as logophors.

The first goal of this experiment was to test the differing predictions of these three approaches to PNP reflexives. Because participants’ final target choice indicates how they interpreted the anaphor, we can examine the interpretations assigned to reflexives and pronouns in PNPs containing possessors. With an instruction such as “Have Joe touch Harry’s picture of him,” the binding theory predicts that participants should use the doll performing the action (Joe, in this example) to touch either the picture of Joe or the picture of Ken above Harry, but never the picture of Harry. If instead the instruction was “Have Joe touch Harry’s picture of himself,” the binding theory predicts that participants should choose Harry’s picture of Harry as the correct referent.

The second goal of this experiment was to use the pattern and timing of eye movements to the pictures as the pronoun and the reflexive unfold to determine which potential referents participants were considering. The early filter model predicts that participants should only consider binding-theory-compatible referents. In contrast the early but defeasible filter predicts that participants may consider binding-theory-incompatible referents later in processing. The multiple-constraints model predicts fixations to both binding-theory-compatible and binding-theory-incompatible referents.

The eye-movement paradigm allows for strong tests of these models because in addition to examining the time course of looks across conditions, we can provide interpretation-contingent analyses based on the action the participant performed. For example, consider a case where binding theory might be violated if a participant chose the subject as the referent for the reflexive. A model such as Sturt’s (2003) defeasible filter model would still be consistent with this result, as long as participants initially considered a picture of the possessor as a potential referent for reflexive, or if looks to the binding-theory-incompatible referent were delayed compared to looks to the binding-theory-compatible referent. However, the defeasible filter model would not be supported if participants’ early looks were to binding-theory-incompatible referents, regardless of whether their action was compatible or incompatible with binding theory.

The target choice data and some of the time-course data from this experiment were presented in Runner et al. (2003). In this article, we summarize those data and then provide more detailed data and analyses relevant to the questions we are pursuing here. The study presented sequences of three instructions as illustrated in

27.  a. Look at Ken.
    b. Pick up Joe.
    c. Have Joe touch Harry’s picture of him/himself.

The action sentence, illustrated in Phrase 27c, instructed the participant to use one of the dolls (the subject) to touch one of the possessor’s pictures. The “look at” lead-in, illustrated in
Phrase 27a, instructed the participant to look at one of the dolls. The “pick up” lead-in was included to make sure that the participant would be holding the action doll when the anaphor was encountered. In Experiment 1 of Runner et al. (2003) we found that during the action instruction, for example, “Have Harry touch Ken’s picture of himself,” participants were still reaching for the doll at the onset of the anaphor, resulting in delayed looks to potential referents of the anaphor.

Finally, we manipulated the order of the pickup and look at instructions. Order of mention influences the degree to which a particular discourse entity will be considered as an antecedent of a pronoun (for review, see Garnham, 2001). The reason for this manipulation was that Runner, et al. (2003) found that for instruction sequences such as “Look at Ken. Have Harry touch Joe’s picture of him/himself,” participants chose the subject (Joe’s picture of Harry) about 25% of the time for both pronouns and reflexives. That choice for reflexives violates binding theory. Moreover, the fact that the same referent was chosen so frequently for reflexives and pronouns would seem to call into question the assumption that the referential domains for pronouns and reflexives are nonoverlapping (complementary). Thus, one question the Runner et al. (2003) experiment was designed to answer was how “linked” the conditions on reflexive and on pronoun binding are. The lead-in order manipulation was expected to affect the pronoun binding; at issue was whether it would also affect the reflexive binding.

4.2.2. Method

4.2.2.1. Participants. This experiment included the same set of participants as Experiment 1A.

4.2.2.2. Materials. Participants heard two lead-in instructions: one telling them to look at a doll and the other telling them to pick up a doll. This was followed by an action sentence instructing them to have one of the dolls touch another doll’s picture of him or himself. Two variables were manipulated: anaphor type (pronoun or reflexive) and lead-in order (whether the lead-in containing the doll referring to the subject came first or second). Table 4 illustrates the lead-in conditions. Note that the name of the doll doing the action is underlined. In the subject-first condition, the doll doing the action (the subject of the action sentence) is mentioned in the first lead-in; in the subject-second condition, it is mentioned in the second lead-in (see Table 5 for full set of materials).

4.2.2.3. Procedure. Instructions and displays were constructed and counterbalanced as in Experiment 1. As discussed previously, Experiment 2 and Experiment 1A were conducted together, so in addition to the 24 experimental trials for Experiment 2, participants were pre-

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lead-In 1</th>
<th>Lead-In 2</th>
<th>Action Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1st</td>
<td>Pick up Joe.</td>
<td>Look at Ken.</td>
<td>Have Joe touch Harry’s picture of him/himself.</td>
</tr>
<tr>
<td>Subject 2nd</td>
<td>Look at Ken.</td>
<td>Pick up Joe.</td>
<td>Have Joe touch Harry’s picture of him/himself.</td>
</tr>
</tbody>
</table>
sented with the 6 experimental trials of Experiment 1A, as well as 30 filler trials containing sentences of a similar structure (see Table 5). All other aspects of the procedure were identical to that of Experiment 1A.

4.2.3. Results and discussion

4.2.3.1. Target choice analyses. As Fig. 2 illustrates, on pronoun trials participants chose the relevant picture of the subject or lead-in 88.9% of the time, whereas on reflexive trials they chose the possessor only 68.9% of the time, resulting in a main effect of binding theory compatibility, $F(1, 17) = 75.54$, $MSE = 6.02$, $p < .01$. Crucially, however, there was an interaction with type of anaphor, $F(1, 17) = 9.08$, $MSE = .72$, $p < .01$, which reflected the fact that reflexives violated binding theory more often than pronouns. An analysis of the total proportion of looks to the appropriate pictures of the mentioned referents also yielded a main effect of bind-
ing theory compatibility, $F(1, 17) = 8.83, MSE = .15, p < .01$, and an interaction with type of anaphor, $F(1, 17) = 39.63, MSE = .68, p < .01$; see Runner et al., 2003, for further details).

These results show that binding-theory-incompatible referents are frequently chosen for reflexives. In addition, the assumption about complementary referential domains for pronouns and reflexives is not confirmed in this construction: Pronouns appear to be constrained by binding theory, whereas reflexives do not.

These results are informative for another reason as well. We outlined two approaches to PNP reflexives previously mentioned: the PRO-in-NP analysis and the logophor analysis. The PRO-in-NP analysis assumes that the reflexive in a PNP lacking an overt possessor gets its reference from a null PRO within the PNP. The main motivation for that approach was the assumption that reflexives in PNP obligatorily took the possessor as antecedent. The results of this experiment (which replicate the results of Experiment 1 in Runner et al., 2003) show that this assumption is false: A reflexive in a PNP containing a possessor is not constrained to take the possessor as antecedent. Without this assumption in place the PRO-in-NP hypothesis is not a motivated account of the binding-theory-violating behavior of reflexives in PNPs without possessors.

In addition, although Pollard and Sag (1992) and Reinhart and Reuland (1993) argued that reflexives in simple PNPs (without possessors) are exempt from structural binding theory—that is, that they are logophoric reflexives—both sets of researchers assume that reflexives in PNPs containing possessors are constrained by structural binding theory and as such are expected to take the possessor as obligatory antecedent. Our results here (and those of Runner et al., 2003, Experiment 1) show that their assumption is incorrect as well.

In place of these approaches we pursue the unified approach outlined in Subsection 2.2. This account posits that all reflexives in PNPs—with possessors and without—are logophoric reflexives. In a later experiment (Experiment 4) we provide some preliminary evidence in favor of this unified approach to PNP reflexives.

### 4.2.3.2. Fixation analyses

We turn now to an analysis of the time course of looks to the binding-theory-compatible and binding-theory-incompatible referents. Although the eye-movement data are primarily relevant to processing models, our experiment presents one set of circumstances where they might bear on linguistic formulations of binding theory. Here, pronoun target choice was consistent with binding theory, whereas reflexive target choice violated binding theory by allowing the subject of the sentence to bind the reflexive within the PNP containing a possessor. Nevertheless, it may still be possible to maintain the complementarity assumption of the binding theory if reference resolution is a two-stage process, with a first stage constrained or “filtered” by binding theory (cf. Clifton et al., 1997; Nicol & Swinney, 1989; Sturt, 2003), followed by a second stage taking into account pragmatic–discourse constraints. Support for such a model would come from evidence that the possessor is initially considered as the main or only potential referent for the reflexive. Such evidence would include increased or earlier looks to the picture of the possessor when compared to the picture of the subject.

Fig. 3 shows the proportion of fixations to pictures of the lead-in, the subject, and the possessor for reflexives overall. Note that the proportions of looks do not add up to 1.0 because we are graphing only looks to these three pictures. Looks to the other pictures in the display and
looks to the dolls were included in the calculation of the proportions but are not graphed. The figure reveals tight time-locking between the onset of the reflexive and looks to potential antecedents. Crucially, there is no hint of an early point in processing where looks to the possessor were more numerous than looks to the subject, as would be expected if the constraints on binding (as defined by classical binding theory) were operating as an early first-stage filter.

For analysis, we isolated a region beginning 300 msec after the onset of the anaphor and ending 1,000 msec after the onset of the anaphor. We chose this region because although 200 msec is the earliest point at which one observes signal-driven fixations that are time-locked to an unfolding word (which is consistent with the 150 to 200 msec it takes to program and launch an eye movement), previous studies have found that fixations to targets consistent with the input rarely diverge from unrelated competitors until 300 msec after the onset of the relevant word (see Allopenna et al., 1998; Dahan & Tanenhaus, 2004, 2005). The proportions of looks while in this region to the picture of the lead-in, the subject, and the possessor on all conditions presented in Table 6.

Beginning with the overall reflexives data, the proportion of looks was .15 to the picture of the possessor, .11 to the picture of the subject, and .08 to the picture of the lead-in. One-tailed t tests revealed that the proportion of looks to the possessor was not different from the proportion of looks to the subject, \( t(16) = 1.54, p > .07 \), and that both of those proportions were higher than the proportion of looks to the lead-in, \( t(16) = 2.53, p < .02 \), and \( t(16) = 1.73, p = .05 \), respectively.\(^7\) In this early region of anaphor-processing, participants are considering both the binding-theory-compatible possessor and binding-theory-incompatible subject dolls.

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Fig. 3. Proportion of fixations to appropriate pictures of lead-in, subject, and possessor on reflexive condition in Experiment 2.

![Figure 3](chart.png)
Figs. 4 and 5 show the proportion of fixations to pictures of the lead-in, the subject, and the possessor for reflexives in the subject-first and subject-second lead-in conditions, respectively. These figures reveal the same overall pattern (see Table 6 for early region proportions). From the earliest moments, participants are considering the picture of the binding-theory-compatible possessor as well as the binding-theory-incompatible subject doll. Note that fixations to the subject persist after fixations to the lead-in have begun to drop off, as would be expected if the subject was being considered as a potential referent.

The strongest evidence against the two-stage model comes from trials in which participants chose the binding-theory-compatible referent: the picture of the possessor. As Fig. 6 shows, the pattern is virtually identical to the pattern found in the other figures; participants consider the picture of the subject from the earliest moments of processing. Given that in these trials participants will ultimately choose the binding-theory-compatible picture, there would be no

<table>
<thead>
<tr>
<th>Picture</th>
<th>Overall Pronoun</th>
<th>Overall Reflexive</th>
<th>Subject First Pronoun</th>
<th>Subject First Reflexive</th>
<th>Subject Second Pronoun</th>
<th>Subject Second Reflexive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead-in</td>
<td>0.12</td>
<td>0.08</td>
<td>0.15</td>
<td>0.06</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Subject</td>
<td>0.21</td>
<td>0.11</td>
<td>0.15</td>
<td>0.08</td>
<td>0.28</td>
<td>0.13</td>
</tr>
<tr>
<td>Possessor</td>
<td>0.14</td>
<td>0.15</td>
<td>0.11</td>
<td>0.11</td>
<td>0.17</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Figs. 4 and 5 show the proportion of fixations to pictures of the lead-in, the subject, and the possessor for reflexives in the subject-first and subject-second lead-in conditions, respectively. These figures reveal the same overall pattern (see Table 6 for early region proportions). From the earliest moments, participants are considering the picture of the binding-theory-compatible possessor as well as the binding-theory-incompatible subject doll. Note that fixations to the subject persist after fixations to the lead-in have begun to drop off, as would be expected if the subject was being considered as a potential referent.

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Fig. 5. Proportion of fixations to appropriate pictures of lead-in, subject, and possessor on subject-second reflexive condition in Experiment 2.

Fig. 6. Proportion of fixations to appropriate pictures of lead-in, subject, and possessor in reflexive trials in which possessor is target, collapsed over lead-in order in Experiment 2.
reason that so many early looks should be devoted to the binding-theory-incompatible option if binding theory constraints were acting as an early filter.

The pattern and timing of fixations on the reflexive conditions is inconsistent with the early filter account of binding theory. From the earliest moments of processing both binding-theory-compatible and binding-theory-incompatible referents are being considered as potential antecedents for the reflexive.

The target choice results suggested that pronouns in PNP s with possessors were constrained by binding theory but reflexives were not, resulting in a breakdown in complementarity between the two. Neither the PRO-in-NP nor the logophor approach accounts for these results. Thus, we pursue the unified approach, in which all reflexives in PNP s are logophors. This would explain the lack of complementary distribution with pronouns, the target choices, and the early looks to both the picture of the possessor and the picture of the subject. Evidence in favor of this interpretation of the reflexive results is provided in Experiment 4.

If this unified approach is correct, then fixation data for reflexives do not actually bear on the question of when binding theory applies during sentence processing, because by hypothesis binding theory does not constrain reflexives in PNP s. However, the pronouns in this construction do seem to be constrained by binding theory; the final target choices are overwhelmingly consistent with binding theory. Thus, the time course of looks in the pronoun conditions should reveal the online role of binding theory constraints, at least for pronouns.

Fig. 7 is the time-course graph for the overall pronoun conditions. The graph indicates that from the earliest moments of processing, participants are considering both the picture of the lead-in and that of the subject, as predicted by binding theory. However, it is evident that partic-

![Fig. 7. Proportion of fixations to appropriate pictures of lead-in, subject, and possessor on pronoun condition in Experiment 2.](image-url)
Participants are also considering the picture of the possessor—the one picture binding theory should “filter” out, according to the early filter and two-stage models.

For analysis, we again isolated an early region (300–1,000 msec after the onset of the pronoun). In that region the overall average proportion of looks was .21 to the picture of the subject, .12 to the picture of the lead-in, and .14 to the picture of the possessor (see Table 6). One-tailed t tests revealed that the proportion of looks to the subject was higher than the proportion of looks to the possessor, \( t(16) = -1.99, p < .04 \), but that the proportion of looks to the lead-in and to the possessor were not different, \( t(16) = -.82, p > .2 \). In this early region of anaphor processing, although participants are more likely to consider the picture of the binding-theory-compatible subject than either of the other pictures, they are equally likely to consider the picture of the binding-theory-compatible lead-in and the binding-theory-incompatible possessor.

As pointed out in Runner et al. (2003), there was a strong effect of the lead-in manipulation on pronoun interpretation so it is important to look at the time-course data for the pronouns in the different lead-in conditions. Figs. 8 and 9 present the time-course graphs for the pronoun conditions on the subject-first and subject-second conditions, respectively.

We again examine the region (300–1,000 msec after the onset of the pronoun) for analysis. In the subject-first condition the proportion of looks was .15 to the picture of the subject and to the lead-in, and .11 to the picture of the possessor (see Table 6). One-tailed t tests showed that the proportion of looks to the binding-theory-compatible subject and binding-theory-compatible lead-in did not differ from each other or from the proportion of looks to the binding-theory-incompatible possessor, \( t(16) = -.86, p > .2 \), and \( t(16) = -.75, p > .2 \). Thus, in the

![Fig. 8. Proportion of fixations to appropriate pictures of lead-in, subject, and possessor on subject-first pronoun condition in Experiment 2.](image-url)
subject-first condition the early looks do not favor the binding-theory-compatible referents over the binding-theory-incompatible one. One potential concern is that looks to the possessor begin to rise in the 200 msec after the onset of the pronoun. Thus these results need to be interpreted with caution because they might not reflect processes triggered by the processing of the pronoun.

In the subject-second condition the proportion of looks was .28 to the picture of the subject, .09 to the picture of the lead-in, and .17 to the picture of the possessor. One-tailed t tests showed that although the proportion of looks to the picture of the subject was higher than the proportion of looks to the picture of the possessor, t(16) = –2.37, p < .02, the proportion of looks to the picture of the possessor was higher than that of looks to the picture of the lead-in, t(16) = 2.04, p < .03. On the subject-second condition, then, the earliest looks favor the binding-theory-compatible subject, but the binding-theory-incompatible possessor is favored over the binding-theory-compatible lead-in. In this condition, looks to the possessor continue long after looks to the preferred referent have begun to increase. Thus we can safely attribute these fixations to processing after the pronoun has been recognized.

Another possible explanation for increased early looks to the subject on reflexive trials is that participants initially parsed himself as him. As noted previously, the lead-in manipulation in Experiment 2 affected the pronouns much more strongly than the reflexives. In Runner et al. (2003) we showed that within the first 400 msec after the onset of the anaphor, the pronouns were already exhibiting the effects of the lead-in manipulation. No such effects were found with the reflexives, demonstrating that participants did indeed correctly parse them as reflexives, not initially as pronouns. This is consistent with other recent studies that show that in ut-

Fig. 9. Proportion of fixations to appropriate pictures of lead-in, subject, and possessor on subject-second pronoun condition in Experiment 2.
terance-final position listeners are able to distinguish between Moreover, in utterance-final po-

Moreover, in utterance-final position, listeners are able to distinguish between potentially embedded words and potential carrier words, such as *ham* and *hamster* and *him* and *himself*, before the end of the vowel in a monosyllabic word (Salverda, Dahan, & McQueen, 2003). Moreover, these effects are most robust in utterance-final position, which is where the pronouns and reflexives occurred in these experiments (Crosswhite, Masharov, McDonough, & Tanenhaus, under revision; Salverda et al., 2005). In visual world studies of word recognition, the likelihood of a fixation to a potential referent often begins to increase as early as 200 msec after evidence for its name increases, resulting in fixations that are generated before traditional recognition points (for discussion of the linking assumptions that map activation onto fixations, see Allopenna et al., 1998; Dahan, Magnuson, & Tanenhaus, 2001; Dahan, Magnuson, Tanenhaus, & Hogan, 2002; Magnuson, Tanenhaus, Aslin, & Dahan, 2003; Tanenhaus, Magnuson, Dahan, & Chambers, 2000). Thus, in these studies, fixations beginning 300 msec or so after the onset of the pronoun or reflexive are likely to reflect the influence of the anaphor.

Because of the lead-in manipulation in this experiment, the doll referring to the subject and the doll referring to the lead-in were both mentioned in the instructions, possibly accounting for increased looks to the appropriate pictures of those dolls. Because both dolls are binding-theory-compatible antecedents, the increased looks to binding-theory-compatible referents may have been divided between the two pictures. Therefore the proportion of looks to the picture of the possessor may seem to have increased when in fact the looks to these two pictures actually decreased. In addition, there is no baseline against which to compare the proportion of looks to the picture of the possessor, to determine that it was indeed increased. Such a baseline could be used to test more specifically the predictions of the early filter and two-stage models. That model would predict that the earliest looks to the picture of the possessor should not differ from those to the baseline picture, whereas looks to the binding-theory-compatible target (the picture of the mentioned doll) should be increased. If, on the other hand, the earliest looks to the picture of the possessor and to the picture of the mentioned doll did not differ from each another, but did differ from the earliest looks to the baseline, this would provide evidence against the two-stage model. Experiment 3 was designed in part to provide such a baseline and to further test these predictions.

4.3. Experiment 3

Experiment 3 was designed with two goals in mind. One was to test the predictions of the early filter and two-stage hypotheses. This was done by simplifying the instructions of the experiment to provide a baseline against which the earliest looks to the pictures of the possessor and of the subject could be compared. If binding theory constraints are acting as an initial filter on reference resolution, then in the pronoun conditions the earliest looks to the picture of the subject should be increased when compared to the earliest looks to the picture of the possessor, and the looks to the picture of the possessor should not differ from those to the baseline picture. However, if the earliest looks to the pictures of the possessor and of the subject do not differ from each other, but do differ from the baseline, this will provide evidence against the binding theory as initial filter hypothesis.

The second goal was to address a potential methodological artifact present in Experiment 2. Care was taken to record the instructions with as neutral intonation as possible—in particular,
with no contrastive stress on the anaphors. Nonetheless, it is difficult to rule out the possibility that some subtle aspect of the pronunciation of the instructions might have encouraged the binding theory violations found on the reflexive conditions. To address this concern we had three different naive speakers record the instructions used in this experiment. In particular, we biased their pronunciation in favor of binding-theory-compatible choices by telling the speakers that they were recording the instructions for an experiment in which we wanted the participants to perform a certain action, which the experimenter would model. The action modeled was always the one consistent with the binding-theory-appropriate interpretation. We expected that if features of the pronunciation of the instructions had induced the violations of binding theory observed in the previous experiments, then those violations should be neutralized in this experiment, which instead should introduce biases in favor of binding-theory-compatible interpretations. On the other hand, if features of the pronunciation had less of a crucial role in the target choices observed in the previous experiments, we should find a similar pattern of target choices in this experiment.

By not including manipulations of discourse, the materials of Experiment 3 also allow for further investigation of the claim that binding theory constraints act as an early filter on referent selection. The results of Experiment 2 have already established that binding theory does not constrain early looks to potential referents for reflexives in PNPs. However, because the discourse manipulation of Experiment 2 required that all three potential referents be mentioned within the instruction, the same claim could not be conclusively made for pronouns in PNPs. To establish that binding theory constraints were not acting as an early filter, we would need to show that the binding-theory-incompatible referent (here, the possessor of the PNP) received the same number of early looks as did binding-theory-sanctioned referent choices. Because referent selection for pronouns is known to be extremely sensitive to the previous mention of entities in the discourse (see, e.g., Arnold et al., 2000), we would expect that our Experiment 2 materials (instructions of the type, “Pick up Joe. Look at Ken. Have Joe touch Harry’s picture of him”) should yield two likely binding-theory-compatible choices for the pronoun (Joe and Ken). Furthermore, as both are likely referents, we would expect to see competition in the form of early eye movements being split between these two choices. This competition would mean that each binding-theory-compatible picture received a smaller number of looks than might normally be expected on the basis of its binding theory compatibility. Although this in itself is not problematic, it does raise concerns about the appropriate comparison for evaluating early looks to the binding-theory-incompatible referent. That is, if the binding-theory-incompatible referent received the same number of early looks as the binding-theory-compatible referents, it could be for either of two reasons: (a) Binding theory constraints do not act as an early filter, and the possessor (in the example previously mentioned) is initially being considered as a possible referent for the pronoun; or alternatively (b) due to competition, the binding-theory-compatible referents are each receiving abnormally small proportions of early looks, which artificially makes them seem as if they are being considered to the same degree as referents that are not possible antecedents of the pronoun, but are nonetheless receiving a certain small number of random looks (i.e., Harry).

Because the materials of Experiment 3 mention only two of the three potential referents for the pronoun, and of these, only one is binding-theory-compatible, we are now afforded a viable comparison for the evaluation of looks to the binding-theory-incompatible choice. If binding theory
constraints are acting as an early filter for pronouns in PNPs, there should be a similar number of early looks to the picture of the possessor of the PNP and looks to the picture of the unmentioned doll. If binding theory constraints are not acting as an early filter, and the possessor of the PNP is being considered as a possible referent for the pronoun, there should be a similar number of early looks to the picture of the possessor and the picture of the binding-theory-compatible referent (here, the doll performing the action of the instruction [the subject doll]).

Three naive speakers were recruited from the University of Rochester community to record the materials that would be used in Experiment 3. The speakers were unaware of the results of Experiment 2. They were also naive with respect to binding theory and the predictions binding theory makes for reflexives in PNPs.

The speakers were given a printed list of all materials that would be used in Experiment 3. They were informed that they would be recording materials to be used in an upcoming experiment and that their job was to read each material in such a way as to elicit a certain behavioral response. Before the speakers read each item, the experimenter would model the desired behavioral response. In all experimental cases, the experimenter performed only the binding-theory-compatible response. That is, for the item, “Pick up Joe. Have Joe touch Ken’s picture of himself,” the experimenter would pick up the doll Joe, and then using the doll, touch Ken’s picture of Ken. The speakers were free to ask the experimenter to repeat the action as many times as they felt necessary. Once the speakers understood the desired action, they were instructed to read the experimental material in the way that they felt best matched that action and would be most likely to elicit that action when played for a third party. The experimenter digitally recorded their rendition of the instruction. If the speakers were not satisfied with their performance for any reason, they were allowed to request a “do-over,” and their previous reading was discarded.

By using naive speakers who were explicitly instructed to produce forms that would elicit binding-theory-compatible responses, we generated materials with prosodic features that do not support or encourage violations of binding theory. If anything, the prosody of these materials should be biased in favor of binding-theory-compatible responses. If the pattern of more binding theory violations for reflexives than pronouns holds under these conditions, we can conclude that binding theory violations of this sort are a general feature of reflexives in PNPs containing possessors.

4.3.1. Method

4.3.1.1. Naive speakers. Three naive speakers were recruited from the University of Rochester community to record the materials that would be used in Experiment 3. They were paid $7.50 for their participation.

4.3.1.2. Participants. Twenty-four members of the University of Rochester community participated in this experiment and were paid $7.50.

4.3.1.3. Materials. As in Experiment 2, all items begin with a lead-in phrase instructing the participant to pick up the doll that will serve as the subject of the main instruction. This ensures that at the point where the critical material is heard, the participant will already have the correct
doll in hand, which allows for a close time-locking between spoken materials and eye movements to the display of pictures (see Table 7 for full set of materials).

4.3.1.4. Procedure. Four versions of each instruction type were constructed for a total of 16 experimental items. In addition, 16 filler materials were included in the experiment. Filler materials were of the same basic form as experimental materials, but included neither pronouns nor reflexives (see Table 7). Other features of the procedure were identical to that of Experiments 1A and 2.

4.3.2. Results and discussion

4.3.2.1. Target choice analyses. The results replicated the basic pattern found in the previous experiments: for pronouns, on 94% of trials participants chose the subject of the sentence as antecedent for the pronoun, whereas on only 6% of trials participants chose the possessor. For reflexives, on 82% of trials participants chose the possessor as antecedent, whereas they chose the subject of the sentence as antecedent on 18% of trials. An ANOVA revealed a main effect of Binding theory compatibility, $F(1, 23) = 152.36$, $MSE = 13.85$, $p < .01$, and a marginal interaction with Anaphor type, $F(1, 23) = 3.59$, $MSE = .4$, $p = .07$. Thus, as in the previous experiments, the target choices for pronouns conformed to binding theory better than the target choice for reflexives. Although the absence of a reliable interaction weakens this claim somewhat, recall that the three speakers read the instructions with the intention of biasing the binding-theory-compatible action. Thus the instructions are biased against binding-theory-incompatible interpretations. Despite this bias, participants still frequently chose the binding-theory-incompatible target on reflexive trials.

4.3.2.2. Fixation analyses. Fig. 10 illustrates the patterns of fixations on the reflexive trials. The basic pattern found here mirrors that of Experiment 2: From the earliest moments participants are considering both the picture of the binding-theory-compatible possessor and that of the binding-theory-incompatible subject. The picture of the third doll in the same column receives relatively few fixations. The average proportion of looks to the other pictures in the display is also included for comparison. The proportions of looks to the pictures of the subject and the possessor have clearly separated by about 300 msec after the onset of the reflexive. Because it takes up to 200 msec to program an eye movement, the separation begins about 100 msec into the reflexive itself. As we discussed earlier, this is when information from the vowel will have already begun to disambiguate the anaphor as a pronoun or a reflexive.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lead-In</th>
<th>Action Sentence</th>
<th>Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflexive</td>
<td>Pick up Joe.</td>
<td>Have Joe touch Ken’s picture of himself.</td>
<td>8</td>
</tr>
<tr>
<td>Pronoun</td>
<td>Pick up Joe.</td>
<td>Have Joe touch Ken’s picture of him.</td>
<td>8</td>
</tr>
<tr>
<td>Filler</td>
<td>Pick up Joe.</td>
<td>Have Joe touch Ken’s picture of Harry.</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 7

Experiment 3 sample materials
Fig. 11 illustrates the pattern of fixations for the pronoun trials. During the earliest moments participants consider the picture of the binding-theory-compatible subject doll as well as the binding-theory-incompatible possessor doll. The picture of the third doll in the same column receives relatively fewer fixations.

To test the initial filter hypothesis for pronouns, we isolated an early window from 300 to 1,000 msec after the onset of the anaphor and compared the proportions of fixations to the various pictures in the display during time spent in that region, averaged over all of the participants. As Fig. 12 illustrates, 26% of looks were to the relevant picture of the subject, and 25% of looks were to the relevant picture of the possessor; in addition, 17% of looks were to the relevant picture of the third doll in the same column. There was no difference between the proportion of looks to the subject and the proportion of looks to the possessor (\( p > .4 \)), but both differed from the proportion of looks to the picture of the third doll (\( p < .03 \), and \( p < .01 \), respectively). This result is inconsistent with the initial filter hypothesis, which would predict instead that the proportion of looks to the picture of the subject should be higher than the proportion of looks to the picture of the possessor; furthermore, the proportion of looks to the picture of the possessor should not differ from the proportion of looks to the picture of the third doll. Looks to the possessor diverge from looks to the third picture about 300 msec after the onset of the pronoun, as would be expected if the possessor is being considered as a potential referent.

To rule out the possibility that participants simply looked more frequently at pictures of the overtly mentioned possessor, we compared the proportion of looks to the other pictures of the
Fig. 11. Proportion of looks to appropriate pictures of subject, of possessor, of third unmentioned doll, and to other pictures in display on pronoun condition in Experiment 3.

Fig. 12. Percentage of looks to pictures during first 1,000 msec of pronoun condition in Experiment 3.
possessor doll to the proportion of looks to the other pictures outside the possessor’s column in the display (see Fig. 12 again). Looks to these other two pictures of the possessor were at 3% and 4%, which did not differ from the proportion of looks to the other pictures (averaged), which was 3% ($p > .3$, and $p > .1$, respectively).9

The previous analyses looked at a 700-msec window beginning at 300 msec after the onset of the pronoun. In this window there was no difference in the proportion of fixations to the picture of the binding-theory-compatible subject and the binding-theory-incompatible possessor. As inspection of Fig. 11 shows, there is no hint that this effect is carried primarily by looks that occur late in the window. Nonetheless, we further divided this 700-msec window into two 350-msec windows. If a two-stage process is in effect, we might expect that in the early window the fixations would be consistent with the binding theory constraints, that is, few looks to the binding-theory-incompatible possessor and more looks to the binding-theory-compatible subject. In the later window, which on the early filter view might reflect a second stage of processing, we would expect the fixations to mirror the later stages of processing, at which time more looks to the picture of the binding-theory-incompatible possessor might be evident. Thus, this analysis would predict a main effect of picture fixated (different proportions of fixations to different pictures), but crucially we would expect an interaction between picture fixated and window, with the early window looks being more consistent with the binding theory constraints than the late window. Table 8 shows the proportions of looks to the picture of the subject, possessor, and other during these two windows. A 2 × 3 ANOVA with two factors, Window (early vs. late) and Picture (picture of subject, possessor, or third doll), showed a marginal main effect of Picture, $F(2, 46) = 3.02, MSE = .11, p < .06$; there was no main effect of Window ($p = .38$). But crucially, there was no interaction between Picture and Window ($p = .28$). As pointed out, an interaction would have supported the two-stage processing model. The lack of interaction, thus, fails to support the two-stage model.

Another important comparison is between looks to the picture of the possessor and looks to the third unrelated picture, we performed a further 2 × 2 ANOVA with two factors, Window (early vs. late) and Picture (picture of possessor vs. picture of third doll). Again, the early filter view would be one that supported an interaction between picture fixated and window, with looks to the possessor being lower in the early window and increasing in the later window and looks to the third doll remaining relatively stable. However, this ANOVA showed a main effect of Picture, $F(1, 23) = 5.04, MSE = .15, p < .04$, but again, no interaction between Picture and Window ($p = .79$).

Another possible explanation for the increased looks to the possessor comes from the fact that in every instruction, when participants first heard the anaphor, they had just heard the

<table>
<thead>
<tr>
<th>Picture</th>
<th>Early Window</th>
<th>Late Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>0.22</td>
<td>0.28</td>
</tr>
<tr>
<td>Possessor</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>Third doll</td>
<td>0.17</td>
<td>0.16</td>
</tr>
</tbody>
</table>
name of the possessor (e.g., Have Joe touch Ken’s picture of him). If the recent mention of Ken encouraged the hearer to fixate on the picture of Ken within the correct column (the column of pictures above the doll Ken), then this could explain the increase in looks to the possessor. The claim of this explanation would be that the increased looks to the picture of the possessor were due to the prior mention of the possessor doll and that the anaphor itself was not driving the increase of fixations to the picture of the possessor. If this is correct, then looks to the possessor should be increased even before the onset of the anaphor. However, if the increase in looks to the picture of the possessor was driven by the anaphor itself, then the increase should take place after the mention of the anaphor.

To test the prior mention hypothesis we divided the first 1,000 msec after the onset of the anaphor into three points: the onset “0,” 500 msec and 1,000 msec after the onset. If the prior mention of the possessor drove the increase in looks to the picture of the possessor, then the proportion of looks to that picture should remain relatively flat for all three points. If it was the mention of the anaphor that drove the increase in looks to the picture of the possessor, then the proportion of looks to that picture should be lower at the start of the anaphor and should increase after the onset of the anaphor.10

Fig. 13 illustrates the proportions of looks to the picture of the possessor at the onset of the anaphor (“0”), 500 msec after the onset, and 1,000 msec after the onset. We plotted the data from both the pronoun and the reflexive trials for comparison. An ANOVA with two factors, Anaphor type (pronoun and reflexive) and Time (0 msec, 500 msec, and 1,000 msec after anaphor), revealed a main effect of Time, $F(1, 23) = 11.6, MSE = 0.37, p < .0001$, and an interaction between Anaphor type and Time, $F(2, 46) = 6.98, MSE = 0.25, p < .003$. Planned com-

Fig. 13. Proportion of looks to appropriate picture of possessor at onset (“0”), at 500 msec after onset, and at 1,000 msec after onset of anaphor in Experiment 3.
parisons showed that the difference in the proportion of looks at the onset of the anaphor and at 500 msec after the onset was significant \((p < .009)\). Thus, at the onset of the anaphor looks to the picture of the possessor were lower than they were 500 msec after the onset of the anaphor for both the pronoun and the reflexive conditions. This suggests that the anaphors themselves were the triggers for the increased looks to the picture of the possessor. In addition, at the later point (1,000 msec) we see that the two conditions diverged, with looks to the picture of the possessor continuing to increase in the reflexive condition and starting to decrease in the pronoun condition, already beginning to mirror the final target choices.

Another way to ensure that the relevant looks were triggered by the anaphor itself and not by the prior mention of the possessor is to look at only new fixations launched after the onset of the anaphor. This removes any lingering effects of looks launched because of the prior mention of the possessor. Figs. 14 and 15 present these new-look data for the reflexive and pronoun conditions, respectively. The figures show an increase in looks to both the binding-theory-compatible and binding-theory-incompatible referents after the onset of the anaphor in both the reflexive condition and the pronoun condition compared to looks to the third picture.

The results of this experiment support two conclusions. First, reflexives in PNPs in general are not restricted to taking the possessor of the NP as antecedent, even when the prosody of the sentence is intended to encourage such binding. Second, the initial filter hypothesis, which predicts that from the very earliest moments of reference resolution only binding-theory-compatible antecedents should be under consideration, is not consistent with the data reported here.

![Graph](image-url)  
**Fig. 14.** Proportion of new looks to appropriate picture of subject, of third picture in same column, and of possessor launched after onset of anaphor in reflexive condition in Experiment 3.
The results of this experiment combined with the results of Experiment 2 strongly suggest that reflexives in PNPs containing possessors are not constrained by binding theory. They are not in complementary distribution with pronouns in that context; in addition to selecting the possessor of the PNP, they can also take the subject of the sentence as antecedent, contra binding theory. These facts strongly argue against the PRO-in-NP approach to reflexives in PNPs. That approach was based on the assumption that all PNPs contained a possessor phrase, either overt or covert. Because reflexives in that type of NP were assumed obligatorily to take the possessor as antecedent, as required by binding theory, the null NP would provide a principled means of attaining the observed reference pattern. However, because our results show that even in PNPs containing an overt possessor the reflexive need not take it as antecedent strongly suggests that binding theory is not constraining reflexives in this construction, and it is no longer justified to posit a null pronoun to preserve the integrity of binding theory with respect to PNPs.

In addition, our results argue against the logophor approach as proposed by Pollard and Sag (1992) and Reinhart and Reuland (1993). That approach assumes a bifurcation of reflexives in PNPs: Those in PNPs lacking a possessor are logophors; those in PNPs containing a possessor are structural reflexives constrained by binding theory. Our results suggest that the latter assumption is incorrect.

We take our results to provide initial support to what we called the unified approach, outlined previously in Subsection 2.2. On that account, all reflexives in PNPs—both those with and without possessor phrases—are logophors and, thus, not subject to binding theory. The
unified approach can straightforwardly account for the data from the literature suggesting that reflexives in PNPs lacking a possessor phrase are logophors (cf. Phrases 4–9); it can also account for the data collected in Experiments 2 and 3, in which a reflexive in a PNP containing a possessor is able to take the sentence subject as antecedent. Further evidence that the unified approach is correct would come from further data suggesting that reflexives in PNPs are logophors. Experiment 4 was designed as an initial test of this hypothesis.

4.4. Experiment 4

This experiment investigates two hypotheses about the reflexives in PNPs containing a possessor. It is clear from the results of our previous experiments that binding theory as it stands does not constrain the reflexives in PNPs containing a possessor. However, one could abandon the claim that the complementary distribution of pronouns and reflexives is the hallmark of binding theory and assume that binding theory places separate unlinked constraints on pronouns and reflexives. On this view, which we will call the structural view, the reflexives in possessed PNPs are structurally constrained anaphors whose referential domain is the whole sentence, not just the possessed NP (Kiparsky, 2002, discussed such a view; see also Bresnan, 2001, and Dalrymple, 2001). We contrast this view with the unified approach mentioned previously and in Subsection 2.2. On the unified view, reflexives in possessed PNPs are not constrained by binding theory, but rather are logophors and are not sensitive to the structural constraints of the binding theory. Because both hypotheses reject the complementarity assumption for pronouns and reflexives in PNPs containing possessors, they both provide potential analyses for the results of the previous experiments.

These two approaches differ, however, in their predictions for aspects of the behavior of reflexives in PNPs. On the structural view, reflexives in PNPs containing possessor phrases should behave like other structural reflexives in all relevant respects. On the unified view these reflexives should behave like other logophors. One difference between structural reflexives and logophors is discussed by Reinhart and Reuland (1993) and Grodzinsky and Reinhart (1993): They have suggested that pronouns and logophors can be interpreted as both bound variable and “coreferential” anaphora, whereas true structural reflexives can be interpreted only as bound variables. This distinction, then, can provide a testing ground for our reflexives in possessed PNPs. If they are structural reflexives, then only a bound variable interpretation should be available to them; if they are logophors, then both bound variable and coreferential interpretations should be available.

The ellipsis construction is often used to illustrate the distinction between bound variable and coreferential interpretations. Consider the following examples (based on Grodzinsky & Reinhart, 1993, p. 74; Reinhart & Reuland, 1993, p. 674):

28. a. Alfred thinks he is a great cook, and Felix does [e], too.
   b. Lucie praised herself, and Lili did [e], too.
   c. Lucie liked the picture of herself, and Lili did [e], too.

The pronoun example in Phrase 28a is ambiguous. The bound variable interpretation can be paraphrased as, “Alfredx thinks that x is a great cook, and Fearya thinks that y is a great cook,
too.” The coreferential interpretation can be paraphrased as, “Alfred \(_x\) thinks that \(x\) is a great cook, and Felix \(_y\) thinks that \(x\) is a great cook, too.” The bound variable reading is consistent with a situation in which Alfred thinks that Alfred is a great cook, and Felix thinks that Felix is a great cook. The coreferential interpretation is consistent with a situation in which both Alfred and Felix think that Alfred is a great cook.

However, Phrase 28b does not seem to be similarly ambiguous. This sentence can be paraphrased as, “Lucie \(_x\) praised \(x\) and Lili \(_y\) praised \(y\), too.” This is the bound variable interpretation. It does not seem to have an interpretation paraphrased as, “Lucie \(_x\) praised \(x\) and Lili \(_y\) praised \(x\), too,” which represents the coreferential interpretation. The first reading might arise in a situation in which Lucie is happy about work that she (Lucie) has done, and Lili is happy about work that she (Lili) has done. Each woman is praising herself, and crucially, Lili is not praising Lucie. The second reading would require the possibility that both Lucie and Lili are pleased with Lucie’s work and are praising her. This second situation is not judged to be consistent with this sentence.

What is of interest here is the fact that the reflexive in a sentence such as Phrase 28c seems to be ambiguous in a way similar to the pronoun examples. It can have a bound variable reading such as, “Lucie \(_x\) liked the picture of \(x\), and Lili \(_y\) liked the picture of \(y\),” or a coreferential reading such as, “Lucie \(_x\) liked the picture of \(x\), and Lili \(_y\) liked the picture of \(x\), too.” The bound variable interpretation is compatible with a context in which Lucie and Lili each liked her own self-portrait; whereas the coreferential interpretation is compatible with a context in which both Lucie and Lili like the picture of Lucie.\(^{11}\)

The readings available for a reflexive in a PNP lacking a possessor—both the bound variable and coreferential readings—differ from those available for the true structural reflexive, which allows only the bound variable interpretation. Thus, the ellipsis construction seems to be a plausible testing ground for the nature of the reflexive in a PNP containing a possessor. Experiment 4 uses NP ellipsis to test the reflexives in PNPs containing a possessor to determine the range of interpretations available to them. The structural view of these reflexives will be supported by evidence that they receive only a bound variable interpretation. The unified view will be supported by evidence that they can also receive a coreferential interpretation.\(^{12}\)

Participants in Experiment 4 listened to a sequence of three instructions: The first two were identical to the instructions from Experiment 3, with one “pick up” lead-in phrase, followed by an action sentence. The third instruction contained a second action sentence that had either a full PNP with a possessor, or an elided one.

   b. Now have Joe touch Harry’s <picture of him/himself>.
we will call the A-clause possessor (or A-possessor). Of particular interest, then, is whether participants choose Harry’s picture of Ken in Phrase 29b.

4.4.1. Method

4.4.1.1. Participants. Participants were 19 members of the University of Rochester community, all native speakers of English, participating in the study for $7.50 in compensation.

4.4.1.2. Materials. The two variables manipulated in this experiment were anaphor type (reflexive or pronoun) and ellipsis (ellipsis or no ellipsis). The participants first heard an instruction to pick up the doll that would do the action (the subject of the action sentences). This was followed by an instruction such as Phrase 30 or 31. Again, note that the brackets indicate the material that is left out on the no-ellipsis condition (see Table 9 for full set of materials).

30. Pronoun Condition: pronoun in both PNPs
   a. Have Joe touch Ken’s picture of him.
   b. Now have Joe touch Harry’s <picture of him>.

31. Reflexive Condition: reflexive in both PNPs
   a. Have Joe touch Ken’s picture of himself.
   b. Now have Joe touch Harry’s <picture of himself>.

4.4.1.3. Procedure. Each participant heard each instruction type four times. In addition, 16 fillers of a similar structure but containing only full NPs (no pronouns or reflexives) were used. This made a total of 32 trials (see Table 9). The instructions and displays were constructed and counterbalanced as in the previous experiments. Other aspects of the procedure were identical to those of the previous experiments.

4.4.2. Results and discussion

The same data analysis procedure was used as in the previous experiments. Overall, on pronoun trials participants chose the appropriate picture of the subject on 83% of trials and the picture of the possessor on 12% of trials; on another 5% of trials they chose some other picture. On reflexive trials participants chose the appropriate picture of the possessor on 78% of trials and the picture of the subject on 18% of trials; on an additional 3% of trials they chose a different picture. Overall, then, binding theory is violated on about 12% of pronoun trials and about 21% of reflexive trials. These results again replicate the basic pattern found in Experiments 2 and 3.

Table 9
Experiment 4 sample materials

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lead-In + Clause A</th>
<th>Clause B</th>
<th>Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Look at Joe. + Have Joe touch Ken’s picture of him/himself.</td>
<td>Now have Joe touch Harry’s &lt;picture of him/himself&gt;</td>
<td>16</td>
</tr>
<tr>
<td>Fillers</td>
<td>Look at Joe. + Have Joe touch Ken’s picture of Harry.</td>
<td>Now Have Ken touch Harry’s picture of Joe/Ken.</td>
<td>16</td>
</tr>
</tbody>
</table>
Our main question concerns the behavior of the reflexive in the ellipsis construction. Thus, the remainder of our analyses will focus on these conditions. Overall, on reflexive ellipsis conditions, participants chose the picture of the possessor on 68% of trials and chose the subject on 22% of trials. The crucial target choice, where participants chose the antecedent clause’s possessor occurred on 5% of trials (see Fig. 16).

Although the number of trials where the possessor from the antecedent clause was chosen is small, we will try to tease apart whether this proportion of trials is greater than would be expected by chance if the logophor view were incorrect. First, if we compare the proportion of trials where the A-clause possessor is chosen as the target in the reflexive ellipsis condition with the proportion of trials in which that same picture was chosen in the reflexive no-ellipsis condition, the difference is significant, $F(1, 19) = 8.58, MSE = .02, p < .01$. In light of the low variance in the data in the no-ellipsis condition, we also did a nonparametric analysis of this comparison; a Wilcoxon signed-rank test confirmed that these proportions are different, $T(5) = 1.2, p < .05$. Thus, we can conclude that the coreferential interpretation does become available with NP ellipsis (see Fig. 17).

A second comparison we can make is between the target choices for the A clauses compared to the B clauses on the ellipsis condition. How often participants choose the “third picture” (not the picture of the subject or of the possessor) serves as a baseline. That is, two of the three pictures in the appropriate column—the picture of the subject and the picture of the possessor—are appropriate antecedents for the reflexive, given the results of the previous experiments. The third picture then can provide a baseline because it will virtually never be the target choice except by accident. On the ellipsis trials, however, the same third picture corresponds to the A-clause antecedent, which according to the logophor hypothesis is a potential referent for the
elided reflexive. Thus, comparing the proportion of trials in which the third picture is “accidentally” targeted in the A-clause trials with the proportion of trials in which that third picture is targeted in the B-clause ellipsis trials will indicate the degree to which the A-clause antecedent picture is targeted due to the ellipsis condition itself. Again, although participants choose the “third picture” in the B clause of the ellipsis condition on 5% of trials (i.e., the A-clause possessor), they never choose the “third picture” in the A clauses.

To summarize, participants interpreting B clauses do choose the A clause’s possessor in the reflexive ellipsis condition. Although the number of trials is small, it does not seem to be due simply to chance. Participants choose the A-clause possessor in the ellipsis condition more than in the no-ellipsis condition; by the same token, they choose this picture more than the comparable picture in the A clause. These results provide preliminary support for the proposal that reflexives in possessed PNP are logophoric reflexives. This proposal then serves to unify the treatment of PNP reflexives: They are all logophoric reflexives regardless of the presence of a possessor phrase.13

5. Summary, conclusions, and implications

5.1. Summary

Binding theory has played a central role in syntactic theory since the 1960s and continues to be used to diagnose and argue for syntactic representations. Binding theory constraints are also
believed to guide reference assignment in language comprehension. However, there have been suggestions in the linguistics literature that the central tenet of binding theory, complementarity between pronouns and reflexives, might not hold under all conditions, especially for PNPs, a construction that has featured prominently in arguments about syntactic representation. Assessing the scope and seriousness of these apparent violations of binding theory has been difficult because many of the judgments for the relevant structures are context dependent and vary both within and between speakers. Given the importance of binding theory for theoretical linguistics and binding theory constraints for models of language processing, we explored an experimental approach in which participants’ eye movements were monitored as they performed actions that required assigning a referent to a pronoun or a reflexive in a PNP. For the experiments, each of three dolls, Ken, Joe, and Harry, was seated in front of an array containing that doll’s pictures of the dolls. Participants were instructed to use one of the dolls to touch another doll’s picture of the dolls. Participants were instructed to use one of the dolls to touch another doll’s picture of him or himself (e.g., Have Harry touch Ken’s picture of him/himself).

Experiment 1 was conducted to validate the task. Participants heard instructions such as “Look at Joe. Have Ken touch (a picture of) him/himself.” Participants’ behavior followed the patterns predicted by classic binding theory, with participants nearly always interpreting the reflexive as referring to the local subject of the sentence containing the anaphor and the pronoun as referring to a nonlocal antecedent.

Experiment 2 introduced action instructions containing a pronoun or a reflexive in a PNP with a local NP—the possessor phrase (Have Joe touch Harry’s picture of him/himself). One instruction asked the participant to pick up a doll (e.g., Pick up Joe). The other instruction asked the participant to look at another doll (e.g., Look at Ken). Binding theory was violated more often for reflexives than for pronouns. The eye movements showed that looks to the binding-theory-incompatible referent (the possessor’s picture of the subject) occurred as early as looks to the binding-theory-compatible referent (the possessor’s picture of the possessor). Moreover, even when participants performed the binding-theory-compatible action, they looked at the possessor’s picture of the subject more often than the picture of the third doll.

Experiment 3 used instruction pairs in which the action instruction followed a pickup instruction. Naïve participants generated the instructions. These participants first saw the binding-theory-compatible action and then recorded the instruction so that another participant would perform the modeled action. Reflexive trials again resulted in more binding-theory-incompatible actions than did pronoun trials, replicating the main results from Experiment 2. Looks to potential referents for both reflexives and pronouns showed early consideration of binding-theory-incompatible referents, even when the action was binding-theory appropriate.

We began this article by outlining two primary goals. The first was to evaluate predictions of the two dominant approaches to PNP reflexives. The PRO-in-NP approach assumes that reflexives in PNPs are all constrained by binding theory; PNPs lacking overt possessors are assumed to contain a null PRO to which the reflexive is bound. The logophor approach assumes that reflexives in PNPs lacking possessors are logophors; the reflexives in PNPs containing possessors are structural reflexives constrained by binding theory. The results of Experiments 2 and 3 suggest that neither of these approaches is correct. We showed that reflexives in PNPs containing possessors are not in complementary distribution with pronouns, undermining the
claim that they are constrained by binding theory. In particular, these reflexives violate binding theory by being able to take the sentence subject, and not the possessor of the PNP, as their antecedent. The PRO-in-NP approach is built on the claim that all reflexives in PNPs are constrained by binding theory, which we have shown is incorrect. Without that fact in place, the motivation for the PRO-in-NP approach is lost. The logophor approach assumes a bifurcation of reflexives in PNPs: Those in NPs without possessors are logophors, whereas those in NPs with possessors are structural reflexives. We have shown that the latter claim is not correct.

We called the approach we pursued the unified approach. We argued that all reflexives in PNPs—both those lacking and those containing possessor phrases—are logophors. This approach straightforwardly explains the original data motivating the logophor approach for PNPs lacking possessors. It also explains the data from our Experiments 2 and 3, which show that even the reflexives in PNPs containing possessors do not follow binding theory.

Experiment 4 provided preliminary support for the hypothesis that reflexives in PNPs containing possessors are logophors. Trials contained a sequence of three instructions. The first was an instruction to pick up a doll (e.g., Pick up Joe). The second instruction had that doll perform an action to touch the possessor’s picture of him or himself (e.g., Have Joe touch Ken’s picture of him/himself). The third instruction had that same doll touch another possessor’s picture. The third instruction ended with NP ellipsis or a PNP with either a reflexive or a pronoun (e.g., Now have Joe touch Harry’s <picture of him/himself>). Crucially, participants adopted the coreferential interpretation of the elided NP more often than chance. Thus, the elided reflexives were able to receive bound variable and coreferential interpretations, a characteristic of logophors and not structural reflexives.

The second goal of the experiments presented here was to evaluate proposals about how the constraints described by classic binding theory are used in real-time reference resolution. In particular, we used the pattern of fixations to potential referents over time to determine whether early in processing fixations are restricted to binding-theory-compatible referents. For reflexives, we found that, during the earliest moments of reference resolution, participants considered both binding-theory-compatible and binding-theory-incompatible referents, as predicted by the PRO-in-NP approach and the logophor approach. Moreover, this pattern of results also obtained when we restricted our analysis to just those trials for which the action indicated that participants arrived at the binding-theory-consistent interpretation. However, because the overall pattern of target choices for reflexives frequently violates binding theory, the data for reflexives would be fully compatible with a model in which binding theory constraints are used as an early filter, but those constraints do not apply to reflexives. In contrast, because the pronouns in PNPs containing possessors did behave as if constrained by binding theory, we were able to investigate different proposals in the sentence-processing literature about the interaction of binding theory constraints and online reference resolution. We did this by examining the patterns and timing of fixations during reference resolution on pronoun trials. Our data, especially those of Experiment 3, clearly showed that both binding-theory-compatible and binding-theory-incompatible referents were considered by comprehenders from the very earliest moments of processing. This result is inconsistent with the early filter hypothesis, which claims that the initial set of candidate referents is constrained by binding theory. Even when smaller windows that might correspond to early and late stages of processing were considered separately, fixations to binding-theory-incompatible referents were evident during both windows.
5.2. Conclusions and implications

These results support three major conclusions. The first conclusion is that current binding theory does not provide a satisfactory account of the interpretation of reflexives in PNPs with possessors, as binding theory is frequently violated for these reflexives. Moreover, the antecedents of reflexives in PNPs with possessors are not in complementary distribution with those of pronouns, contrary to the prediction of binding theory. A second, and more tentative, conclusion is that reflexives in PNPs with possessors appear to behave as logophors rather than as structural reflexives, as evidenced by the fact that they appear to allow coreferential interpretations in NP-elided constructions. We consider this conclusion to be tentative because the evidence for coreferential interpretations comes from only a small proportion of trials. Thus it will be important to replicate and extend this finding in future research. The third conclusion is that binding theory constraints do not seem to be used as an all-or-none filter during the earliest moments of processing that restricts the set of potential referents. Binding-theory-incompatible referents were considered early on in processing for both reflexives and for pronouns. The results from pronouns are particularly problematic for the early filter hypothesis because pronouns generally behaved as predicted by binding theory. The view that binding theory constraints are used to filter potential referents at a later stage in processing will also not account for the data for reflexives because participants consistently chose some binding-theory-incompatible referents. However, we cannot rule out a late filter hypothesis for the pronouns, as there are early looks to binding-theory-incompatible referents, but these referents are rarely chosen. We should also note that our data are not necessarily incompatible with early filter models, if the domain of those models is restricted to argument reflexives and excludes reflexives and pronouns in PNPs.

These results have several major implications. First, our demonstration that reflexives in PNPs with possessors are logophors unifies the treatment of reflexives in PNPs. The unified analysis we provide extends the proposals of Pollard and Sag (1992) and Reinhart and Reuland (1993), which were originally limited to reflexives in PNPs without possessors. In addition to unifying the interpretation of reflexives in PNPs, our results challenge the validity of arguments that use reflexives in PNPs to diagnose or argue for syntactic structure. Crucially, attempts to salvage such arguments by proposing a null pronominal subject for reflexives in PNPs without possessors rest on the assumption that reflexives in PNPs with possessors are obligatorily bound by that possessor. We have shown that this assumption is incorrect.

Second, our demonstration that listeners initially consider binding-theory-incompatible referents is inconsistent with an early filter hypothesis. We suggest that the bias to interpret the reflexive as referring to the possessor will require a deeper understanding of the discourse conditions that support the use of a reflexive. For pronouns, we cannot distinguish between a late filter and a multiple-constraints approach to how binding constraints apply during reference resolution. On the latter view, the structural constraints on interpretation provided by the binding theory are among a larger set of constraints that are used probabilistically in reference resolution. There is emerging evidence that different referential forms may weight constraints differently, including constraints such as syntactic prominence and discourse status. According to such a reference-specific approach (Brown-Schmidt, Byron, & Tanenhaus, 2005; Kaiser, 2003; Kaiser & Trueswell, in press), a complete understanding of reference resolution requires
understanding the specific constraints associated with each referential form as well as their relative importance. In addition to syntactic and discourse prominence, linguists have proposed a number of additional factors that influence the interpretation of pronouns and reflexives, including whether a potential referent is a source or a recipient, and different knowledge states associated with potential referents. It will be important for future research on pronouns and reflexives to examine how these factors interact with structural constraints. In particular, there is need for more research comparing the properties of both argument and nonargument reflexives. It will also be important to determine whether or not reflexives and pronouns in PNPs with and without possessors are sensitive to similar constraints. Some languages have two or more distinct types of reflexives, including morphologically distinctive reflexives that are differentially sensitive to syntactic and nonsyntactic factors in different structural environments (see, e.g., Everaert, 2003; Reinhart & Reuland, 1993). Exploring languages with a richer set of reflexives may help shed light on the behavior of English reflexives, which may collapse across different classes of reflexives.

Finally, the linguistic community is increasingly looking to new sources of data to complement data from linguistic intuitions. We believe that the experimental approach we have adopted may prove useful in addressing other linguistic issues. A particularly appealing aspect of the paradigm is that it not only provides insights into real-time processing but also provides an implicit judgment. This may make it easier for psycholinguists and linguists to relate data from tasks like these to the data from intuitions—a significant step toward bridging the gap between theoretical linguistics and psycholinguistics.

Notes

1. We use the term anaphor throughout the article as a traditional cover term for anaphoric expressions, in this case reflexives and pronouns; it is not intended to refer only to the reflexive anaphor.
2. Following standard practice we use indeces to indicate intended referents; an index preceded with an asterisk marks an unattested coreference relation.
3. The judgment provided here is the standard one typically found in the literature (e.g., Chomsky, 1981); our data that follow will show that the reflexive can sometimes take the subject of the sentence as its antecedent.
4. A third fact we do not focus on here is that a measure of structural prominence is relevant to determining what counts as a local antecedent.
5. The term logophor was borrowed from research on certain African languages that have a special type of anaphor called a logophor (Hagege, 1974), which refers to the individual whose thoughts are being reported (see also Clements, 1975). Some researchers have objected to extending the term logophor to cases such as the binding-theory-exempt anaphors in English. Others have chosen to use the term in this more general sense—to refer to nonreflexivizing reflexives, which are exempt from structural binding theory but which are sensitive to discourse and pragmatic factors.
6. This approach to PNPs with possessor phrases would deny that the possessor and the reflexive are “coarguments” in the senses used by Pollard and Sag (1992) and Reinhart
and Reuland (1993). Runner and Kaiser (2005) provided a syntactic analysis of PNPs with possessors that predicts the reflexive is a logophor.

7. Here and in later cases in which we compare proportions, either binding theory or our own analysis predicts that one proportion will be greater than the other; for this reason 1-tailed $t$ tests are reported.

8. This assumes that the recent mention of the possessor doll’s name does not elevate looks to pictures of that doll, an assumption that we justify following.

9. Also observable in Fig. 12 is the fact that participants scan the entire scene, briefly looking at pictures that are not the intended referent; for this reason the proportions of fixations to the pictures in the correct column are always higher than the proportions of fixations to the other pictures in the display. Crucially, however, the proportion of fixations to the picture of the third doll—the one that no participant ever chooses as target—is significantly lower than the proportion of fixations to the pictures participants are considering as potential referents. Thus, although participants do fixate briefly on the picture of the third doll, it is the difference in proportions that is crucial in the analysis.

10. This assumes that any increase in looks to the possessor due to its recent mention will be finished by the onset of the anaphor. To put it differently, in a hypothetical control condition that did not include anaphors (e.g., “Have Bill touch Ken’s picture of Harry”), we would predict that looks to pictures of Ken’s picture of Ken above and beyond looks to Ken’s picture of Joe that might have occurred as a result of having heard “Ken’s” would have stopped increasing by the onset of “Harry.”

11. Sag (1976), who proposed an early analysis of the coreferential and bound variable readings found with verb phrase ellipsis, and others (cf. Sells, Zaenen, & Zec, 1987) have reported some speaker and construction variability associated with these judgments; Goldwater and Runner (in press) provided preliminary evidence that PNP reflexives can indeed receive coreferential as well as bound variable interpretations with verb phrase ellipsis, and work in progress tests these directly against direct-object reflexives.

12. Chisholm (2003) discussed NP ellipsis, providing several examples showing that the reflexive in a PNP containing a possessor can receive both a coreferential and bound variable interpretation.

13. Kaiser, Runner, Sussman, and Tanenhaus (in press) provided preliminary data supporting the logophor analysis of reflexives in PNPs lacking possessors: Participants’ interpretations as well as fixations are influenced by the pragmatic factor “source,” a factor thought to be associated with logophors (cf. Kuno, 1987); work in progress tests this factor with PNPs containing possessors.

Acknowledgments

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from Experiment 2 (competition analyses and analyses of the time course of looks in the pronoun conditions). It contains the first report of the data from Experiments 1, 3, and 4.

References


