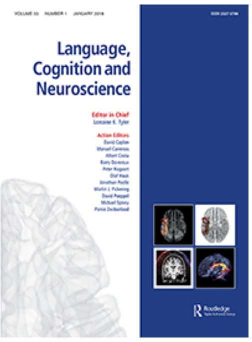

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REGULAR ARTICLE

Prospective NPI licensing and intrusion in Turkish

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ABSTRACT
ERPs were employed to examine the processing of NPI/licensor dependencies in Turkish. Previous work on languages like English/German have documented intrusion effects, where structurally ineligible licensors interfere with violation responses to unlicensed NPIs (a species of "grammatical illusion"). Turkish makes it possible to test intrusion effects in environments where NPIs precede their licensors and thus where intrusive licensors can intervene between NPIs and legitimate licensors. We show that: (i) intrusion effects do arise in Turkish, (ii) that brain responses at positions where intrusive licensors are encountered strongly resemble patterns observed for conditions where licensing permissible (both situations reveal patterns seen for other types of long-distance dependency processing, e.g. filler-gap relationships in interrogatives), leading to (iii) attenuation of downstream violation responses. Accounts of intrusion in terms of cue-based retrieval versus erroneous pragmatic licensing are discussed in the context of these findings, underscoring the importance of cross-linguistic experimental work.

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Intrusion; NPIs; ERPs; Turkish; retrieval

Introduction

The present study probes the temporal dynamics of sentence comprehension mechanisms focusing on the processing of linguistic expressions known as Negative Polarity Items or NPIs. The class of NPIs includes words like English *any* or *ever* which must occur in LICENSING CONTEXTS with a prototypical example being syntactic positions within the scope of negation (e.g. compare: *John has**n't*** ***ever*** *been to Istanbul* versus *John has ****ever*** *been to Istanbul*). Membership in the class of NPIs is independent of syntactic category (e.g. "any" is a determiner/quantifier, "ever" is an adverb), and also includes collocations such as English "at all" (e.g. *They liked it *at all* vs. *They didn't like it at all*), or idioms such as "lift a finger" (e.g. in *He lifted a finger* vs. *He didn't lift a finger*; to the extent the former is acceptable, it has to be understood compositionally, and not idiomatically). For helpful overview discussions of NPIs see Giannakidou (2011), Tovena (1998) and Penka and Zeijlstra (2010).

Importantly, it is not enough for a licensor like negation to be merely present in sentences containing NPIs – the proper structural relationship must also obtain. Witness, for example, the contrast between (1a) and (1b):

(1) a. [**No** man [$_{RC}$ that the woman liked _]] ***ever*** arrived on time. **LICENSED**
b. [The man [$_{RC}$ that **no** woman liked _]] ****ever*** arrived on time. **INTRUSION**
c. [The man [$_{RC}$ that the woman liked _]] ****ever*** arrived on time. **UNLICENSED**

In (1a), the (**underlined**) negative element succeeds in licensing the NPI ***ever***. However, when this same licensor is nested within the preceding relative clause (RC) in (1b), an intuitive sense of deviance arises which is similar to that of (1c), where no licensor is present at all.

Central to the present investigation is the fact that the intuitive similarity in deviance between (1b) and (1c) turns out to be less clear to human sentence processing mechanisms as they operate incrementally in real time. For example, judgments about cases like (1b) become less reliable when native speakers are put under time pressure (e.g. in speeded grammaticality judgment tasks; Drenhaus, Frisch, & Saddy, 2005; Parker & Phillips, 2016). Similarly, in studies monitoring online processing with self-paced reading, eyetracking, or event-related potentials (ERPs), the presence of structurally illegible licensors in cases like (1b) results in either attenuated violation responses (relative to responses seen for unlicensed NPIs like in (1c); Vasishth, Brussow, Lewis, & Drenhaus, 2008; Xiang, Dillon, & Phillips, 2009) or even response patterns that track those elicited for licensed cases like (1a) (Parker & Phillips, 2011). Such cases where illusions of acceptability/grammaticality arise involving NPIs – call these INTRUSION effects – are the main focus of the present study.

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Accounts of intrusive licensing and previous findings

Why do intrusion effects arise? Two accounts that are presently on offer in the literature will here be discussed under the labels CUE BASED RETRIEVAL (CBR) and ERRONEOUS PRAGMATIC LICENSING (EPL).[1] According to CBR (Vasishth et al., 2008; see Lewis, Vasishth, & Van Dyke, 2006 for review), intrusion occurs because retrieval cues generated when NPIs are encountered match to features of previously encountered NPI-licensors, even in cases where grammatical restrictions suggest they should be illegible as possible licensors. The CBR account can be said to come with the benefit of assimilating intrusion into a broad view of the underlying mechanisms for encoding and retrieval at work in the processing of all sorts of linguistic dependencies, affording comparisons between intrusion and other well-studied phenomena. For example, consider classic agreement attraction effects which arise in cases like (2b):

(2) a. [The key [to the cabinets]] IS …
b. [The key [to the cabinets]] *ARE …

Although plural agreement in (2b) is illicit, illusions of acceptability in such cases have been shown to arise both in language production (Bock, Carreiras, & Meseguer, 2012; Bock & Miller, 1991) and comprehension (Wagers, Lau, & Phillips, 2009). According to CBR, encountering the plural agreement in (2b) serves as a retrieval cue including the feature [+plural]. Candidate nominal expressions that have been previously encountered and encoded (i.e. [the key-SG], [the cabinets-PL]) are activated in parallel, and in (2b) the subordinate plural noun phrase *the cabinets* will yield a full match in features. Thus retrieval interference from a matching element is understood to give rise to the illusion of acceptability (2b).

CBR suggests that the same mechanisms proposed to address such attraction effects can also help us understand intrusive NPI licensing, except in the intrusion situation the relevant retrieval cue that NPIs give rise to would involve features such as [+licensor] or [+negation]. This retrieval cue is then understood to match with the features of structurally ineligible licensors in cases like (1b). Of course, unlike the agreement attraction case, with intrusion there is no competition involved between multiple candidates. What intrusion has in common with agreement attraction is that in both cases elements intrude in processing that – from the point of view of grammatical theory – should ultimately be blocked from consideration as a candidate matches for dependency resolution on the basis of structural/syntactic considerations.

One issue which requires further attention in the CBR account is how intrusive licensing is captured in terms of *partial* match of retrieval cues, analogous to the story for the agreement attraction effects mentioned above. In Vasishth et al. (2008), intrusion is modelled by positing an additional feature encoding the structural/relational notion of c-command. Thus, encounters with NPIs would give rise to a retrieval cue [+negation, +c-commander]. The idea is that licensors like negation which occur in structurally *appropriate* licensing configurations relative to an unlicensed NPI would constitute a full match (so licensing succeeds). In contrast, an intrusive licensor would realise the features [+negation, - c-commander], and thus would only constitute a partial match of the retrieval cues (thus giving rise to only occasional incorrect retrieval and thus intrusion effects). A technical, but we believe important consideration in connection with this view, concerns the suggestion that a relational notion like c-command ought to be encoded as an intrinsic property of a particular item. We will postpone discussion of this matter for now, returning to elaborate on this in our Discussion below.

In contrast to CBR, the account of intrusion that we will here refer to as the EPL view (Xiang et al., 2009; Xiang, Grove, & Giannakidou, 2013) appeals to a proposed species of erroneous inference that is claimed to arise when licensors like negation co-occur with contrastive implicatures triggered by modifiers (e.g. the relative clauses in (1)). This account makes reference to two main ingredients. First, note that NPIs in English can be acceptable in certain environments where there is no obvious licensor present, illustrated for both *any* and *ever* in (3):

(3) a. I am surprised that we have ***any*** sugar
(compare: *We have* *__any__ *sugar*)
b. I am surprised that there was ***ever*** an investigation
(compare: *There was* ***ever*** *an investigation*)

It has been previously proposed that NPIs may be licensed by pragmatic inference (Giannakidou, 2006; Horn, 2002; Israel, 2004; Linebarger, 1980). That is, registering the sense of "surprise" arising from a state-of-affairs where, for example, sugar is in fact present (3a), or where an investigation actually did happen (3b), can be understood to give rise to the inference that the speaker believed that the state-of-affairs was either not the case or perhaps not likely to be the case (i.e. [*I'm surprised there is* **any** *sugar*] → [*I thought there was***n't any** *sugar*]).

Assuming that negative inferences can play this kind of role in licensing NPIs, the EPL then appeals to a second ingredient, namely contrastive implicatures associated with modification. For example, from "*the man* [$_{RC}$ *that the woman liked*]" a non-empty contrast set may be inferred picking out individuals that the woman does not like. It is the combination of negation and such contrastive implicatures that, according to the EPL, results in the illusion of well-formedness for cases like (1b) (see Xiang et al., 2009, 2013). Note that the claim is *not* that there is a valid pattern of inference that leads to pragmatic licensing in these intrusion cases. Rather, the claim of the EPL account is that this state-of-affairs results in a type of inferential confusion.

One kind of evidence in favour of EPL which seems problematic for CBR, comes from a study comparing the processing of NPIs with structurally ineligible licensors nested either in preceding relative (4a) or complement (4b) clauses (Parker & Phillips, 2011):

(4) a. The bicycles [that **no** experienced cyclists bought _ for their daily training]
have ****ever*** used aluminum gears.
b. The analyst's prediction [that **no** stock would fall overnight]
was ****ever*** taken seriously by the financial executive.

In a self-paced reading experiment, Parker and Phillips (2011) report a pattern of online intrusion effects only for (4a), and not (4b). This is explained by the fact that complement clauses do not give rise to the contrastive implicatures that relatives do. Thus, since one of the two ingredients necessary for EPL-type intrusion is missing in (4b), the online illusion of acceptability should not arise (i.e. precisely the reported pattern). Note, however, that the intrusion effect is eventually overridden, since these sentence types showed equal rejection rates in a sentence-final acceptability judgment task.

It is not immediately obvious how CBR could account for these data. Encountering an NPI in either (4a)/(4b) should involve the same retrieval cues with the same matching but structurally inaccessible NPI licensors available. Therefore, all else equal, (4a) and (4b) are predicted not to differ by the CBR account.

Moreover, there are additional findings about intrusion effects that seem to set them apart from other phenomena, like agreement attraction, which CBR would be expected to treat uniformly in terms of feature-matching operations involved in retrieval. For example, lengthening the time/distance between intrusive licensors and NPIs in English can reduce or "switch off" such effects in ways that seem to differ from cases of retrieval interference involving agreement (Parker & Phillips, 2016).

Finally, it seems that not all NPIs show intrusion effects: Parker and Phillips (2016) show that they arise for the English NPI *ever* but not for *any* (see also Parker, 2014). Now, although the EPL account does not offer a principled explanation for these facts either (so far as we can see), this collection of findings do suggest there may be special features connected to intrusive NPI licensing that are not shared by other phenomena that the CBR view is arguably committed to grouping together with intrusion. This does not entail that the CBR view is incorrect – only that additional factors may need to be specified somehow in the approach in order to predict the full range of empirical findings.

An important piece of the puzzle, we think, arises in Parker and Phillips (2016) discussion, where they suggest that the time/distance effects on intrusion involving English *ever* may be understood in terms of the dynamics of semantic encoding, specifically involving the part/whole composition of syntactically complex units. The idea is that structurally ineligible NPI licensors may intrude in online processing just so long as the containing structure has not undergone a reduction/recoding as a result of compositional operations (which are assumed to render its constituent structure opaque). This idea bears on the present study's examination of Turkish in interesting ways that will be unpacked in what follows.

Present study

Previous investigations of intrusion have focused on languages like English and German, where NPI licensing dependencies are prototypically *retrospective*, as in (1). When NPIs are encountered in such languages, comprehension mechanisms must have a way of inspecting the previously encountered context to check whether an NPI licensor is present (but see Steinhauer, Drury, Portner, Walenski, & Ullman, 2010[2]). However, in contrast to English/German, in other languages such as Turkish (or Japanese, Korean, among others), encountering an NPI *predicts* an upcoming licensor, as can be seen in (5a/b). Observe that unlike English *any*, the Turkish NPI *kimse* ("anybody") can appear as a matrix (main) clause subject. In (5a) *kimse* is licensed by the negative-marker (*-mA*) that appears as a suffix on the verb. When negation is absent deviance results (see (5b)), just as with English and other languages where such dependencies are typically retrospective.

(5) a. **Kimse** uyu-**ma**-dı
anybody *sleep*-**NEG**-PST.3SG
"Anybody did not sleep" = "Nobody slept"
b. ***Kimse** uyu-du
anybody *sleep*-PST.3SG
"Anybody slept"

So what would possible cases of intrusion look like in Turkish? Consider the examples in (6), which show that Turkish NPI licensing also obeys structural restrictions analogous to other languages (note the condition labels, e.g. $\text{NPI}^{M}\text{NEG}^{M}$ for (6a), which will be used throughout this paper, indicate whether NPIs and Negation occur in the matrix clause (superscript "M") or embedded clauses (superscript "E")).

(6) a. **Kimse** [Ali'nin çalış-tığ-ı]-nı söyle-**me**-di
anybody [*Ali*-GEN *work*-FN-AGG]-ACC *say*-**NEG**-PST.3SG **NPI^{M}NEG^{M}**
"Anybody didn't say that Ali worked" = "Nobody said that Ali worked"

b. ***Kimse** [Ali'nin çalış-**ma**-dığ-ı]-nı söyle-di
anybody [*Ali*-GEN *work*-**NEG**-FN-AGG]-ACC *say*-PST.3SG ***NPI^{M}NEG^{E}**
"Anybody said that Ali did not work"

Note that Turkish exhibits SOV word order. The bracketed structure in (6a) is an embedded nominalised clause (*Ali worked*) which is the complement of the matrix verb (*say*).[3] Since the matrix verb is marked by the negative morpheme –*mA*, **NPI^{M}NEG^{M}** in (6a) is well-formed, like the simple case in (5a).[4] However, like other languages, Turkish NPIs cannot be licensed when they are not within the scope of negation. The ***NPI^{M}NEG^{E}** example in (6b) provides a relevant case where –*mA* appears on the verb within the embedded clause, and fails to license the matrix subject NPI. Thus, although these Turkish NPI-licensor dependencies contrast with the retrospective dependencies seen in languages like English or German, analogous structural requirements must still obtain for NPIs to be licit.

Implications for accounts of intrusive licensing

Whether ***NPI^{M}NEG^{E}** configurations like (6b) in Turkish give rise to intrusion effects bears on the generality of the CBR and EPL accounts. Briefly: CBR but not EPL predicts intrusion effects for ***NPI^{M}NEG^{E}**/(6b), since this environment is a complement (not a relative) clause where the contrastive implicatures needed for the erroneous inferences driving intrusion in the EPL account should not arise (recall the Parker & Phillips, 2011 self-paced reading findings mentioned above). Further, note that these Turkish cases involve an NPI (*kimse*) that is the analogue of the NPI in English (*any*) which has been shown to *not* to elicit intrusion effects (Parker & Phillips, 2016).

We will elaborate on these points in more detail below against the backdrop of our experimental design and more specific predictions. For the moment, observe that taking current accounts and previous empirical findings into consideration, examination of ***NPI^{M}NEG^{E}** cases like (6b) should stack the deck *against* finding intrusion effects. That is, if intrusion effects obtain in our study for these cases, then the generality of the EPL account may be called into question, and the empirical generalisations about NPI-specific patterns regarding the presence/absence of intrusion will have been narrowed in scope.

Non-local dependency resolution

The study of these dependencies in Turkish using ERPs is important for broader reasons relevant to our understanding of the neural markers of mechanisms involved more generally in managing non-local linguistic dependencies extending across clause boundaries. For example, consider the pair in (7). These are derived from (6) by simply switching the matrix and embedded subjects so that the NPI is in the *embedded* clause subject position.

(7) a. Ali [**kimsenin** çalış-tığ-ı]-nı söyle-**me**-di
Ali [***anybody***-GEN *work*-FN-AGG]-ACC *say*-**NEG**-PST.3SG **NPI^{E}NEG^{M}**
"Ali didn't say that anybody worked"

b. Ali [**kimsenin** çalış-**ma**-dığ-ı]-nı söyle-di
Ali [***anybody***-GEN *work*-**NEG**-FN-AGG]-ACC *say*-PST.3SG **NPI^{E}NEG^{E}**
"Ali said that anybody didn't work" = "Ali said that nobody worked"

Unlike (6a/b), *both* of these cases in (7) are intuitively acceptable.[5] So, although embedded negation cannot license a matrix subject NPI (6b), embedded subject NPIs can be licensed either by negation on the embedded verb (**NPI^{E}NEG^{E}** in (7b)) or by matrix verb negation (**NPI^{E}NEG^{M}** in (7a)), yielding the corresponding interpretative differences as glossed above.

Together, (6) and (7) offer valuable comparisons relevant to our understanding of: (i) the processing of non-local linguistic dependencies generally, and (ii) NPI licensing in particular. Regarding the latter, more specific point (ii), note that previous ERP research examining the processing of NPIs has necessarily inspected effects tied to the presence/absence or position of licensors measured on the NPIs themselves, focusing on violation responses elicited by unlicensed NPIs (see Drury & Steinhauer, 2009; Panizza, 2012 for reviews). In contrast, what the **NPI^{E}NEG^{M}**/**NPI^{E}NEG^{E}** contrast in (7a/b) should allow us to see is a brain response profile associated with NPI licensing mechanisms at a point in the processing stream *where no violation is present*. That is, the negative-marked embedded verb in **NPI^{E}NEG^{E}**/(7b) should engage NPI licensing operations whereas in **NPI^{E}NEG^{M}**/(7a) these operations should not be engaged until the matrix verb is encountered. Thus, ERP signals time-locked to these embedded verbs for the **NPI^{E}NEG^{M}**/**NPI^{E}NEG^{E}** contrast in (7a/b) should in principle yield response profiles distinguishing between the presence/absence of the engagement of NPI licensing operations.

Returning now to the more general point (i) above, we hypothesise that the processing profile for licensing dependencies in cases like (7) might relate to findings from studies of filler/gap dependencies. To illustrate, consider the following examples from English (Phillips, Kazanina, & Abada, 2005) in (8) and German (Fiebach, Schlesewsky, & Friederici, 2001) in (9):

(8) The detective hoped that the lieutenant knew …
a. … that the shrewd witness would **recognise** the accomplice in the lineup
b. … **which accomplice** the shrewd witness would **recognise** in the lineup

(9) Thomas fragt sich …
Thomas asks himself …

a. … **wer** am Mittwoch nachmittag nach dem Unfall **den Doktor verständigt hat**
who$_{NOM}$ *on Wednesday afternoon after the accident* ***the doctor***$_{ACC}$ ***called has***

b. … **wen** am Mittwoch nachmittag nach dem Unfall **der Doktor verständigt hat**
who$_{ACC}$ *on Wednesday afternoon after the accident* ***the doctor***$_{NOM}$ ***called has***

The successful processing of such configurations requires establishment of a prospective dependency between the filler (*wh*-phrase) and the gap position. In ERP studies, the storage cost of the filler has been shown to elicit sustained anterior negativities (LAN effects) between the filler and the gap. In addition, relative positivities (P600 effects) have been observed at the position where the filler must be integrated (see also Felser, Clahsen, & Munte, 2003; Kaan, Harris, Gibson, & Holcomb, 2000 for other related findings). Another such study, which is perhaps most closely connected to the present investigation, used ERPs to examine Japanese contrasts like those in (10) (Ueno & Kluender, 2009):

(10) a. MATRIX QUESTION
[senmu-ga **donna pasokon-o** katta-to] keiri-no kakaricho-ga iimashita-**ka**
[*director-*$_{NOM}$ *what.kind.ofPC-*$_{ACC}$ *bought-that*] *accounting-of manager-*$_{NOM}$ *said.*POL-Q
"What kind of computer did the accounting manager say the director bought?"

b. EMBEDDED QUESTION
[senmu-ga **donna paskono-o** katta-**ka**] keiri-no kakaricho-ga kikimashita-ka
[*director-*$_{NOM}$ *what.kind.ofPC-*$_{ACC}$ *bought-*Q] *accounting-of manager-*$_{NOM}$ *asked.*POL-Q
"Did the accounting manager ask what kind of computer the directory bought?"

Note that these cases are abstractly similar to our embedded NPI examples (**NPI^E^NEG^M^/NPI^E^NEG^E^** in (7)). Unlike English, Japanese does not displace *wh*-words – they remain *in-situ*. What determines the scope of the *wh*-element, yielding either a matrix question like (10a) or an embedded one like (10b), is the link between the *wh*-element and the morpheme –*ka*. When –*ka* occurs locally in the embedded clause as the *wh*-element, then the interrogative scope is obtained in the embedded clause (10b). On the other hand, when –*ka* appears only on the matrix verb, then a matrix question is realised (10a). This link between the *wh*-element and –*ka* morpheme is argued to reflect an active forward search in the course of the processing.

Ueno and Kluender (2009) found that the absence of the –*ka* morpheme on the first verb after the *wh*-element in (10a) yielded processing cost, indexed by the presence of an anterior negativity which sustained until sentence end.[6] Parallel to this state-of-affairs, in our Turkish cases we may expect to see differences between our **NPI^E^NEG^M^/NPI^E^NEG^E^** (in (7a/b)) arise in terms of anterior negativities, with the matrix negation **NPI^E^NEG^M^**/(7a) case more negative going than **NPI^E^NEG^E^**/(7b) at the embedded verb (where the embedded subject NPI can be both thematically integrated and licensed by embedded negation, thereby reducing the burden on working memory systems to track the otherwise unresolved dependency).

Interestingly, Ueno & Kluender did not find evidence of P600-type effects (e.g. at the matrix verb, when presumably the embedded *wh*-element can be related to the *ka*-morpheme, determining its matrix scope), which is unlike findings discussed above for English and German. They suggest that this is the case because Japanese does not displace its *wh*-items, and they also note that in studies of other cases where there are arguments for displacement in Japanese (e.g. scrambling, see Hagiwara, Soshi, Ishihara, & Imanaka, 2007; Ueno & Kluender, 2003), such P600/integration effects do in fact obtain. In our **NPI^E^NEG^M^/NPI^E^NEG^E^** Turkish cases in (7a/b), it is thus not obvious whether we might expect to see modulations of both anterior negativities (LAN-type effects) *and* the P600 as has been found for English and German *wh*-dependencies, or just anterior negativities alone (like the Japanese cases), since our Turkish cases could be argued to not involve displacement either.

Using local vs. non-local NPI/licensor dependency resolution to compare to intrusion

Whatever the details of the processing profile exhibited by local (versus non-local) NPI licensing in the **NPI^E^NEG^M^/NPI^E^NEG^E^** cases in (7), illuminating their profile this contrast will be important for understanding what happens with our contrasts testing for Turkish intrusion (**NPI^M^NEG^M^/*NPI^M^NEG^E^** in (6a/b)). For example, if sentence processing mechanisms erroneously engage NPI licensing mechanisms for ***NPI^M^NEG^E^**/(6b) when the embedded negated verb is encountered, we should be able to see this in the form of a similar response profile for the **NPI^M^NEG^M^/*NPI^M^NEG^E^** contrast in (6a/b) as we find for the **NPI^E^NEG^M^/NPI^E^NEG^E^** in (7a/b). Such a pattern, should it obtain, would suggest that intrusive licensing in these situations results from an engagement of the normal operation of dependency resolution mechanisms in ways that are not (ultimately) countenanced by the grammar of Turkish.[7]

However, note that comparisons in an ERP study involving only (6) and (7) would be problematic on their own, since response profiles for the embedded and matrix verbs across the a/b examples in (6) and (7) may also be sensitive more generally to presence/absence of negation (i.e. present on the embedded verb in the b-cases, absent in the a-cases, and vice-versa for the subsequent matrix verbs). Thus, without additional control comparisons, examination of **NPI^M^NEG^M^/*NPI^M^NEG^E^** and **NPI^E^NEG^M^/NPI^E^NEG^E^** (in (6)/(7), respectively) are inadequate to tease apart effects connected to NPI licensing or intrusion from effects connected to negation generally (see Steinhauer & Drury, 2012; Steinhauer et al., 2010, regarding target- versus context- manipulation violation paradigms in ERP research). Though this is a general concern for experimental design, it is a particular worry in the present study because negation, as is well-known, is independently associated with increases in processing difficulty (see, e.g. Kaup, Zwaan, & Lüdtke, 2007, and see Tian & Breheny, 2016 for helpful review discussion). Further, though there are a range of ERP studies that have manipulated presence/absence of negation for a variety of research purposes (Fischler, Bloom, Childers, Roucos, & Perry, 1983; Nieuwland & Kuperberg, 2008; Staab, 2007), there is scant available evidence comparing negative-marked elements to unmarked ones directly (to our knowledge, there is only one such study – Lüdtke, Friedrich, De Filippis, & Kaup, 2008; see predictions below, and Discussion).

ERP responses for NPI licensing violations and their absence/attenuation for intrusion

A number of studies have examined NPI licensing violations using ERPs (see Drury & Steinhauer, 2009; Panizza, 2012; Steinhauer et al., 2010 for reviews). However, across these previous studies there is considerable variability in reported response profiles elicited by unlicensed NPIs. Given the range of findings it is perhaps not surprising that two available reviews of the literature come to different conclusions regarding what generalisations and regularities are to be found in this work. Drury and Steinhauer (2009), in their discussion of this literature, conclude that the most reliable ERP pattern connected with the processing of unlicensed NPIs is a late posterior positive-going deflection that is argued to be a member of the broad class of P600-type effects (see also Steinhauer et al., 2010). However, in an important and insightful discussion of formal semantics and neurolinguistics (Panizza, 2012), a similar review of some of the same ERP studies covered in Drury & Steinhauer's review comes to different conclusions. Panizza argues that the most reliable ERP profile connected to NPI licensing violations is rather a centro-parietal negative-going response which he assimilates to the family of N400-type effects (Kutas & Federmeier, 2011). Other response profiles have included late left anterior negativities (L-LAN, see Steinhauer et al., 2010) and frontal positivities (Panizza, 2012), though these latter two effects have been less consistently reported.

In the context of the present study, the precise nature of ERP response profiles for unlicensed NPIs, and an accounting of the nature of variability in the reported response profiles across previous studies, while important, is of secondary interest. That is, the reason these matters require attention in the present study has less to do with the specific nature of the ERP violation response profile, and more to do with the expectation that such violation effects (whatever their nature for unlicensed NPIs in Turkish) might be either attenuated or absent in intrusion cases, as has been reported in studies of German and English (Drenhaus et al., 2005; Parker & Phillips, 2016; Xiang et al., 2009).

To examine the nature of such violation responses when licensors are absent, in the present study we also tested outright violations for both matrix and embedded NPIs, as in the No Negation (NEG$^{\varnothing}$) cases in Table 1 below (i.e. no licensor present). Note that for ease of reference the three level negation manipulation will be indexed by NEG^{M} / NEG^{E} / NEG$^{\varnothing}$ (i.e. matrix negation, embedded negation, no negation). Similarly, our NPI manipulations will be labelled NPI^{M} / NPI^{E} / NPI$^{\varnothing}$ (matrix, embedded, and no NPI), and ungrammatical/violation cases prefixed with a *-mark, as follows:

The three cases with matrix NPIs (NPI^{M}NEG^{M}, *NPI^{M}NEG^{E}, and *NPI^{M}NEG$^{\varnothing}$) together with the corresponding three cases with embedded NPIs (NPI^{E}NEG^{M}, NPI^{E}NEG^{E}, and *NPI^{E}NEG$^{\varnothing}$) illustrate the core manipulations of the present study. Note that the matrix NPI cases are parallel to the triple of conditions that have been previously examined in English and in German (see our initial English examples in (1) above). Additional control conditions with no NPIs (included to estimate ± negation

Table 1. Present study.

NPI	NEG	MATRIX SUBJECT	EMBEDDED CLAUSE SUBJECT + VERB	MATRIX VERB
NPI^{M}	NEG^{M}	**Kimse** ***anybody***	[Ali'nin çalış-tığ-ı]-nı [*Ali*-GEN *work*-FN-AGG]-ACC	söyle-**me**-di *say*-**NEG**-PST.3SG
		"Anybody didn't say that Ali worked" = "Nobody said that Ali worked"		
*NPI^{M}	NEG^{E}	***Kimse** ***anybody***	[Ali'nin çalış-**ma**-dığ-ı]-nı [*Ali*-GEN *work*-**NEG**-FN-AGG]-ACC	söyle-di *say*-PST.3SG
		"Anybody said that Ali did not work"		
*NPI^{M}	NEG$^{\varnothing}$	***Kimse** ***anybody***	[Ali'nin çalış-tığ-ı]-nı [*Ali*-GEN *work*-FN-AGG]-ACC	söyle-di *say*-PST.3SG
		"Anybody said that Ali worked"		
NPI^{E}	NEG^{M}	Ali *Ali*	[**kimsenin** çalış-tığ-ı]-nı [***anybody***-GEN *work*-FN-AGG]-ACC	söyle-**me**-di *say*-**NEG**-PST.3SG
		"Ali didn't say that anybody worked"		
NPI^{E}	NEG^{E}	Ali *Ali*	[**kimsenin** çalış-**ma**-dığ-ı]-nı [***anybody***-GEN *work*-**NEG**-FN-AGG]-ACC	söyle-di *say*-PST.3SG
		"Ali said that anybody didn't work" = "Ali said that nobody worked"		
*NPI^{E}	NEG$^{\varnothing}$	*Ali *Ali*	[**kimsenin** çalış-tığ-ı]-nı [***anybody***-GEN *work*-FN-AGG]-ACC	söyle-di *say*-PST.3SG
		"Ali said that anybody worked"		

effects independent of NPIs), as well as other filler violation conditions, will be discussed below (see *Methods*).

Predictions

The present study makes available many potentially informative comparisons targeting the embedded and matrix verbs. Here we discuss predictions corresponding to the analyses we present below, which partition our conditions in the way motivated by our introductory discussion and which will allow us to expose our three main empirical goals. Our first goal is to examine whether intrusion shows a similar processing profile to cases of well-formed local NPI licensing. Our second goal is to identify the nature of violation responses in Turkish when licensors are absent. Our third goal is to examine the extent to which intrusive licensing attenuates downstream violation responses. We now elaborate on each in turn.

Intrusion = NPI-licensing processes which ignore structure? Our first order of business is to evaluate whether effects tied to NPI licensing operations obtain for the NPI^{E}NEG^{M} vs. NPI^{E}NEG^{E} comparison, following our suggestions above, and whether the intrusion comparison (NPI^{M}NEG^{M} vs. *NPI^{M}NEG^{E}) patterns similarly or not. That is, neural activity corresponding to the formation of an NPI/licensor dependency between the embedded subject NPI and negation on the embedded verb in NPI^{E}NEG^{E} should be absent in the corresponding matrix negation condition (NPI^{E}NEG^{M}). Previous related work studying other types of dependencies (e.g. filler/gap dependencies in *wh*-questions), as well as findings from studies of violation paradigms involving NPIs (Steinhauer et al., 2010; Xiang et al., 2009) led us to expect this *may* be reflected in a P600 type effect (NPI^{E}NEG^{E} > NPI^{E}NEG^{M}).

Further, given that the *absence* of embedded negation in NPI^{E}NEG^{M} should result in a *lack* of engagement of licensing processes at the embedded verb, if this in turn corresponds to the need to maintain the unresolved licensing requirements of the embedded NPI in working memory, then we should also observe an embedded verb LAN effect for NPI^{E}NEG^{M} relative to NPI^{E}NEG^{E}, which should dissipate after matrix verb negation is encountered in NPI^{E}NEG^{M}, perhaps coinciding with the integration/licensing P600 effect for NPI^{E}NEG^{E} suggested above. However, given the absence of P600 effects in the parallel cases of *wh*-dependencies that have been investigated in Japanese (see discussion of (10a/b) above), a predicted P600 finding is perhaps on less firm ground than our expectation of LAN differences. These predictions are summarised graphically in Figure 1, along with schematic representations of matrix/embedded negation comparisons for matrix subject NPIs and the corresponding embedded subject NPI cases, as well as the presentation/time-locking information (detailed below, see *Methods*). These schematic representations of the configurations to be tested will be employed to index our comparisons in the report of our results below (e.g. as mnemonics for our conditions in plot legends).

Whether these specific patterns emerge for our NPI^{E}NEG^{M} versus NPI^{E}NEG^{E} comparisons or not, we more generally predicted that *if* it is the case that the mechanisms subserving NPI/licensor dependency resolution are activated at the negated embedded verb in our intrusion condition (*NPI^{M}NEG^{E}), our matrix/embedded negation comparison for matrix NPIs (NPI^{M}NEG^{M} versus *NPI^{M}NEG^{E}) should reveal a similar response profile to the corresponding comparison involving embedded NPIs (i.e. for NPI^{E}NEG^{M} versus NPI^{E}NEG^{E}).

That is, analyses including all four of the conditions in Figure 1 may be expected to yield only main effects of negation at the embedded verb, with no NPI × NEGATION interactions, if intrusion involves engagement of licensing mechanisms at the embedded verb negation. If, in contrast, the embedded clause environment somehow blocks the engagement of NPI/licensor

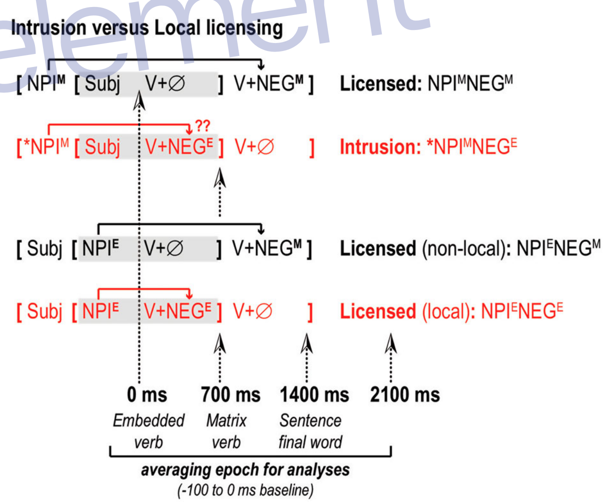

Figure 1. Schematic representation of critical embedded verb position contrasts. Area shaded in grey indicates the embedded clause. Timing of presentation of critical events (onset of embedded clause verb and matrix clause verb) indicated at the bottom. In the local licensing configurations (bottom pair) we predict a LAN response for the non-local relative to the local licensing cases (i.e. NPI^{E}NEG^{M} > NPI^{E}NEG^{E}) starting at the embedded clause verb. We also (more tentatively) predict a possible ERP reflex of engagement of NPI licensing mechanisms at the embedded verb for the local relative to the non-local licensing cases (i.e. NPI^{E}NEG^{E} > NPI^{E}NEG^{M}). If intrusion effects in Turkish result from the engagement of NPI licensing mechanisms at the main verb, then the same effects are predicted to obtain for the matrix NPI comparisons (top pair). See main text for discussion.

dependency resolution in the intrusion condition *NPI^{M}NEG^{E}, then we expect to see an interaction pattern reflecting this difference between intrusion and local licensing.

Finally, the pattern of effects that emerges for the contrasts illustrated in Figure 1 must be teased apart statistically from effects that may be connected to negation alone. This confound can be addressed via comparisons with control conditions which do not involve NPIs yet which show the same pattern with respect to the presence/absence of negation (see Table 2 in *Methods*).

ERP responses for outright licensing violations and their attenuation in intrusion? Whatever effects may be tied to the processing of the embedded verbs for our local licensing (NPI^{E}NEG^{M}/NPI^{E}NEG^{E}) and intrusion comparisons (NPI^{M}NEG^{M}/*NPI^{M}NEG^{E}), it will be of further interest to see what response profiles obtain for our intrusion case when non-negated matrix verbs are encountered. It could be, for example, that sentence processing mechanisms do not locally engage dependency resolution mechanisms at the embedded verb in *NPI^{M}NEG^{E}, but that the presence of that embedded negation nonetheless influences violation responses at the matrix verb when the required negation is found to be missing. In contrast, if embedded negation is simply not accessible ("blocked") as an intrusive licensor, then we would predict that at the matrix verb there should be a violation response profile comparable to cases where no negation is present at all.

In order to evaluate this, we must establish the nature of outright licensing violation responses for Turkish (e.g. NPI^{M}NEG^{M} vs. *NPI^{M}NEG^{Ø} and NPI^{E}NEG^{M} vs. *NPI^{E}NEG^{Ø} in Table 1), which are investigated here for the first time. Previous work, as discussed above, suggests we might obtain either N400 or P600 effects at the matrix verb, or perhaps both together (see Figure 2). However, given that this is the first ERP study to examine these phenomena in Turkish, as well as the first to use this method to examine prospective NPI licensing dependencies in general,[8] we did not make strong predictions as to the specific nature of the violation profile, or whether it might differ across our matrix versus embedded subject NPI comparisons. Whether N400 or P600 violation

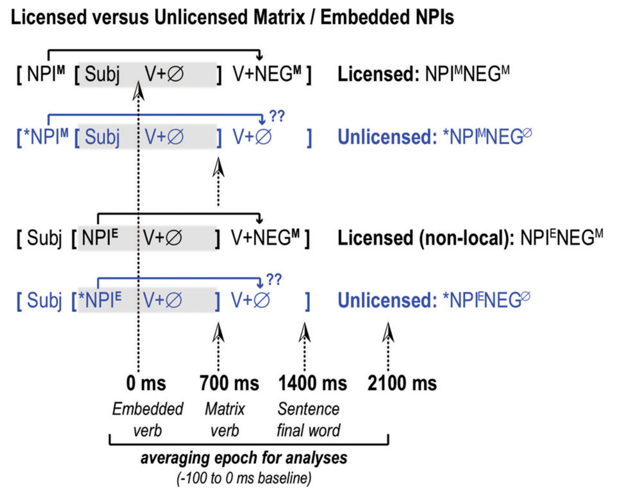

Figure 2. Schematic representation of critical matrix verb position contrasts. Area shaded in grey indicates the embedded clause. Timing of presentation of critical events (onset of embedded clause verb and matrix clause verb) indicated at the bottom. Both matrix NPIs (top pair) and embedded NPIs (bottom pair) are predicted to give rise to ERP violation responses beginning at the position of the matrix verb. We predict at least P600 responses (and perhaps also preceding N400 effects) for the licensed/unlicensed contrasts in both cases (i.e. NPI^{M}NEG^{Æ} > NPI^{M}NEG^{M} and NPI^{E}NEG^{Æ} > NPI^{E}NEG^{M}). See main text for discussion.

responses emerge (or perhaps some new, previously undocumented pattern), our mission here was simply to document its nature, and then examine the question of whether this profile emerges for our intrusion comparison, or not.

Finally, setting to the side the specific ERP response patterns, and returning to the opposition between the two major views of intrusive licensing we introduced above: a straightforward prediction of the EPL view is that intrusion effects should not arise in our study. Since our intrusion cases involve potential licensors embedded in nominalised *complement* clauses, and not *relative* clauses, one of the two crucial ingredients for intrusion effects is absent here (i.e. contrastive implicatures triggered by modification). Thus, intrusion effects are not predicted to obtain.

In contrast, it is a clear expectation of the CBR account that intrusion effects should arise. That is: (i) there should be nothing stopping the retrieval operations in our *NPI^{M}NEG^{E} case when embedded negation is encountered, therefore, (ii) *NPI^{M}NEG^{E} should behave similarly, if not identically, to the well-formed NPI^{E}NEG^{E} condition, where clausemate NPI licensing occurs. Further, to the extent that dependency resolution mechanisms have been engaged at the embedded verb for our intrusion case, this could presumably result in an attenuation of violation response profiles for *NPI^{M}NEG^{E} at the matrix

Table 2. No NPI control conditions.

NPI	NEG	MATRIX SUBJECT	EMBEDDED CLAUSE SUBJECT + VERB	MATRIX VERB
NPI^{Ø}	NEG^{M}	Aysel *Aysel* "Aysel didn't say that Ali worked"	[Ali'nin çalış-tığ-ı]-nı [*Ali*-GEN *work*-FN-AGG]-ACC	söyle-**me**-di *say*-**NEG**-PST.3SG
NPI^{Ø}	NEG^{E}	Aysel *Aysel* "Aysel said that Ali did not work"	[Ali'nin çalış-**ma**-dığ-ı]-nı [*Ali*-GEN *work*-**NEG**-FN-AGG]-ACC	söyle-di *say*-PST.3SG
NPI^{Ø}	NEG^{Ø}	Aysel *Aysel* "Aysel said that Ali worked"	[Ali'nin çalış-tığ-ı]-nı [*Ali*-GEN *work*-FN-AGG]-ACC	söyle-di *say*-PST.3SG

verb (compared to the effects we should see for the no-licensor case *NPI^{M}NEG$^{\varnothing}$).

However, attenuation of the violation response at the matrix verb is not necessarily, we think, a strong prediction of the CBR account. At the matrix verb, it will still be the case that the matrix subject will have to be thematically integrated, and if licensing of the matrix subject NPI has already (illicitly) occurred at the embedded verb, this may result in a conflict. That is, such a situation would presumably require an output to parsing procedures whereby the matrix subject NPI must somehow be simultaneously within the scope of the embedded verb *and* outside its scope, in virtue of its thematic integration with the subject. Put another way, if our intrusion comparisons show indications at the embedded verb that licensing operations have erroneously been engaged, that state-of-affairs could yield downstream difficulties for thematic integration at the matrix verb.

Sentence final acceptability judgments. Finally, whether or not online ERP response patterns diverge from the profile of downstream sentence-final measures (e.g. behavioural responses to acceptability judgment prompts) is an open question. Self-paced reading data from English (Parker & Phillips, 2011, 2016) suggest online and offline measures may diverge, with evidence of intrusion emerging only online. Also, several previous ERP studies of intrusion have not coupled ERPs with acceptability judgment (Drenhaus et al., 2005; Xiang et al., 2009), so for those previous studies we simply don't know whether such sentence-final judgment measures would have shown indications of intrusion effects or not.

In anticipation of the possibility that intrusion effects may obtain for these sentence-final judgment measures in the present study, we included an additional manipulation of NPI/licensor distance (this was also to vary the predictability of the stimulus materials – see *Methods: Materials*). Though our study did not include enough items overall to make it reasonable to examine such a distance manipulation in the ERP data, we did want to see whether this would impact sentence final acceptance rates. Recall from above that NPI/licensor distance influences the presence/absence of intrusion effects for English *ever* (Parker & Phillips, 2016). Parker & Phillips suggest that as more time passes the likelihood increases that complex structures containing intrusive licensors may undergo a recoding in virtue of semantic composition operations, rendering the part structure of such complexes inaccessible. However, if this is the correct diagnosis of effects of NPI/licensor distance on intrusion, we may not expect to see such distance effects in the kinds of Turkish configurations tested here. The reason is that we presumably wouldn't expect the embedded complement clauses containing our intrusive licensors to have undergone the assumed composition-driven recoding until *after* the embedded verb itself is encountered, but this is precisely the point at which intrusive licensing may occur in our study. In any case, given the possibility that intrusion effect may *only* be visible in our online ERP measurements, and not in the sentence-final judgment data, we did not make strong predictions regarding these patterns.

Methods

Participants

Twenty-two native speakers of Turkish participated in the experiment (12 female; mean age = 28.6, SD = 7.1) in exchange for monetary compensation ($12/hour). All participants were right-handed, with no history of familial sinistrality. Four participants were excluded from the analyses presented below due to excessive noise in the EEG data (blinks, muscle noise, etc.). Thus, the data we discuss below were based on 18 participants (7 male, mean age 27.7 years (SD = 6.9)).

Materials

Individual participants were presented with a total of 432 sentences, half of which (216 sentences) were constituted by the six core conditions of the present study (Table 1, with 36 sentence items per condition). The other half of the stimuli were constituted by (i) three types of well-formed sentences containing no NPIs with either matrix, embedded, or no negation (serving target word control comparisons – see Table 2), or (ii) three types of violations not involving NPIs. Thus, each presentation list involved 12 types of sentences (half involving violations), each represented by 36 sentences (12 × 36 = 432).

Three presentation lists were derived from a masterlist of 1296 sentence items which was constructed as follows. First, sentence triples constituting the core matrix NPI conditions of the experiment (i.e. NPI^{M}NEG^{M}, *NPI^{M}NEG^{E}, *NPI^{M}NEG$^{\varnothing}$) were constructed so that each of the three core conditions were represented by 36 sentences. These core items were then manipulated to create the three embedded NPI conditions (NPI^{E}NEG^{M}, NPI^{E}NEG^{E}, *NPI^{E}NEG$^{\varnothing}$) by switching in a non-NPI nominal expression (proper name or noun phrase) for the matrix subject NPI, and switching in genitive marked NPI (*kimsenin*) for the embedded subjects. The non-NPI controls were similarly derived by replacing all NPIs with non-NPI nominal expressions, as shown in Table 2.

Finally, the three types of filler violations (thematic-role, agreement, and case violations) were generated by manipulating the properties of the matrix verb (for thematic role and agreement conditions) or the embedded verb (for the case-violation), based on the non-NPI control conditions (Table 2). Importantly, each of these three additional violation types was introduced orthogonally to our negation manipulation so that presence/absence of negation did not predict the type of filler violation in these cases. Thus, for each of the three filler violation types, one third contained no negation, one third contained embedded negation, and one third contained matrix negation. So as not to overburden the reader with a more lengthy exposition, discussion of these filler violation cases is suppressed here (but see Yanilmaz, *in preparation* for detailed discussion, and comparison of the violation profiles for these filler conditions to the NPI licensing manipulations).

These foregoing steps yielded sufficient items for a single presentation list (432 sentences / 12 condition = 36 sentence per condition) but with significant repetition of lexical material. Thus, two *additional* lists with the same properties were generated based on different lexical material (e.g. names, verbs, etc.), and were combined together to yield the masterlist of (432 × 3) 1296 sentences. This enabled us to generate three presentation lists of 432 items each where only four items from each set of 12 matched cases were used for a given list. This strategy reduced repeated presentation of sentences containing the same lexical items. Items constituting repetitions in this sense (i.e. drawn from a given set of 12) were separated into the quarters of each of the three presentation lists, maximising their distance from one another. For each list, items representing the 12 conditions were evenly distributed across the experiment, and then pseudo-randomized such that no more than two of any given condition were adjacent in the list, and such that there were never more than three "correct" or three "violation" conditions in a row.

Finally, three other important restrictions on our sentence items were implemented. First, the embedded and matrix verbs in these stimuli were always *adjacent*. This allowed us to time-lock EEG signals to the onset of the embedded verb, and examine epochs corresponding to both the embedded verb and the matrix verb (illustrated in Figures 1 and 2 above). Second, we manipulated the linear distance (in terms of numbers of intervening words) between the matrix NPIs and that matrix verbs by systematically inserting additional material (e.g. direct objects of the embedded verbs, which precede the verb given Turkish SOV word order; adjunct/modifier phrases, etc.). Thus, NPI-licensor distance fell into one of three categories: "short" conditions had just the embedded subject and embedded verb intervening between the matrix subject and the matrix verb, so that this verb was the third item following the matrix NPI; "medium" conditions had the matrix verb as the fifth item following the matrix NPI, and "long" conditions had the matrix verb occur as the seventh item following the matrix NPI. Table 3 illustrates this manipulation with representative examples.

Again, though our design did not include sufficient items to examine ERP data for these conditions separately, this distance manipulation did enable us to examine the sentence-final judgment task data taking this factor into account. Given that all stimuli were constructed using our matrix subject NPI items as the base, this means the distance manipulation was carried out across the entire stimulus set. This yielded the further benefit of reducing the predictability of our stimuli (given that all sentences in this study realised the same abstract syntactic structure (i.e. [matrix-Subject [embedded-Subject embedded-Verb] matrix-Verb]]).

Last, to avoid ERP effects on our matrix verbs associated with sentence final "wrap up" (Hagoort, 2003), all sentences contained at least one word following the matrix verb (either an indirect object or adjunct/modifier).[9] Thus, our main verbs were always the penultimate words in our sentences.

Procedure

Participants were seated in a dimly lit testing booth and silently read the 432 sentences, presented in six blocks of 72 sentences, with a short break in between each. Sentences were presented one word at a time in the centre of the computer monitor with a presentation time of 700 ms per word (informal pre-testing indicated this relatively slow presentation rate was necessary due to the morphosyntactic complexity of Turkish words). Participants were asked to refrain from blinking while reading, but they were permitted to blink their eyes at a blink prompt

Table 3. Example items for the distance manipulation.

DISTANCE	MATRIX SUBJECT	EMBEDDED CLAUSE SUBJECT + VERB	MATRIX VERB
Short	**Kimse**	[Ali'nin çalış-tığ-ı]-nı	söyle-**me**-di
	"Anybody didn't say that Ali worked" = "Nobody said that Ali worked"		
Medium	**Kimse**	[Ali'nin salonda televizyon izle-diğ-**i**]-ni	söyle-**me**-di
	"Anybody didn't say that Ali watched TV in the living room" = "Nobody said that Ali watched TV in the living room"		
Long	***Kimse**	[Ali'nin geçen yaz dil kursuna git-tiğ-i]-ni	söyle-**me**-di
	"Anybody didn't say that Ali went to the language course last summer" = "Nobody said that Ali went to the language course last summer"		

which appeared between items. After each sentence, participants made an acceptability ("good"/"bad") judgment by mouse click. Each session was preceded by a practice block with 12 sentence items (6 acceptable and 6 unacceptable). They received feedback and were invited to ask clarification questions at that time. Experimental sessions typically lasted approximately three hours, including the set-up, clean-up, participant debriefing, with approximately ~70–80 min of that total time in the booth for the actual experiment.

EEG recording, data processing, and analysis

During the experiment EEG was continuously recorded from 32 cap-mounted electrodes (Biosemi Active2 system). Horizontal and vertical EOG was also recorded via electrodes placed above and below the right eye, and at the outside of both the left and right eye (outer canthi). Finally, electrodes were also placed to record activity from the mastoids (left/right). EEG were sampled at 512 hz with an online bandpass filter of 0.01–125 Hz.

All EEG data were processed using Matlab based platforms EEGLAB/ERPLAB. Raw data were imported and offline referenced to the average of left/right mastoids. All data files were then filtered (0.1–30 hz bandpass), epoched into 2100 ms windows time-locked to the embedded verbs (−100 to 2100 ms, with −100 to 0 ms serving as the baseline), and subjected to automatic artefact rejection routines. Following this step, each participant's data were evaluated by hand, to ensure no artefacts were missed (and no trials were erroneously excluded). Finally, participant's data were averaged for each condition, and all participant's files were averaged together to create a grand average file used for data visualisation (plots shown below were additionally low-pass filtered at 9 hz, but statistical analyses were carried out over the unfiltered data).

Repeated measures ANOVAs were carried out separately over midline electrodes (Fz/Cz/Pz) and lateral electrodes, with mean amplitude for targeted latency ranges (time-windows) as the dependent measure (see below). Lateral analyses were conducted over four averaged regions of interest (ROIs) realising a 2×2 grid as shown in Figure 3 (i.e. left anterior (LA), right anterior (RA), left posterior (LP) and right posterior (RP)). Thus, in addition to condition factors, unless otherwise specified below, midline analyses included the three level topographical factor ANTERIOR/POSTERIOR (AP: Fz/Cz/Pz), and lateral analyses included two 2-level factors ANTERIOR/POSTERIOR (AP: Anterior/Posterior) and HEMISPHERE (HEMI: Left/Right).

Condition factors in our analyses included NPI (NPI^{M}/NPI^{E}/NPI^{M}) and NEGATION (NEG^{M}/NEG^{E}/$\text{NEG}^{Ø}$). Following the motivations of the design and predictions as sketched above, we pursued our analyses in several steps.

First we evaluate ERP effects for both local licensing of embedded NPIs and intrusion effects involving matrix NPIs, as well as effects tied to the presence/absence of negation on embedded and matrix verbs in our control conditions where NPIs were absent. Second, we turn to the ERP profiles for outright licensing violations involving both embedded and matrix NPIs, again considering no-NPI control conditions in the mix to evaluate the effects that may be tied to the presence/absence of matrix verb negation. Third, we present further analyses relating our central case of intrusion to the patterns seen for outright licensing violations involving matrix NPIs,

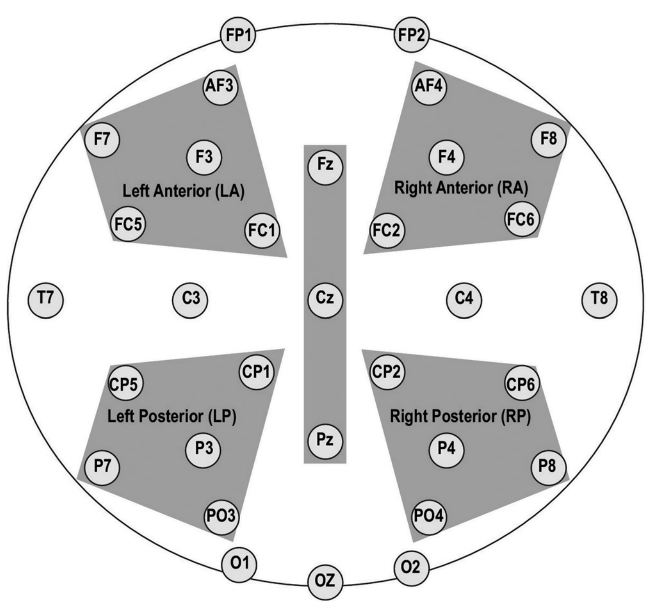

Figure 3. Regions of interest (ROIs).

where we document an interesting mixed pattern involving both attenuated/absent violation effects for intrusion (concerning the P600 response) as well as one particular shared effect that intrusion and unlicensed NPIs seem to have in common (concerning the N400). Finally, we present the behavioural data from our sentence final acceptability judgment task, with special attention paid to the NPI/licensor distance manipulation in our intrusion conditions.

Results

NPI-licensing & presence/absence of embedded negation

Three ERP effects of interest connected to the processing of the embedded verb obtained in these comparisons (Figures 4 and 5) which will be analyzed in the present section. In Figure 4(A), grand average ERPs are shown for matrix/embedded negation conditions, with matrix and embedded NPI comparisons superimposed, highlighting the main effects of negation (common patterning across the intrusion and local licensing comparisons). In Figure 4 (B), the matrix NPI conditions are superimposed with the no NPI controls, demonstrating that responses seen for the NPI conditions were not due to the simple presence/absence of negation (and, that there are additional effects connected with negation processing in the absence of NPIs – see below). Figure 5(A–C) present select ROIs highlighting the effects in both NPI and no NPI controls, with scalp voltage maps plotting difference waves for 100 ms time-windows in Figure 5(D) (row (i) and (ii) show voltage maps for matrix and embedded NPIs, respectively; (iii) collapses across NPI types, showing the main effects of negation in NPI conditions; (iv) shows negation effects in the no NPI control conditions).

First, for both the matrix (NPI^{M}NEG^{M}/*NPI^{M}NEG^{E}) and embedded (NPI^{E}NEG^{M}/NPI^{E}NEG^{E}) comparisons, a LAN effect emerged with matrix negation conditions more negative-going from ~300 to 1100 ms (Figures 4(A) and 5(A, B); and see voltage maps (i)-(iii) in 5(D)). Second, the offset of this shared LAN effect across both NPI comparisons was punctuated by a another (also shared) effect consisting of a posterior relative positivity around ~850–1050 ms (P600 effect), with embedded negation conditions more positive-going (Figures 4(A) and 5(A,B); and see voltage maps in 5(D)). Note that neither the LAN nor the P600 effects for embedded verb negation manifested in our no-NPI controls (Figure 5(C)). However, the third effect of interest manifested in the no-NPI conditions only (NPI^{Ø}NEG^{M}/NPI^{Ø}NEG^{E}) where negated embedded verbs yielded an N400 effect relative to non-negated embedded verbs (Figures 4(B) and 5(C), and voltage maps (iv) in 5(D)). The LAN/P600 pattern for the NPI conditions and the N400 emerging for the controls will be detailed directly below. Finally, a fourth effect that is prominent in Figures 4 and 5(A) is a relative negativity for the intrusion comparison only that emerged at the end of the measurement epoch. This appears to be a sentence final N400 response. However, we will postpone discussion of this effect, returning to this below in the context of other comparisons for reasons that will become evident as we proceed (to anticipate: this effect emerged also for unlicensed matrix NPIs, constituting a shared response between intrusion and unlicensed matrix NPI conditions – see below).

Lan & P600 effects for intrusion and local licensing

The LAN and P600 effects visible in Figure 4(A) (see also Figure 5(A,B), and voltage maps in 5(D) (i)-(iii)) were predicted outcomes, and their presence was confirmed by our statistical analyses. The LAN effect emerged for *both* the matrix and embedded NPI conditions (Figure 5 (A,B)). Analyses over just the anterior ROIs (LA/RA, see Figure 3) involving all four NPI conditions for an 800 ms time-window (300–1100 ms) revealed an NEG × HEMI interaction [$F(1,17) = 16.83$, MSE = 0.22, $p = 0.0007$]. This interaction was driven by a main effect of Negation over the left anterior ROI [$F(1,17) = 8.24$, MSE = 1.96, $p = 0.0106$], and the absence of any effect of Negation of the right anterior ROI [$F < 1$, MSE = 2.06] (i.e. a left lateralised effect). Crucially, in none of these analyses was there any indication of NPI × NEG interactions [F's < 1], indicating a shared effect across our two NPI comparisons.

Second, near the end of this shared LAN effect, another shared response emerged in the form of a relative positivity, with embedded verb negation conditions more positive going (P600 effect – see Figures 4(A) and 5 (A,B), and voltage maps (i)-(iii) in 5(D)). Analyses including all four NPI conditions for posterior recording sites (i.e. collapsing across our two posterior ROIs and Pz on the midline) revealed, just as with the LAN effect, a main effect of Negation [$F(1,17) = 4.38$, MSE = 9.74, $p = 0.0517$] and no NPI × NEG interactions or condition × HEMI interactions [F's < 1], indicated a broadly distributed bilateral effect, consistent with visual inspection of the data. However, as is also evident in the grand average ERPs Figure 5(A,B) and voltage maps (i) vs. (ii) in 5(D), this P600 effect appeared to demonstrate a slightly earlier onset for the intrusion comparison (NPI^{M}-NEG^{M}/ *NPI^{M}NEG^{E}) than for the local licensing of the embedded subject NPI (NPI^{E}NEG^{M}/NPI^{E}NEG^{E}). To examine this, we divided the P600 time-window in two (850–950 and 950–1050 ms) and compared the four NPI conditions within each of these latency ranges, again including just the posterior ROIs and Pz. These narrower

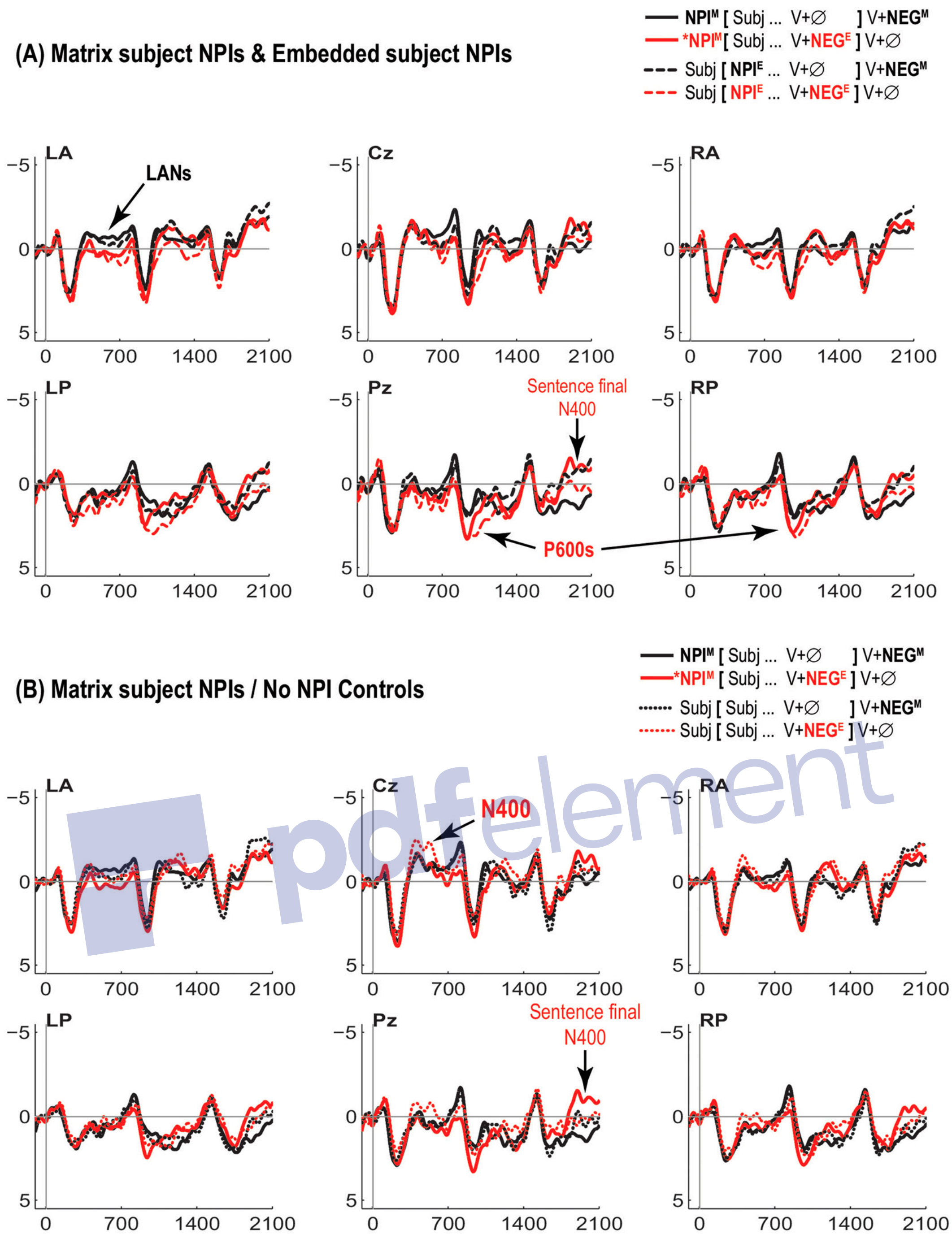

Figure 4. Embedded versus Matrix Negation comparisons for matrix and embedded subject NPIs (A) and matrix NPIs vs. no NPI controls (B).

comparisons revealed a trend towards an NPI × NEG interaction from 850 to 950 ms [$F(1,17) = 3.29$, $MSE = 3.99$, $p = 0.0872$]. Separate analyses for matrix and embedded NPIs showed a significant effect of Negation for the former [$F(1,17) = 6.86$, $MSE = 7.44$, $p = 0.0180$], and not for the latter [$F < 1$]. In contrast, in the later of the two time-windows (950–1050 ms) we find only a Negation main effect [$F(1,17) = 4.97$, $MSE = 8.72$, $p = 0.0394$] and no hint of any NPI × NEG interaction [F's < 1].

In summary, our intrusion comparison (NPI^{M}NEG^{M}/ *NPI^{M}NEG^{E}) and our local licensing comparison (NPI^{E}-NEG^{M}/NPI^{E}NEG^{E}) yielded nearly identical response patterns consisting of a LAN effect (with embedded negation conditions less negative-going over the left anterior ROI) which was punctuated by a P600 effect (with embedded negation conditions more positive-going over posterior regions).[10] Narrower follow-up analyses showed the onset of the P600 for intrusion

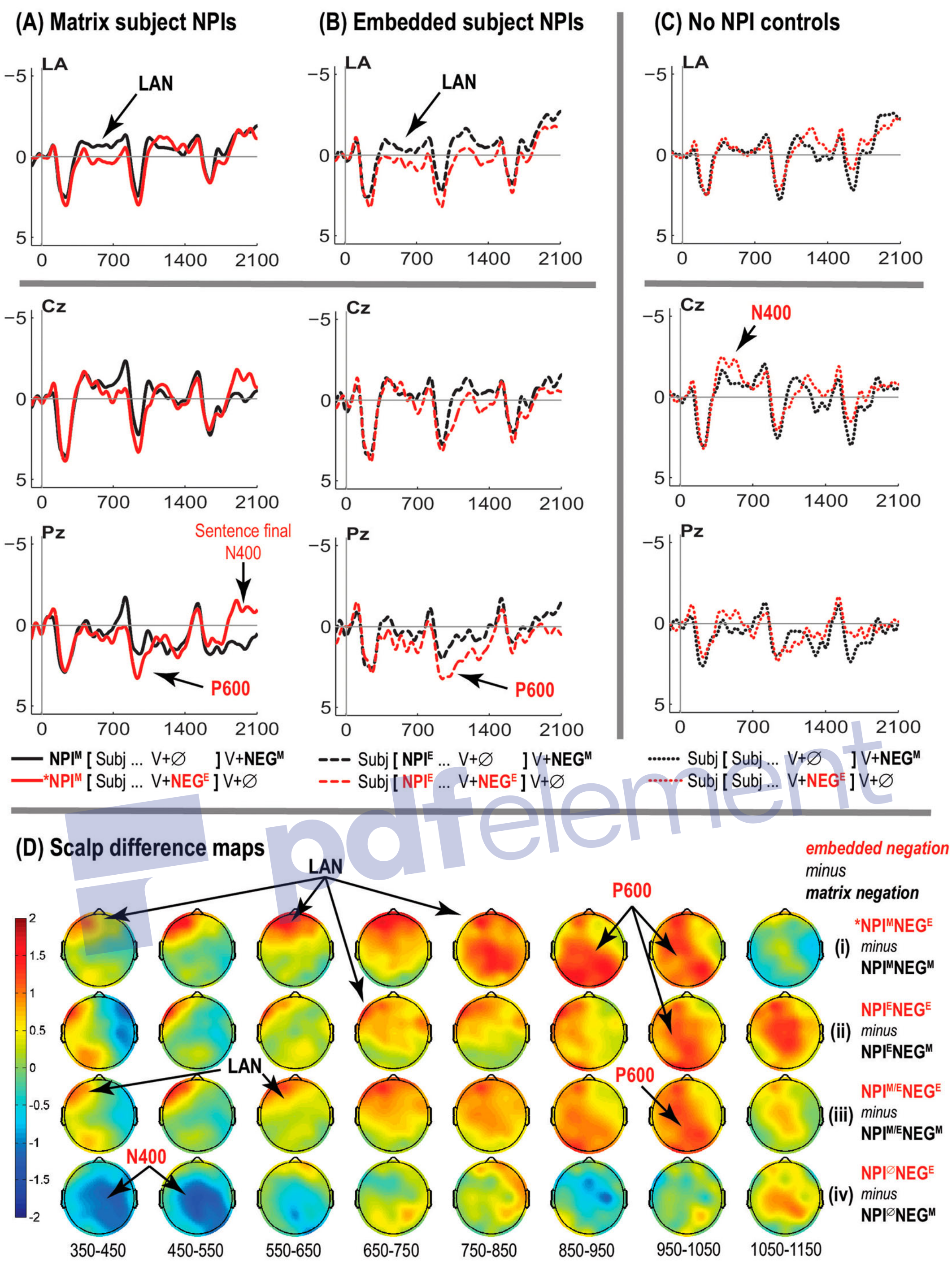

Figure 5. Select Regions of Interest (ROIs) and scalp difference maps for matrix/embedded negation comparisons. (A) matrix NPIs, licensed vs. intrusion; (B) embedded NPIs, locally vs. non-locally licensed; (C) No NPI controls; (D) Difference maps showing embedded/matrix negation contrasts for (i) matrix NPIs, (ii) embedded NPIs, (iii) main effects collapsing over NPI types; (iv) No NPI controls.

to have been ~100 ms earlier than the P600 for the local licensing contrast. Note this latency difference is evident in visual inspection of the data (compare the P600 at electrode Pz in Figure 5(A) versus (B), and voltage maps (i) versus (ii) in Figure 5(D) across the 850–1150 ms range).

Setting aside these slight timing differences, inspection of the embedded/negation main effects for the NPI conditions (see (iii) in Figure 5(D)) compared to the No NPI control conditions ((iv) in Figure 5(D)) show that the two NPI conditions had yet another feature in common. That is, they both *lacked* an effect that manifested only for our no-NPI control conditions (NPI^{Ø}NEG^{M}/ NPI^{Ø}NEG^{E}), to which we turn directly.

Embedded/matrix negation no-NPI control comparisons

As can be seen in Figure 4(B) (see also Figure 5(C) and voltage maps (iv) in 5(D)), inclusion of the control comparisons with no NPIs were important for two reasons. First, there was a clear N400 effect for negated (relative to non-negated) embedded verbs in these control comparisons which was *absent* for our NPI conditions. Analysis for this control comparison demonstrated significant main effects of Negation [midline, NEG: [F(1,17) = 9.15, MSE = 5.85, p = 0.0076; lateral ROIs, NEG: F(1,17) = 4.75, MSE = 4.94, p = 0.0436]. Analyses including all six conditions for both the lateral ROIs and midline electrodes revealed NPI × NEG interactions [midline, NPI × NEG: F(2,34) = 2.49, MSE = 8.01, p = 0.0980; lateral, NPI × NEG × AP × HEMI: [F(2,34) = 4.09, MSE = 0.16, p = 0.0257].

The second important feature of the control comparisons is that the LAN and P600 effects that were evident for our NPI comparisons were completely absent, demonstrating that those crucial patterns for NPIs cannot be attributed to target word (± Negation) differences alone. For both the long 300–1100 ms LAN time-window for anterior ROIs and the P600 time-window (850–1050 ms) for posterior recording sites, global analyses including all six conditions yielded significant NPI × NEG interactions (i.e. for the LAN, [NPI × NEG × HEMI: F(2,34) = 3.99, MSE = 0.19, p = 0.0286], and for the P600 [NPI × NEG: F(2,34) = 3.28, MSE = 4.29, p = 0.0498]). Follow-up analyses for just the no-NPI controls alone showed no LAN or P600 effects connected with Negation [F's < 1].

Summary. When no NPIs were present, negated embedded verbs yielded an N400 effect relative to non-negated embedded verbs. When NPIs were present – whether in the matrix or embedded subject positions – this negation-related N400 effect was suppressed. And finally, LAN and P600 effect elicited for our NPI conditions were absent in our no NPI control conditions.

NPI-licensing & presence/absence of matrix negation

Unlicensed NPIs

Our unlicensed NPI conditions revealed partly shared and partly distinct effects for matrix and embedded NPIs. As can be seen in Figures 6 and 7(A), the common pattern across these comparisons was a robust P600 effect, which manifested clearly for both matrix and embedded subject NPIs. However, for the matrix subject NPIs only there were both pre- and post-P600 negativities demonstrating timing and scalp distributions consistent with N400 effects (see Figure 7 (A)).

These observations were confirmed by our statistical analyses. First, analyses including all four NPI conditions showed a significant NPI × NEG × AP interaction [Lateral ROIs: [F(1,17) = 7.34, MSE = 1.38, p = 0.0147] in the N400 time-window (1150–1250 ms). This interaction was driven, as evident in Figures 6 and 7(A), by a N400 deflection for the matrix NPI conditions (i.e. NPI × AP interaction [Lateral ROIs: F(1,17) = 8.93, MSE = 1.53, p = 0.0082]) with the unlicensed NPIs more negative-going, and the absence of the effect for embedded subject NPIs [F's < 1].

Second, the P600 time-windows (1250–1450 and 1450–1650 ms) revealed a shared P600 deflection for embedded and matrix NPIs, but scalp distribution differences across time-windows and conditions. In the 1250–1450 ms time-window, for example, we found main effects of Negation on the midline [F(1,17) = 12.52, MSE = 13.52, p = 0.0025] and no interactions with topography and no NPI × NEG interactions [F's < 1]. In the subsequent 1450–1650 ms range, however, midline analyses revealed only a NEG × AP interaction [F(2,34) = 9.98, MSE = 1.46, p = 0.0004]. These results were due to the fact that the effect began as a broadly distributed positivity which subsequently localised to more posterior scalp regions.

Further, though the midline analyses did not show any evidence that the scalp topography of these effects differed as a function of NPI type (matrix vs. embedded), the lateral ROI analyses did reveal such interactions. In the first P600 time-window (1250–1450 ms), in addition to the main effect of Negation [F(1,17) = 6.90, MSE = 13.28, p = 0.0177], there also was an NPI × NEG × AP interaction [F(1,17) = 4.93, MSE = 1.55, p = 0.0403]. Separate analyses of the matrix and embedded NPI comparisons showed only a main effect of Negation for matrix NPIs [F(1,17) = 5.10, MSE = 8.84, p = 0.0374] with no NPI × topography interactions, while for embedded NPIs there was a NPI × AP interaction [F(1,17) = 5.04, MSE = 1,45, p = 0.0384]. These results were due to the fact, as can be seen in the voltage maps in Figure 8, that in this first P600 time-window the matrix NPI conditions exhibited a more uniform scalp distribution, whereas the P600 for embedded NPIs was larger over the right than the left hemisphere, and larger over posterior compared to anterior ROIs.

In the later time-window (1450–1650 ms), though there were marginal indications of NPI × NEG interactions (e.g. NPI × NEG × AP: F(1,17) = 2.86, MSE = 1,64,

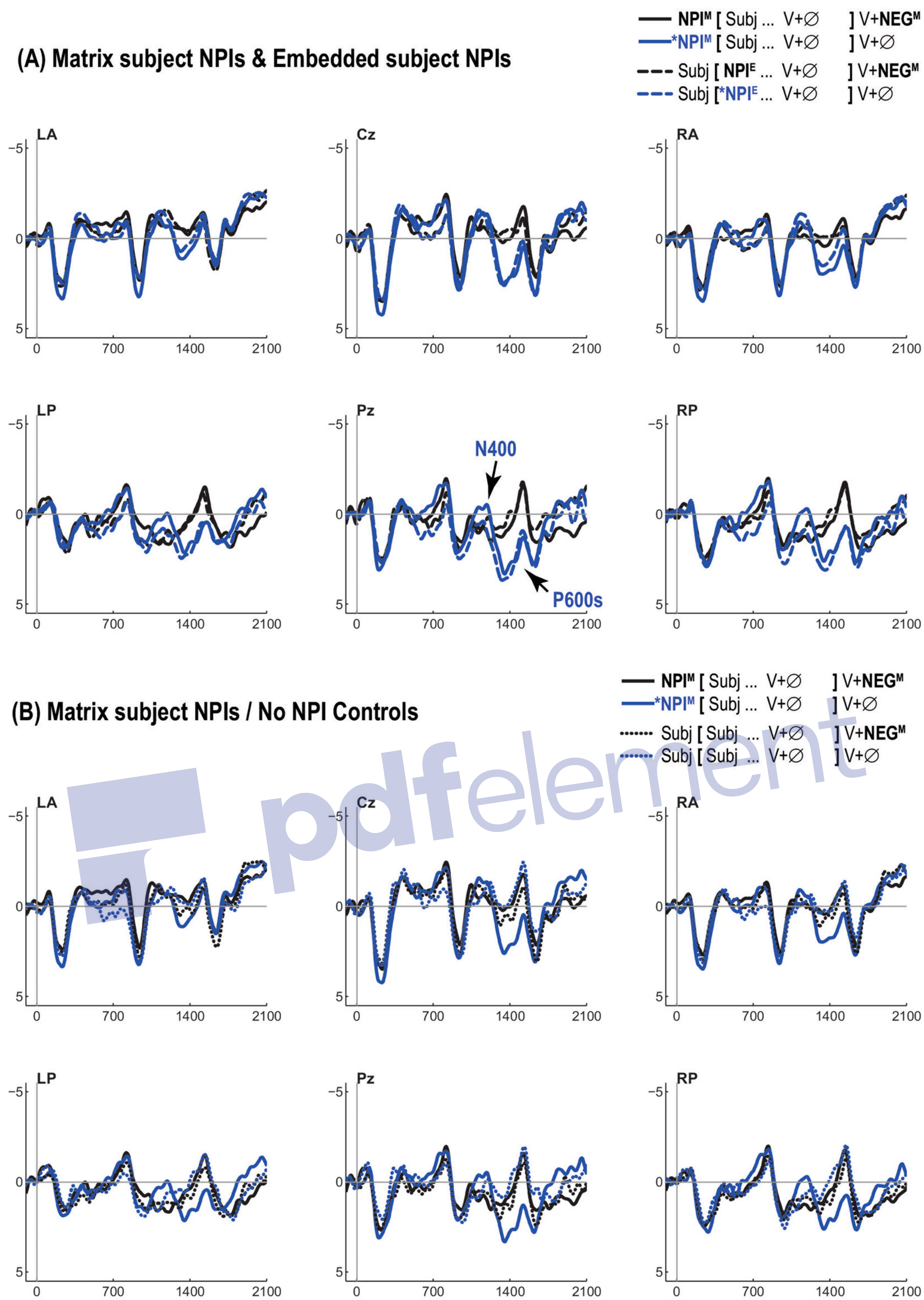

Figure 6. Matrix negation versus No Negation comparisons for matrix and embedded subject NPIs (A) and matrix NPIs versus no NPI controls (B).

$p = 0.1092$; NPI × NEG × AP × HEMI: $F(1,17) = 3.25$, MSE = 0.39, $p = 0.0891$]), the shared pattern of the more posterior distribution evident in the midline analysis was dominant [NEG × AP: $F(1,17) = 12.88$, MSE = 2.20, $p = 0.0022$].

Finally, in the matrix NPI comparison only, there was a sentence-final word N400 effect. Comparisons over all four NPI conditions exhibited significant NPI × NEG × AP interactions in both the lateral ROI [$F(1,17) = 10.06$, MSE = 0.89, $p = 0.0056$] and midline analyses [$F(2,34) =$

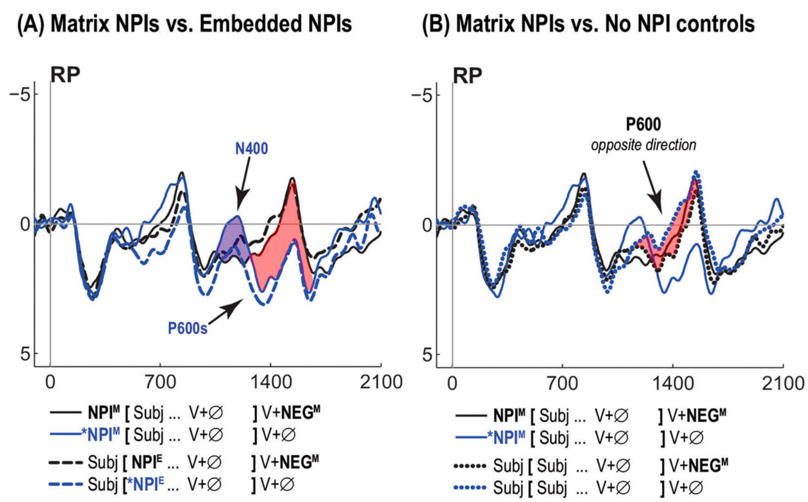

Figure 7. Right posterior ROI showing matrix/embedded NPIs in licensed (matrix negation) and unlicensed (no negation) contexts (A); matrix NPI licensed/unlicensed vs. No NPI controls (B).

4.18, MSE = 0.83, $p = 0.0238$], consistent with the presence / absence of the negativity across our NPI conditions. We return to this effect in more detail below, in a comparison to a similar sentence final effect elicited in our intrusion condition.

Matrix negation effects in the no NPI control conditions

Presence/absence of negation on matrix verbs in our no NPI control conditions yielded, strikingly, the *opposite* pattern as we see for the NPI violation conditions, namely a P600-like response for negated relative to non-negated verbs (see Figures 6 and 7(B)). However, analyses conducted in the 1250–1450 and 1450–1650 ms time-windows revealed no significant effects of Negation or Negation × topography interactions for these noNPI control comparisons. Nonetheless, a marginal effect of Negation on the midline for the later of these two time-windows [$F(1,17) = 2.90$, MSE = 9.82, $p = 0.1069$], in combination with the importance of documenting ERP response patterns connected to negation processing, prompted us to consider two additional exploratory analyses.

First we reran analyses for the same two P600 time-windows including only the two posterior ROIs and Pz on the midline, which yielded a significant effect of negation in the 1250–1450 ms time-window [$F(1,17) = 4.96$, MSE = 5.20, $p = 0.0396$] and a borderline effect in the subsequent 1450–1650 ms range [$F(1,17) = 3.57$, MSE = 6.09, $p = 0.0759$].

We also conducted analyses over all ROIs with the two P600 time-windows split into two (i.e. 1250–1350, 1350–1450, 1450–1550, and 1550–1650 ms). In these analyses a NEG × AP interaction emerged in the 1350–1450 ms time-window for the lateral ROIs [$F(1,17) = 5.47$, MSE = 1.21, $p = 0.0318$]. Follow-up analyses confirmed the presence of a Negation effect over posterior [$F(1,17) = 6.60$, MSE = 2.68, $p = 0.0199$] but not anterior ROIs [$F < 1$]. In sum, though the effect was not particularly robust, in the absence of NPIs main verb negation yielded P600-like positivities compared to non-negated main verbs.

Intrusion and local licensing compared to unlicensed NPIs

We have so far shown that our intrusion and local licensing comparisons strongly resemble one another, and that the observed effects cannot be attributed to target word differences in ERP responses connected to the mere presence/absence of negation. When negated embedded verbs are encountered following either an embedded or a matrix subject NPI, N400 effects which are otherwise elicited by negation are suppressed, and LAN effects emerge ($NPI^{M}NEG^{M} > *NPI^{M}NEG^{E}$ and $NPI^{E}NEG^{M} > NPI^{E}NEG^{E}$) which are punctuated at their offset by P600 effects ($*NPI^{M}NEG^{E} > NPI^{M}NEG^{M}$ and $NPI^{E}NEG^{E} > NPI^{E}NEG^{M}$). In these ways at least, our intrusion condition behaves nearly identically to local/licit licensing of embedded subject NPIs, suggesting the same underlying processing is at work in both cases.

In addition, licensing violations at the matrix verb position differ qualitatively for matrix versus embedded subject NPIs. Though these conditions shared a robust P600 effect, both pre- and post-P600 negativities that strongly resemble N400 effects emerged for the matrix subject NPIs only.

These additional negativities are of even further interest when we consider the intrusion comparison.

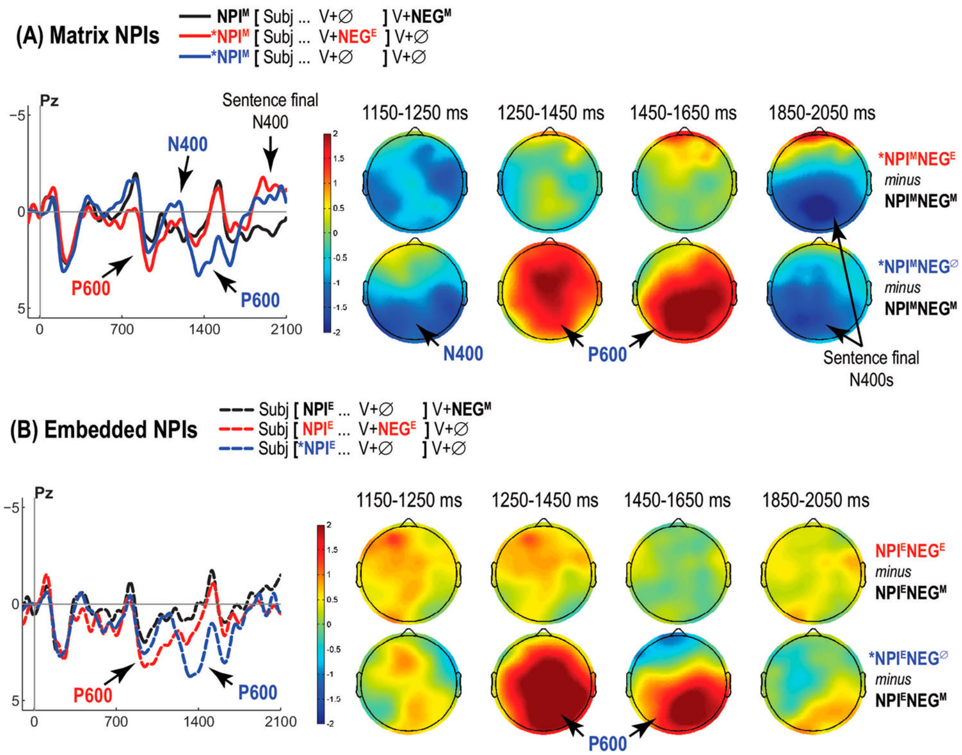

Figure 8. Violation responses for unlicensed matrix NPIs and missing P600 effects for intrusion (A); unlicensed embedded NPI violation responses (B).

Although our intrusion condition did not show any indication of the P600 violation response at the matrix verb position (Figure 8(A)), there appeared to be a weak trend towards a relative negativity in the same time-window (1150–1250 ms; i.e. 450–550 ms after matrix verb onset – see voltage map for this time-window in Figure 8(A)) where the (pre-P600) N400 effect emerged for unlicensed matrix subject NPIs. Also, a sentence-final N400 effect emerged which was indistinguishable from the effect seen when matrix NPIs were unlicensed.

Direct comparisons across our three negation subconditions for matrix NPIs were consistent with the foregoing characterisation of these patterns. First, the matrix verb N400 time-window (1150–1250 ms) demonstrated NEG × AP interactions in both the lateral ROI [$F(1,17) = 4.21$, $p = 0.0233$] and midline analyses [$F(4,68) = 2.74$, $p = 0.0355$]. Above, we showed the N400 effect was significant for unlicensed NPIs. Comparisons between the licensed and intrusion conditions (Ma/Mb) showed no effects of Negation on the midline [$F(1,17) = 1.60$, $p = 0.2296$] but a marginal effect of Negation in the lateral ROI analysis [$F(1,17) = 3.90$, $p = 0.0648$]. This pattern is consistent with visual inspection of the data. As can be seen in Figure 8(A) the negativity for the intrusion condition exhibits a weak bilateral distribution and does not appear to involve midline recording sites. To further examine these negativities for unlicensed matrix NPIs and the intrusion condition, we also compared the difference waves ($\text{NPI}^{M}\text{NEG}^{E} - \text{NPI}^{M}\text{NEG}^{M}$ vs. $\text{NPI}^{M}\text{NEG}^{\varnothing} - \text{NPI}^{M}\text{NEG}^{M}$). In these comparisons, condition × AP interactions emerged in both the midline [$F(2,34) = 4.59$, $p = 0.0171$] and lateral ROI analyses [$F(1,17) = 5.65$, $p = 0.0295$]. However, follow-up analyses for anterior and posterior ROIs, and for individual midline electrodes, showed no significant differences. Thus, interaction pattern seen in the comparison of the difference waves seems to have been driven by the strong posterior distribution of this effect in the unlicensed NPI case compared to the more diffuse, broadly distributed negativity elicited by the intrusion condition. This combined set of results suggests a shared effect (N400 for both intrusion and for unlicensed NPIs), but with a weaker such effect emerging for intrusion.

Comparisons of all three negation conditions in the P600 time-windows (1250–1450 and 1450–1650 ms) yielded main effects of Negation in the first time-window in both the lateral ROI [$F(1,17) = 4.83$, $p = 0.0142$] and midline analyses [$F(2,34) = 5.50$, $p = 0.0085$]. In the subsequent time-window, and consistent with the shift to a more posterior scalp distribution demonstrated above, we find indications of interactions of Negation with topographical factors in the lateral ROI analysis [NEG × AP: $F(2,34) = 2.85$, $p = 0.0717$; NEG × HEMI: $F(2,34) = 4.04$, $p = 0.0267$; NEG × AP × HEMI: $F(2,34) = 2.73$, $p =$

0.0795] and on the midline [$F(4,68) = 3.52$, $p = 0.0113$]. Follow-up comparisons of the intrusion versus licensed case showed no effects of Negation [F's < 1].

Consistent with these results, difference wave comparisons for unlicensed NPIs to intrusion showed significant effects of condition for the 1250–1450 ms time-window in the lateral ROI [$F(1,17) = 5.81$, $p = 0.0275$] and midline analyses [$F(1,17) = 5.46$, $p = 0.0319$], with no interactions involving topography (again, consistent with the initial broad scalp distribution of the P600 for unlicensed NPIs, and the absence of any such effects for intrusion). In the 1450–1650 ms time-window difference wave comparisons were also consistent with the analyses reported above: lateral ROIs showed condition × AP [$F(1,17) = 4.99$, $p = 0.0392$], condition × HEMI [$F(1,17) = 5.12$, $p = 0.0370$], and condition × AP × HEMI interactions [$F(1,17) = 4.93$, $p = 0.0402$], and on the midline there was a significant condition × AP interaction [$F(2,34) = 6.62$, $p = 0.0097$].

Finally, sentence final N400 effects were examined in analyses of all three negation conditions for matrix subject NPIs, yielding Negation × AP interactions in the lateral ROI analysis [$F(1,17) = 3.67$, $p = 0.0360$] and on the midline [$F(4,68) = 4.10$, $p = 0.0176$]. Follow-up analysis comparing unlicensed NPI and intrusion difference waves were consistent with a shared effect (Figure 8 (A)), as there were no significant effects of condition [F's < 1 or p's > 0.20].

Summary. Unlicensed embedded and matrix subject NPIs both demonstrated robust P600 effects with similar timing, but which differed slightly from one another in scalp topography. N400 effects, both preceding and following the P600 violation response, were evident for unlicensed matrix NPIs only. Finally, although our intrusion condition demonstrated no hint of the P600 violation response, a weak trend towards the pre-P600 negativity was present, and a sentence-final N400 effect emerged that was indistinguishable from the late N400 seen for unlicensed matrix subject NPIs.

End of sentence judgment task

Overall our Negation and NPI manipulations yielded the expected pattern of acceptance rates on sentence-final judgments, shown in Figure 9. Sentences with no NPIs demonstrated high acceptance rates overall, and showed no differences in acceptance rates as a function of Negation ($F < 1$).

In contrast, effects of Negation were highly significant for both matrix [$F(2,34) = 134.39$, $p < 0.0001$] and embedded subject NPIs [$F(2,34) = 261.27$, $p < 0.0001$].

Considering just the cases involving NPIs and either matrix or embedded negation, we find an NPI × Negation interaction [$F(1,17) = 55.49$, $p < 0.0001$], corresponding to lower acceptance rates for embedded compared to matrix negation with matrix subject NPIs (i.e. our intrusion effect, [$F(1,17) = 52.71$, $p < 0.0001$], and the opposite pattern for embedded subject NPIs, where acceptance of embedded negation (i.e. local licensing of the embedded subject NPI) was higher [$F(1,17) = 11.55$, $p = 0.0034$].

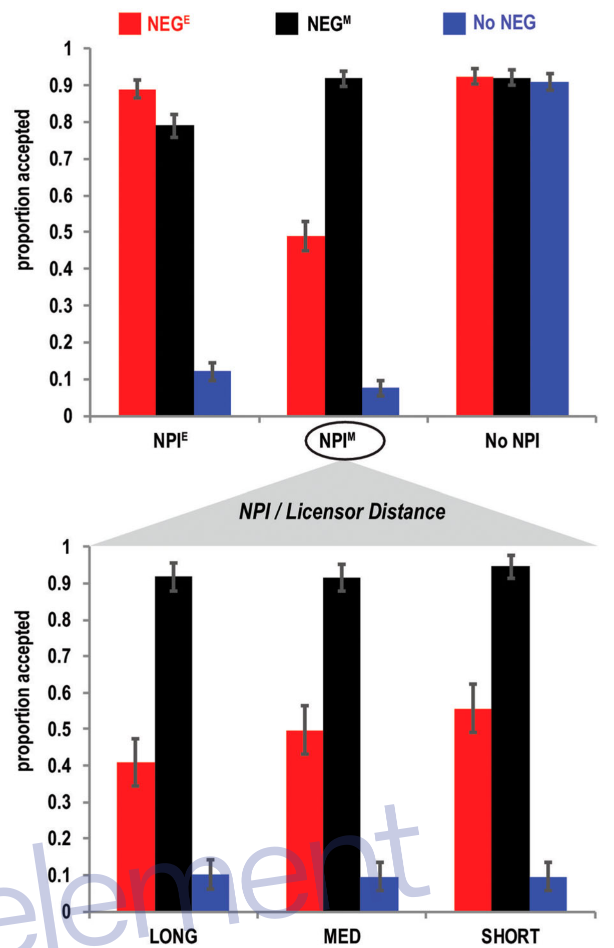

Figure 9. End of sentence judgment task acceptance rates. All conditions (top panel); NPI/Licensor distance manipulation subconditions for matrix NPIs (bottom). Bars represent ± 95% CIs.

In summary, licensed NPIs and sentences without NPIs received overall high acceptance rates while outright violations were overwhelmingly rejected. In addition, acceptance rates for embedded subject NPIs demonstrated a preference for clause-local licensing, but were still quite acceptable when licensed by matrix negation. Finally, intrusion cases showed an intermediate acceptance rate profile, patterning like neither the well-formed nor the violation cases.

Finally, we also examined effects of NPI/licensor distance on acceptance rates for matrix subject NPIs, which are also shown in Figure 9 (bottom panel). An ANOVA including two three level factors Negation (matrix, embedded, and no-negation) and NPI/licensor Distance (long/medium/short) revealed a significant Negation × Distance interaction [$F(4,68) = 2.79$, $p = 0.0331$]. Follow-up comparisons within the levels of negation showed no effects of distance for the well-formed matrix negation cases [$F(2,34) = 1.07$, $p = 0.3555$] or the no-negation violation cases [$F < 1$], but a significant effects of Distance in the embedded negation (intrusion) cases [$F(2,34) = 4.45$, $p = 0.0191$], with the highest acceptance rates (strongest intrusion effects) seen for shortest NPI/licensor distances and the lowest rates (weakest intrusion effects) emerging for the longest NPI/licensor distances, as can be seen in Figure 9.

Discussion

The present study aimed to contribute to our understanding of the mechanisms underlying the encoding, maintenance, and retrieval of information relevant for establishing dependencies between non-adjacent elements during sentence processing, with a specific focus on NPIs. Our investigation of Turkish made available contrasts involving NPI licensing that are simply not testable in the languages that have been the focus of all previous work in this area (e.g. English, German). Perhaps most importantly, employing Turkish as the test language enabled us to investigate conditions that were predicted to differ in terms of the presence versus absence of the engagement of NPI licensing mechanisms *for well-formed sentences*, in addition to cases involving *outright violations* and possible cases of *intrusion*. To summarise, we found that:

(1) Embedded subject NPI licensing at the embedded verb position yielded a P600 relative to the condition where licensing was postponed until the subsequent matrix verb, which itself elicited a relative LAN response (Figure 5(B,D)(ii)).

(2) Crucially, matrix subject NPI comparisons showed this same pattern (Figure 5(A,D)(i)), suggesting that NPI licensing mechanisms were engaged at the embedded verb position, despite the fact that this is not a relationship that is (ultimately) allowed by the grammar of Turkish.

That is, the online processing of our intrusion conditions were nearly identical in their ERP response patterns to contrasts revealing effects of legitimate local NPI licensing.

Moreover, these patterns strongly resemble previously reported effects for processing of filler-gap dependencies (e.g. in *wh*-interrogatives, topicalization, etc., see our Introduction above). Crucially, these LAN and P600 response patterns were absent in control conditions contrasting presence/absence of embedded verb negation in sentences without NPIs. But of equal interest was the fact that these no NPI controls revealed another effect:

(3) The No NPI control conditions demonstrated an N400 for negated embedded verbs relative to non-negated embedded verbs. And, this embedded verb negation N400 response was *absent* in sentences containing NPIs.

Another set of important findings pertains to comparisons at the matrix verb of the intrusion cases to outright violations where NPIs were unlicensed, and in comparisons of violation responses at the matrix verb for unlicensed matrix NPIs versus unlicensed embedded NPIs:

(4) P600 violation effects emerged for both matrix and embedded unlicensed NPIs, and this effect was absent altogether for our intrusion comparison.

(5) N400-like negativities were observed both before and after the P600 effects only for matrix NPI licensing violations (and not for unlicensed embedded NPIs). This dissociation is of further interest because: (i) though our intrusion condition showed no hint of the violation P600 at the matrix verb, it did elicit a weak correspondent of the (pre-P600) N400 effect seen for unlicensed matrix NPIs, and (ii) sentence-final N400 effects that emerged for unlicensed matrix NPIs also clearly emerged for intrusion.

Thus, our intrusion comparison show a partly shared profile with matrix NPI licensing violations: though the violation P600 was absent for intrusion, the N400 responses seen for the outright violations did obtain in the intrusion comparisons (both pre-P600 at the matrix verb, and on sentence-final words). Furthermore, like our embedded verb comparisons, examination of control conditions containing no NPIs revealed an effect of negation on matrix verbs:

(6) When NPIs were absent, negated matrix verbs yielded a P600-like positivity relative to non-negated matrix verbs.

Finally, our sentence final acceptability judgment task confirmed our manipulations worked as we expected them to, and revealed several further patterns of interest:

(7) Sentences with licensed NPIs and control sentences without NPIs were generally judged as acceptable/well-formed, and cases where NPIs were not licensed (where negation was absent) were overwhelmingly rejected.

(8) Our intrusion condition showed an intermediate pattern, differing from both well-formed/correct and outright violation cases.
(9) Embedded subject NPIs revealed a slight preference for clause-local licensing by embedded verb negation, as opposed to licensing by matrix verb negation.
(10) NPI/licensor distance demonstrated a parametric effect on acceptance rates for intrusion, with shorter distances corresponding to stronger illusions of grammaticality (i.e. higher acceptance rates).

These findings have many important implications. **First**, if the EPL account of intrusion is correct, it cannot be general, since this view predicted the *absence* of intrusion effects here. **Second**, NPI licensing dependencies in Turkish are shown here for the first time to pattern in ways that align with previous cross-linguistic evidence concerning other kinds of dependency resolution (e.g. involving *wh*-words in interrogatives). **Third**, the facts that our intrusion cases: (i) pattern with embedded subject NPI licensing comparisons at the embedded verb, and (ii) do *not* show matrix verb P600 violation responses, provide strong evidence that illusory licensing in the configurations we tested is the result of the engagement of normal licensing mechanisms in contexts which are not (ultimately) countenanced by the grammar. **Fourth**, our data also serve to fill a gap in the literature dedicated more generally to understanding the role of negation in sentence processing. Until the present study, to our knowledge, only one previous investigation has reported comparisons time-locked directly to (auditorily presented) negated versus non-negated elements (Lüdtke et al., 2008).[11] Here we not only showed what brain responses to negation look like in Turkish, we also show that these responses (at least the N400 effect for embedded verb negation) are attenuated when negation is *predicted* (i.e. when NPIs occur upstream in processing). **Fifth**, and finally, the behavioural findings for our NPI/licensor distance manipulation provide an interesting complement to proposals offered by Parker and Phillips (2016) to explain the fact that intrusion effects can be ameliorated by time/distance manipulations in languages like English.

Intrusion in Turkish

Comparisons targeting embedded subject NPIs showed a (partly) predicted pattern involving LAN and P600 type effects. When embedded verbs following embedded NPIs were negated, a P600 effect was elicited compared to cases where negation was not encountered until the subsequent main clause verb. This effect was preceded by and overlapped with a LAN difference, with non-negated verbs more negative going. This pattern is consistent with processing components we suggested may be present on the basis of parallel findings from work on *wh*-dependencies in interrogatives in Japanese (Ueno & Kluender, 2009) and in other languages (see Introduction). That is, where embedded negation is encountered following an embedded subject NPI, working memory systems can be relieved of the burden of tracking an unresolved licensing dependency: the embedded subject NPI in this case can be integrated thematically with the embedded verb, and the licensing needs of the NPI can be discharged. These integration processes are aligned here, following previous work, with the P600 effects we documented above (see Steinhauer et al., 2010). However, where negation does *not* appear on the embedded verb, an embedded subject NPI will at that point remain unlicensed, and we suggest that the need for working memory systems to continue tracking this unresolved licensing dependency is what underlies the LAN effect.

Now, we hypothesised that should intrusive licensing patterns emerge in our study, one possible way understanding such patterns would be in terms of the normal operations of NPI licensing mechanisms. That is, if the parser engages these mechanisms at the point where a licensor which is (ultimately) structurally inaccessible is encountered, then our intrusion cases might show response patterns similar to those observed for licit local licensing.

And, indeed, this is precisely what our data show. Though there were slight differences in the timing of the effects, our embedded/matrix negation contrasts revealed nearly identical profiles for matrix and embedded NPIs: in addition to the shared LAN/P600 patterns, the presence of either matrix or embedded subject NPIs also attenuated an N400 effect for embedded negation which otherwise emerged for cases with no NPIs present.

Supposing the foregoing view of the embedded verb response patterns to be correct (we address a few additional points about this below), a further prediction would be that violation response profiles seen in cases where licensors are absent altogether should not arise in intrusion, and this seems to be mostly correct. We show here for the first time what the response profile actually is for unlicensed Turkish NPIs: the consistent effect across conditions was a P600 (in line with Drury & Steinhauer's, 2009 expectations; see also Steinhauer et al., 2010). Importantly, this P600 response was shown to be *completely absent* for our intrusion case, consistent with the upstream effects which we argued above signal the engagement of NPI licensing mechanisms at the position of embedded verb negation (intrusion = local licensing).

Thus, these patterns strongly support the conclusion that, at least in Turkish, intrusion effects result from the local engagement of normal NPI licensing mechanisms in ways that (at least temporarily) ignore structural restrictions on these dependencies (though below we consider the possibility that at the relevant point in parsing these examples, the embedded domain may not be completely analyzed as such). However, it is clearly also important that: (i) our intrusion cases were on average judged as deviant – though much less so than the outright violations, and (ii) that intrusion did elicit N400 like effects that also emerged for unlicensed matrix NPIs (but not for unlicensed embedded NPIs). That is, though the ERP patterns are consistent with the idea that NPI licensing mechanisms are triggered at the embedded negation in the intrusion condition and that this could explain why no matrix verb P600 effect was found, it was still *not* the case that our participants simply treated the intrusion cases as generally grammatical/acceptable. We return below to discuss the shared pattern of main verb (and sentence-final) N400 responses across our unlicensed matrix NPI and intrusion conditions.

Consequences for accounts of intrusion

One conclusion that can be drawn from the present data is that the EPL view of intrusion, if correct, cannot be general. Since the environments we tested (involving complement clauses) were missing one of the two key ingredients that the EPL view requires for the proposed erroneous negative implicatures to be triggered (i.e. contrastive implicatures triggered by modifiers like relative clauses), intrusion effects were predicted not to arise here.

Given that EPL cannot account for the presence of intrusion in Turkish, we must ask whether a CBR account can handle our observed patterns. So far as we can see, it can. Recall that the range of potential Turkish NPI licensors is more restricted compared to a language like English. Therefore, this confined source of available environments might in fact make these dependencies in Turkish more like an item-to-item dependency. As a result, a prospective search for one of the (only two) available licensors (negation or yes/no-question morphemes) will be established upon the comprehension of the subject NPI in the constructions we tested. One can reasonably assume that encounters with NPIs result in some featural encoding of an unmet relational requirement (a prediction of a necessary yet-to-be-encountered element that is [+licensor] or perhaps [+negation]). When such an element is encountered, both in legitimate local licensing environments and in our intrusion case, NPI licensing dependency resolution mechanisms are triggered. This perspective is consistent with the complete attenuation of P600 violation responses at the subsequent matrix verb in our intrusion condition.

However, several important issues still confront a CBR view of our intrusion findings and for the other available data in the literature. Though we cannot address all of the concerns in detail here due to time/space limitations, note that we already flagged some of the issues in our Introduction. Open questions remain regarding how the variety of licensor types in languages like English ought to be encoded, how to treat the apparent role of syntactic structure in regulating the availability of items for retrieval operations (see a useful discussion of these matters in Kush, 2014), and why intrusive licensing seems to pattern differently than cases of agreement attraction in English with respect to time/distance manipulations (Parker & Phillips, 2016).[12]

Of course, the present findings do not *rule out* an application of the EPL to understand findings from English and German (Drenhaus et al., 2005; Xiang et al., 2009). It may be the case, for example, that intrusive licensing has several possible sources that differently manifest cross-linguistically, or perhaps even manifest differently for various sub-types of NPI/licensor dependencies within a given language (as suggested by Xiang et al., 2013). This point of view is also consistent with the data from Parker and Phillips (2016) showing that English *any*, unlike *ever*, does not seem to yield intrusion effects.

In this connection, it is worth re-emphasising the point just made above that Turkish has an extremely limited range of possible NPI licensors compared to a language like English. In particular, Turkish does not seem to have any analogue of the kind of pragmatic licensing we mentioned in the introduction (e.g. *I am surprised we have* ***any*** *sugar*; see Xiang et al., 2013 for relevant discussion). And while Turkish arguably lacks the ingredients needed for the EPL view of intrusion, it may be that *other* features present in Turkish that are absent in English or German are crucial, in particular the prospective nature of these dependencies and the specifics of the structural relationships that obtain in the intrusion environments we tested.

The English/German cases that have been studied involve the presence of a licensor preceding an NPI in the absence of the required structural relationship between the two. In our Turkish cases, in contrast, the required structural relationship could be said to actually obtain, but that the structural asymmetry runs in the wrong direction (i.e. the NPI scopes over negation, instead of the other way around). Since languages with prospective NPI-licensor relationships have not previously been investigated with these methods, this type of configuration has never been tested. Thus it could be that the intrusion effects we have documented here may constitute a special case when added to the range of existing findings.

When does the parser "know" it's dealing with a complement clause?

In addition to the unique linear/hierarchical configuration involved in the present study, it is also worth considering the possible nature of the parse state at the point at which the embedded verbs in our study were encountered. That is, we mentioned above that part of the interest of our findings is that the ERP response patterns suggest the engagement of NPI licensing mechanisms involving two elements that the grammar of Turkish should (ultimately) prohibit from entering into such a relationship.

But one might raise the question of whether this is state-of-affairs is obvious to parsing mechanisms incrementally (i.e. at the relevant point where our ERP data suggest NPI licensing mechanism are engaged in our intrusion condition). That is, considering our crucial intrusion case, repeated here in (11), the question is: At what point is it clear to parsing mechanisms what the structure is?

(11)	*<u>**Kimse**</u>	[Ali'nin çalış-<u>**ma**</u>-dığ-ı]-nı	söyle-di
	anybody	[*Ali*-GEN *work*-<u>**NEG**</u>-FN-AGG]-ACC	*say*-PST.3SG
	"Anybody said that Ali did not work"		

At the point where the main clause subject NPI (*Kimse*) and the subsequent proper name marked with genitive case (*Ali'nin*) have been encountered, there are in fact a range of grammatically possible alternative continuations, the most relevant of which are illustrated in (12), with alternative continuations marked in **bold**.[13]

(12) **Kimse [Ali'nin …**
***Possible continuations*:**

a.	**POSSESSIVE**		
	Kimse	[Ali'nin **ev-i]- ni**	**beğen-me-di**
	anybody.NOM	*Ali*.GEN *house*-AGR]-ACC	*like*.NEG.PST.3SG
	"Nobody liked Ali's house"		
b.	**OBJECT RELATIVE CLAUSE**		
	Kimse	**[[$_{RC}$** Ali'nin **yap-tığ-ı] yemeğ]-i**	**beğen-me-di**
	anybody.NOM	*Ali*.GEN *do*-FN-AGR *food*-ACC	*like*.NEG.PST.3SG
	"Nobody liked the food that Ali made"		
c.	**"HEADLESS" OBJECT RELATIVE CLAUSE**		
	Kimse	**[[$_{RC}$** Ali'nin **yap-tığ-ı]-nı]**	**beğen-me-di**
	anybody.NOM	*Ali*.GEN *do*-FN-AGR -ACC	*like*.NEG.PST.3SG
	"Nobody liked what Ali made"		

In addition to the possibility that the genitive case-marked name (*Ali'nin*) will be the subject of the type of complex nominalised clausal structure we targeted in the present study, the input at this point is also consistent with a continuation as a possessive structure (12a), or the subject in an object relative clause modifying a yet to be encountered direct object (12b),[14] or in an object relative clause with the modified NP omitted (i.e. a "headless" relative clause[15]), as in (12c).

Consideration of these alternatives raises the question of when, exactly, the parser could in principle encounter information in the input which unambiguously signals the presence of embedded / clausal complement domain (the eventual target structure). This is important because, at least in our "short" sentence stimuli, the embedded verb followed the genitive-marked noun phrase directly. Thus the continuation options in (12) could be said to be "in the mix" until the point that the embedded verb is encountered. However, *when* the embedded verb is encountered in our target cases like (11), the alternatives in (12) are all ruled out: a possessive structure like (12a) is no longer possible because the subsequent item is verbal, and the object relative clause continuations in (12b/c) are now impossible due to the ACCUSATIVE case-marking and/or the intransitivity of the embedded verb.

But, importantly, these various cues signalling the target structure are present in the input *at the same time* as the parser is encountering the negative morpheme *–mA*. Thus, again for at least our "short" sentence stimuli, the question of whether the presence of intrusion effects can be understood in terms of parsing mechanisms "ignoring" the grammatical restrictions of Turkish is not entirely clear since it is not obvious that the embedded clausal domain has been, at this point, *parsed as such*. It may be that since NPI/licensor dependencies are prospective in Turkish, recognition of the presence of the negative affix on the verb is sufficient to trigger licensing dependency resolution mechanisms *before* parsing systems have fully converged on a representation of the input as constituting the type of subordinate clausal domain that blocks such dependencies. If this was true in general in our experiment, our intrusion cases are perhaps best understood as a type of garden-path effect, involving commitments made by the parser before, as it were, "all the evidence is in". This can be thought of as analogous to findings involving so-called *hyperactive gap-filling* (see Omaki et al., 2015) – i.e. in our case: hyperactive NPI licensing.

While we cannot with certainty rule this out entirely, at least two other relevant features of our study could be said to weigh against this interpretation of our findings. First, in the majority of our stimuli (constituted by the "medium" and "long" NPI/licensor distance sentences – i.e. two-thirds of the cases), the alternative continuations are already ruled out *prior* to encountering the embedded verb. Second, *every sentence* in our study realised the same structure – none of the other possible continuations discussed above ever obtained. Thus, it could be said that our target structure was strongly primed throughout the experiment, so across the experiment there was not much uncertainty with respect to whether the sentences would continue as our target structures involving complement clauses.

Still, the foregoing considerations about the encoding dynamics that may be involved in processing our stimuli suggest an interesting possible interpretation of the parametric effect on sentence-final acceptance rates in our intrusion condition. Recall that we did not anticipate this pattern, for a couple of reasons. First, it was unclear from prior research whether we would expect to see intrusion reflected in this (offline/downstream) measure *at all*, even if we found online ERP evidence for intrusion, since previous studies have either been mixed or are uninformative on this point. Second, the available evidence from English regarding licensor/NPI distance manipulations (Parker & Phillips, 2016) has been interpreted in terms of composition-related semantic encoding dynamics that we would not expect to obtain here given the prospective nature of these dependencies in Turkish. However, a possibility we did not actually consider in advance of this inquiry is that our acceptance rates for the distance manipulation might reflect variable *decay* of the memory trace for the matrix subject NPI. This would predict the observed pattern: shorter NPI/licensor distances yield stronger intrusion effects (less decay).

It also may be important to point out that the effects of NPI/licensor distance seen in the present study are fairly small compared to the categorical "on"/"off" behaviour of intrusion seen for time/distance manipulations in English, where it seems intrusion effects can be "switched off" entirely (Parker & Phillips, 2016).[16] In our view, this is precisely what one might expect for prospective/predictive versus retrospective NPI/licensor dependencies if Parker & Phillips are in general correct about why it is that intrusion effects can be "switched off" in languages like English. That is, the constituent structure of embedded domains will *always* be available for retrieval operations in a language like Turkish (or Japanese, Korean, etc.), since it will not be until *after* the earliest moments that licensing mechanisms could be engaged that compositional semantic operations could serve to render the contents of embedded domains inaccessible. However, in the typical English case, one might expect a very limited window for intrusion effects to arise, depending on the time-course of compositional semantic operations.[17] This general picture leads us to suspect the that available data may be pointing to a broader cross-linguistic generalisations about intrusive licensing: time/distance effects on NPI/licensor relationships should be more robust in English-type languages (in general: where these dependencies are retrospective), and more marginal in languages like Turkish (where these dependencies are prospective/predictive). However, so far as we can see, whether such effects in languages like Turkish may be due to decay of the encoded memory trace for the NPI, or due to the extent to which the embedded clause domain has been parsed *as such* (or both), cannot be determined on the basis of the present data.

Further remarks on prospective NPI licensing & other types of dependency resolution

Independent of the findings for the central case of intrusion, as noted already above our data also show that prospective NPI licensing dependencies appear to be handled by processing mechanisms much like other kinds of dependencies between non-adjacent elements that have been investigated cross-linguistically (e.g. filler-gap relationships of the sort involved in *wh*-interrogatives, topicalization, etc., see discussion of examples (8)-(10) in our Introduction).

Our data make for a particularly interesting comparison to previous work examining Japanese *wh*-dependencies, mentioned in our introduction (Ueno & Kluender, 2009). Recall that Ueno & Kluender tested (their Experiment 2) configurations (repeated below in (10a/b)) very much like our embedded/matrix negation NPI contrasts ((7a/b) repeated below), and reported anterior negativities for the condition which required the continued tracking of an unresolved dependency ((10a) > (10b), i.e. relation between an *in situ wh*-phrase and the –*ka*-morpheme marking its scope).

(10) a. MATRIX QUESTION
[senmu-ga **donna pasokon-o** katta-to] keiri-no kakaricho-ga iimashita-**ka**
[*director*-$_{NOM}$ *what.kind.ofPC*-$_{ACC}$ *bought-that*] *accounting-of manager*-$_{NOM}$ *said*.POL-Q
"What kind of computer did the accounting manager say the director bought?"
b. EMBEDDED QUESTION
[senmu-ga **donna paskono-o** katta-**ka**] keiri-no kakaricho-ga kikimashita-ka
[*director*-$_{NOM}$ *what.kind.ofPC*-$_{ACC}$ *bought*-Q] *accounting-of manager*-$_{NOM}$ *asked*.POL-Q
"Did the accounting manager ask what kind of computer the directory bought?"

(7) a. Ali [**kimsenin** çalış-tığ-ı]-nı söyle-**me**-di
Ali [***anybody***-GEN *work*-FN-AGG]-ACC *say*-**NEG**-PST.3SG **$NPI^{E}NEG^{M}$**
"Ali didn't say that anybody worked"
b. Ali [**kimsenin** çalış-**ma**-dığ-ı]-nı söyle-di
Ali [***anybody***-GEN *work*-**NEG**-FN-AGG]-ACC *say*-PST.3SG **$NPI^{E}NEG^{E}$**
"Ali said that anybody didn't work" = "Ali said that nobody worked"

Despite the formal similarity in the structures they tested compared to the present study however, there were two aspects of their reported ERP responses which contrast with our findings. First, their anterior negativity was conspicuously right lateralised, while ours was clearly left lateralised.[18] Second, while our anterior negativity was punctuated by a P600-like relative positivity, Ueno & Kluender found no such positivity for their Japanese *wh*-dependency contrasts.

As we noted above, Ueno & Kluender suggest that the absence of the P600 effect is tied to the fact that Japanese does not displace their *wh*-phrases, so that there is no additional integration effort involved of the sort seen in other languages (e.g. German, English), where completion of the *wh*-dependency involves thematic integration processes (i.e. at the "gap" site). In support of this line of thinking they point out that even in Japanese such P600 effects have been reported for dependencies that *do* involve displacement (e.g. in cases of scrambling; see Hagiwara et al., 2007; Ueno & Kluender, 2003). It seems reasonable to extend this line of thinking to the present data by noting that what may be important is not whether or not displacement/movement relationships are involved, but rather whether or not the relevant kinds of scope-related dependencies (involving *wh*-elements in previous studies, or NPI/licensor relationships here) must happen at the same time as thematic integration or not (which we could tie to the presence/absence, respectively, of P600s across studies).

Possible interpretations of our observed violation and intrusion main verb response patterns

It may also be that whether or not the parser is concurrently engaged in thematic processing when the NPI licensing violation is encountered has implications for our observed patterns. This is one salient difference between our matrix and embedded subject NPI cases: in the former, the point at which it is clear that there is no negation present to license the NPI is also the point at which the NPI itself must be thematically integrated with the main verb. Independent evidence suggests that disruption of argument structure processing can lead to N400 responses (Friederici & Frisch, 2000; Frisch, Hahne, & Friederici, 2004), so this may be one way to think about the presence/absence of matrix verb N400 effects. That is, embedded subject NPIs were already thematically integrated at the preceding embedded verb position, and when it is clear at the matrix verb that they will not be licensed, only a P600 effect emerges.

Alternatively, the distinction between the biphasic N400/P600 pattern for unlicensed matrix NPIs versus the monophasic P600 response for embedded NPIs could also have to do with NPI/licensor distance (Steinhauer et al., 2010). For example, on views of working memory that aim to divest themselves of the notion of various representational "buffer" systems in favour of a view that takes working memory to be about attention control of the activation of long term memory (LTM) representations, it may be that the more (linearly) distant matrix subject NPIs must be returned to the focus of attention (FoA), having been displaced by more recently encountered items. In contrast, this may not be necessary for the embedded subject NPIs (but note, this depends on how we conceive of the architecture, see Larocque, Lewis-Peacock, & Postle, 2014).

It is of interest that intrusion cases patterned with the matrix subject NPI violations with respect to the N400 effects, despite the fact that otherwise consistent P600 effects were completely suppressed. This suggests to us that these N400 effects are *independent* of the NPI licensing violations (contra Panizza, 2012), which in our view would help to account for the fact that N400s are not as reliably observed as P600 responses in NPI licensing violation paradigms. It seems not unreasonable to claim that, if the N400s are due to troubles involving thematic integration for the unlicensed NPIs, the same could be said for the intrusion cases.

We speculated at the outset that if intrusion arises in virtue of the normal engagement of licensing mechanisms at the embedded verb, this could lead to a situation at the matrix verb where a scope conflict arises. If licensing occurs at the embedded verb, then at the point where the NPI must be integrated with the main verb it must somehow simultaneously scope *over* the embedded domain (as subject of the main verb), yet *under* embedded verb negation. We suggest that this state of affairs may be what generally underlies the N400 responses see at the matrix verb, as this would plausibly interfere with thematic integration processes.

Negation in Turkish, NPIs, and predictive processing

A last note concerns the processing of negation. Negation is well-known to engender processing difficulties (see Kaup et al., 2007; Tian & Breheny, 2016 for reviews). Here we show, to our knowledge for the first time, what ERP responses to negated verbs look like (see Lüdtke et al., 2008 for negation effects on nominals in an auditory study). Embedded verb negation, in the absence of NPIs, yielded N400 effects. In contrast, matrix verb negation, in the absence of NPIs, yielded P600-like positivities. When NPIs were present, interestingly, the embedded verb N400 effect for negation was suppressed. Is it difficult to examine what happens with/without NPIs at the matrix verb position, as this involves contrasts that differ in upstream context (which are problematic for baseline reasons, see Steinhauer & Drury, 2012). However, that these two effects differ qualitatively is of interest. If we take the N400 to index lexical access, and the P600 to generally reflect integration/composition operations, this dissociation may be interpretable in terms of whether the negation is encountered at the point where propositional meaning and truth value must be computed (which could be said not to happen locally at the embedded clause level, as these structures we tested in Turkish were nominalised). That the N400 effect at the embedded verb was cancelled by upstream NPIs is consistent with other work (Yoshida, 2008), and appears to reflect the fact that at least lexical complexity effects connected with the access/retrieval of negated items may be neutralised when these items are predicted.

Notes

1. Note that "EPL" is our own label for this account, introduced here for ease of reference.
2. As noted in Steinhauer et al. (2010), there a number of types of different theoretically motivated mechanisms we might consider to be operative in real-time NPI licensing. For example, monotonicity properties might be locally encoded (Dowty, 1994), in which case the local context into which an NPI is integrated indicates its licensing powers.
3. These kinds of subordinate clauses are nominalised in Turkish. Thus, the embedded verbs are marked with case suffixes assigned by the matrix verb (e.g. the accusative (ACC) marker *–nı* on the embedded verb) and the embedded subjects are marked genitive and exhibit agreement on the embedded verb (e.g. *-ı* (AGG) on the embedded verbs). Thus, a better translation for these nominalised complements might be more like the English nominal "Ali's working" as in "We discussed [$_{NP}$ Ali's working]" or "[$_{NP}$ Ali's working] was a good thing". Here, however, we follow standard glosses as in Kornfilt (2003, 2008), where these expressions are translated to verbal complement clauses in English.
4. Turkish exhibits vowel harmony (Göksel & Kerslake, 2005), which is why *–mA* surfaces as it does in (6a) versus (6b).
5. Note that (7a) has been discussed in the literature as deviant (Kelepir, 2001; Kornfilt, 2007). However, intuitively these cases seem perfectly fine, and the acceptability judgment data we present below bears this out. It turns out that the (7a/7b) contrast seems to be a matter of a slight preference for clause local (7b) compared to non-local (7a) licensing.
6. Note that unlike English/German sustained anterior negativities reported for filler-gap dependencies, Ueno & Kluender's effect was conspicuously right lateralised. See their Discussion for elaboration on the possible significance of the topography of their effect, which we will not address further in this paper.
7. We have also carried out a self-paced reading study on German-Turkish bilinguals by focusing on the matrix NPI conditions of the present study (see Arslan, Lago, Yanilmaz, Drury, & Felser, 2017).
8. But see behavioural work by Yoshida (2008), which suggests that negation processing costs are ameliorated when negation is preceded by NPIs in Japanese. We will return to this issue in our Discussion.
9. Such as *bana* "to me" or *bugün* "today".
10. An anonymous reviewer points out that the P600 effects may be seen as occurring fairly late in response to the embedded verbs, relative to typical onset of such effects reported in the literature. However, note that given the length/complexity of Turkish words, our presentation rate was slower (700 ms / word) than is typical of in studies of other languages (where presentation is often 500 ms / word). Further, P600 effects seen across positions for our NPI licensing manipulations were consistent in their timing (and scalp distribution) with responses to filler conditions (not reported here; see Yanilmaz, *in preparation*), which involved agreement and argument structure violations.
11. Though see Tettamanti et al. (2008) and Tomasino, Weiss, and Fink (2010) for fMRI work on negation, which we will not discuss here.
12. Of this list of concerns, the idea of using inherent featural distinctions on individual items to encode fundamentally relational notions like c-command, we believe, requires rethinking. At present, we favour the development of a way to have structure regulate the availability (activation levels) of previously encountered potential targets for retrieval operations consistent with the sketch offered by Parker and Phillips (2016) to explain how/why intrusion effects can be "turned off" by time/distance manipulations. Their account suggests that items within structural domains that have been composed or recoded by compositional operations are no longer available for retrieval, but what can be regarded as a categorical "available"/"unavailable" distinction, we would argue, could just as easily be regarded as a continuous/graded distinction. These matters are discussed in further detail in Yanilmaz (*in preparation*).
13. It could also be that such lead-ins could be continued with a different type of complex nominal: *Kimse Ali'nin gitmesini istemedi*. "Nobody wanted Ali to go".
14. Note that relative clauses occur prenominally in Turkish.
15. See Göksel (2007) for "headless" relatives in Turkish.
16. We thank an anonymous reviewer for bringing this latter point about time/distance effects to our attention.
17. Note that attention to the time-course of semantic composition of complex embedded structures may provide a route towards explaining the presence/absence of intrusion effects reported for relative versus complement clauses (respectively), in languages like English (Parker & Phillips, 2011). The prediction is that the longer an embedded domain remains un-composed (i.e. with its constituent structure still available), the more likely it is that an NPI licensor contained within that domain can exhibit its influence (cause intrusion). Thus, it could be that relative clauses must necessarily remain "open" in this sense (un-composed) longer than complement clauses due to the fact that they require resolution of the dependencies between the head of the relative (nominal expression modified by the relative) and the

predicate within the relative clause. We leave these suggestions for future investigation, but note that this speculation could point towards a way of reconciling these facts with a CBR view of intrusion.

18. We have nothing to say at present about the distributional differences between the present study and Ueno and Kluender's (2009) findings. We refer readers to their Discussion, which offers some interesting speculation on this matter.

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