2023

Line Breaks Can Make You Miss Out a Complement: Developing Predictions in Reading

Andromachi Tsoukala  
*University of Cambridge*

Margreet Vogelzang  
*University of Cambridge*

Ianthi Tsimpli  
*University of Cambridge*

Follow this and additional works at: https://repository.upenn.edu/pwpl

**Recommended Citation**  
Tsoukala, Andromachi; Vogelzang, Margreet; and Tsimpli, Ianthi (2023) "Line Breaks Can Make You Miss Out a Complement: Developing Predictions in Reading," *University of Pennsylvania Working Papers in Linguistics*: Vol. 29: Iss. 1, Article 22.  
Available at: https://repository.upenn.edu/pwpl/vol29/iss1/22

This paper is posted at ScholarlyCommons. https://repository.upenn.edu/pwpl/vol29/iss1/22  
For more information, please contact repository@pobox.upenn.edu.
Line Breaks Can Make You Miss Out a Complement: Developing Predictions in Reading

Abstract
Previous research focusing on direct object/subject garden path sentences, as in “While Anna dressed the baby played in the crib”, has provided evidence for the influence of multiple syntactic and non-syntactic factors on disambiguation. The present study sheds light on the role of a textual parameter that has received little attention in the literature: line breaks. In a self-paced reading study, participants were presented with multiline texts containing locally ambiguous optionally transitive verbs positioned before a line ending. By manipulating transitivity status, we investigated whether the intransitive analysis would be promoted – compared to the more commonly entertained transitive parse – as a function of the line break triggering early closure. Furthermore, we explored whether the presence of syntactically incomplete lines – as opposed to complete ones – preceding the verb region would cause readers to refrain from early closure due to an expectation of structural incompleteness. While results provided support to the first hypothesis, we found inconclusive evidence for the second. More specifically, no facilitation in reading rate was observed for either interpretation when the reader was primed with structurally incomplete lines; rather, an irregular reading pattern emerged in such contexts. Nevertheless, there was some evidence to suggest that when the parser operated on a prediction of structural incompleteness only to be proven false, comprehension was impacted. Further research is needed to confirm whether this is indeed a consequence of prediction error.
Line Breaks Can Make You Miss Out a Complement: Developing Predictions in Reading

Andromachi Tsoukala, Margreet Vogelzang and Ianthi Tsimpili*

1. Introduction

Over the past decades, extensive research has been conducted to examine how individuals parse and interpret ambiguous structures. One type of syntactic ambiguity that has been widely studied is found in direct object/subject garden path sentences as shown in (1). In this example, the ambiguity arises once the listener/reader encounters the verb “dressed” in the dependent clause (DC). The verb can be transitive, taking as its object (OBJ) the noun phrase (NP) “the baby”, or intransitive, in which case it is reflexive (i.e. Anna dressed herself), while the NP “the baby” is the subject (SUB) of the verb “played” in the main clause (MC). Out of these two options, the latter is felicitous, as the transitive reading, which is often initially entertained during parsing, leads to ungrammaticality.

(1) While Anna dressed the baby played in the crib (Christianson et al. 2001).

   The tendency of participants to erroneously consider a transitive parse - only to realize that revision is necessary later on once disambiguating material has been reached - is described as a garden path effect arising from local/temporary ambiguity. Notably, syntactic repair is not always fully successful as traces of misinterpretations often persist. This suggest that parsers may settle for a “good enough” analysis (Christianson et al. 2001, Ferreira, Christianson, and Hollingworth 2001).

   In line with early seminal work (Frazier 1978, Frazier and Rayner 1982), this misanalysis phenomenon can be accounted for if certain principles, such as Late Closure, are assumed to guide parsing. According to this structural heuristic, incoming lexical items are to be attached inside the phrase/clause currently being processed (late closure) rather than outside it (early closure). Thus, in (1), it is predicted that the parser by default accommodates “the baby” as the OBJ of “dressed”, instead of assuming that it is the SUB of an upcoming verb.

   Nevertheless, alternative proposals have since been put forth to account for garden path phenomena. While Frazier’s two-stage, serial model holds that initial parsing commitments are made purely on the basis of syntactic information, other constraint-based accounts (MacDonald, Pearlmutter, and Seidenberg 1994) allow for multiple types of information to be considered in parallel. Among the variables that have been shown to influence early structural analysis are pragmatic plausibility and context, verb subcategorization frequencies and lexical biases, prosodic cues and punctuation (for a review, see Lee and Watson 2012). For instance, Pickering and Traxler (1998) manipulated a critical verb for plausibility using examples like (2) so that one version of the sentences participants read would result in an implausible transitive interpretation (shown here in italics). They found that participants experienced difficulty in the face of implausibility, but fully committed to the transitive misparse when it was plausible. Based on this finding, they concluded that readers performed substantial semantic processing during parsing and that pragmatic factors changed the activation of competing analyses before syntactic disambiguation occurred.

(2) As the ambassador visited/negotiated the village that burned asked the government for help.

   Moreover, Staub (2007) provided evidence that although an incorrect direct OBJ analysis of an intransitive verb can be activated, it is rapidly suppressed due to subcategorization restrictions of the verb. The experiments reported in Patson and Ferreira (2009) further highlight that morphosyntactic properties of SUB-verb pairings (e.g. plural constituent followed by a reciprocal verb

*Many thanks to Ianthi Tsimpili’s lab team members, with special thanks to Alex Cairncross, for their helpful feedback regarding stimuli development. A further thanks is extended to attendees of this paper presentation during the 46th annual Penn Linguistics Conference. This study was made possible thanks to funding for doctoral studies provided by the Economic and Social Research Council (Project Reference: 2275541).
as in (3)) make alternative interpretations readily available, thus blocking garden path effects.

(3) While my mom and dad kissed my brother was making faces.

Additionally, studies examining the role of overt prosody in disambiguation have shown that the presence of prosodic boundaries between clauses can help the listener avoid the transitive misanalysis, whereas incongruent boundaries can lead to costly disruptions (Itzhak et al. 2010, Pauker et al. 2011). Steinhauer and Friederici (2001), who focused on implicit prosodic manipulations, reported similar findings on the effects of comma-induced boundaries during silent reading.

All the evidence discussed above elucidates how various syntactic and non-syntactic factors interact in guiding disambiguation. Whereas some cues, such as implausibility, can facilitate recovery from a misanalysis (Pickering and Traxler 1998), others, such as prosody, may entirely eliminate garden path effects (Itzhak et al. 2010). The aim of the present study was to extend previous findings by focusing on the role of an underexplored parameter, namely line breaks in text.

2. The Current Study

2.1. Implicit Prosody and the Line Break Hypothesis

Research focusing on prosodic phrasing in speech has demonstrated that individuals regularly use prosodic boundary information to parse syntactic structure and resolve ambiguities (for review, see Cutler, Dahan, and van Donselaar 1997). The same disambiguating function has also been assigned to subvocal prosody. The Implicit Prosody Hypothesis (IPH) (Fodor 2002) suggests that a default prosodic contour is projected onto text during silent reading\(^1\), resulting in both a prosodic as well as syntactic structure being produced. This is because the comprehender postulates syntactic boundaries at the location of prosodic boundaries. Crucially, in the face of ambiguity, this prosodic packaging helps identify sentence constituents, it clarifies structure and facilitates interpretation.

Although there has been growing interest in considering implicit prosody in syntactic ambiguity research, providing conclusive empirical support for the IPH constitutes a challenge. This is largely because implicit prosodic phrasing cannot be measured directly (Traxler 2009). It is not possible to record the “inner voice” (Chafe 1988) of parsers as they silently read text containing prosodic cues. Researchers may only suggest that implicit prosodic manipulations are behind any effects observed. Nevertheless, some methods employed to introduce prosodic breaks in text have provided promising results. Specifically, in Steinhauer and Friederici (2001) commas were used to investigate whether the direct OBJ misanalysis of garden path sentences could be avoided. As was noted by the authors, punctuation is distinct from other visual cues for clause separation (e.g. spacing); it was argued that commas in reading mirror most closely processes involved in boundary perception in speech.

An alternative way of triggering prosodic boundaries is through the mode of presentation of textual stimuli. In Swets et al. (2007) sentences involving relative clause (RC) ambiguity were presented to participants segment-by-segment as shown in (4). The groupings imposed, i.e. the complex NP contained in the 1st segment displayed as an integrated unit followed by the RC, led readers to favour high attachment to the first NP “the maid”, a result consistent with the predictions of the IPH.

(4) The maid of the princess // who scratched herself in public // was terribly embarrassed.

In a similar fashion, segmentation can be achieved through the use of frame breaks. In a self-paced reading study by Hirota, Terry, and Sadato (2016), parts of scopally ambiguous wh-questions appeared on a computer screen in distinct visual frames. The findings were argued to provide support to an extension of the IPH, namely the Line Break Hypothesis, in that the chunking induced through frame breaks (or line breaks) determined participants’ interpretation. A relatively more ecologically valid method of studying prosodic boundaries is through the utilization of physical line breaks in text. Traxler (2009) designed an eye-tracking study in which ambiguous RC

\(^{1}\)It should be noted that one of the primary objectives of the IPH was to account for cross-linguistic differences in parsing. Thus, it is not assumed that any prosodic phrasing patterns are universal.
items were presented on two lines (complex NP separated from RC). He found that this segmentation promoted high attachment and concluded that this was most likely due to implicit prosodic phrasing.

Taking into account the evidence presented above, the first aim of the present study was to explore how line breaks may affect parsing when readers are exposed to direct OBJ/SUB garden path sentences. To illustrate, example (1) has been visuospatially rearranged in (5a) and (5b). If line breaks do indeed induce implicit prosodic boundaries, it is hypothesized that (5a) leads to disruption in parsing. This is because the DC verb “dressed” is misleadingly grouped with the NP “the baby” in the same processing unit; hence, it is likely to be interpreted as its direct OBJ. Contrastively, in (5b) the prosodic break at the end of the line coincides with a legitimate clause boundary, thus promoting the intransitive analysis and blocking a garden path effect.

(5)  a. While Anna dressed the baby played in the crib.
    b. While Anna dressed the baby played in the crib.

2.2. The Line Break Cue: Developing Predictions in Context

Notably, in earlier work, it had been argued that “line breaks are interpreted by subjects as signals for potential clause endings” (Kennedy et al. 1989). This function of the line break cue in marking clausal endings had thus been discussed in the literature without implicating subvocal prosody. Rather, the visual information at the end of the line was assumed to encourage structural closure, given the ensuing spatial and temporal discontinuity (pause) between lines during reading. Arguably, readers are predisposed towards co-terminality, rather than line break and clause boundary mismatch. There is, however, a special case where that expectation is falsified: the enjambed line.

Enjambement is a device, commonly used in poetry, which results in the verse-line being structurally incomplete. This is achieved by “scissoring” syntactic constituents at line endings, i.e. the break divides units in separate lines. Accordingly, sentences and propositions run over from one line of text to the next (the run-on line). In terms of prosodic implications, enjambments cause disfluency since the prosodic break, as suggested by the line end, conflicts with the continuity of the syntax. The properties of prosodic disruptions depend on whether the enjambment is prospective or retrospective (Koops van ’t Jagt et al. 2014). In the former case, it is evident that the line being processed is syntactically incomplete; hence, the reader realizes in advance (i.e. before they jump to the next line or pre-leap) that missing elements will be found on the subsequent line (e.g. an article separated from a noun complement). In the latter case, the reader encounters an ostensibly complete clause on the line; yet, when the following line is reached, material is found which needs to be incorporated into the parse (e.g. an optionally transitive verb positioned at the end of the line is assumed to be intransitive, yet there is a direct OBJ awaiting on the next line which is only encountered post-leap).

To date, little attention has been paid to literary devices, such as enjambment, in psycholinguistic research. To the best of our knowledge, the only study that has focused on enjambment was conducted by Koops van ’t Jagt et al. (2014). In more detail, they designed two eye-tracking experiments in which participants were exposed to enjambed poetry; notably, their primary aim was to explore the effects of enjambment on reading behaviour, rather than on the processing and resolution of local ambiguity. The results revealed that participants adapted their reading behaviour when they were presented with poetic fragments containing enjambment compared to fragments without it. A key finding was that readers recognised early on an incomplete quality in fragments with prospective enjambments (and even with retrospective ones, though on a more semantic basis). This led participants to adopt a “fast forward” strategy in search of syntactic closure. That is, once a parse is perceived as partially concluded, the processor actively seeks out words or phrasal units to satisfy syntactic roles causing rapid visual search for input which translates into a speed-up in reading. This practice, however, comes with a cost: the speed-up is later compensated for by inflated processing times in the regions post-break, probably the result of integration and parse updating.

Moreover, these findings provide support to one of the hypotheses considered by the authors of that study regarding implicit prosody. More specifically, the “fast forward” approach to pre-break material, which was more clearly observed for prospective rather than retrospective enjambments (see their Experiment 2), suggests that readers’ phrasing could have been marked by
subvocal continuation features at the line ending (e.g. shorter pause, rise in intonation, moderation or absence of preboundary lengthening, etc.). In other words, the perception of syntactic incompleteness may have forced prosodic adaptations. Consequently, this entails that readers presented with enjambments disregard the line break cue - which signals closure - both syntactically and prosodically.

Overall, it appears that comprehenders react to the unexpected fragmentation of the syntax by employing distinctive strategies. What has not been established yet is whether incompleteness can be “regularized” and anticipated in parsing. One can imagine a scenario where readers would be exposed to multiline text with recurring enjambments. In that case, it is hypothesized that parsers would not be quick to assume that the end of the line signals a potential clausal ending (line break cue); rather, they may become more likely to hold off syntactic (and prosodic) closure. Essentially, this would amount to a syntactic priming effect. Research on the effects of priming on disambiguation has shown that previous exposure to a particular structural analysis can cause individuals to parse following target sentences in the same way (Kim, Carbary, and Tanenhaus 2013). Similarly in this case, repeated exposure to enjambment may lead readers to flout the line break cue. Accordingly, they may reassociate line breaks with syntactic incompleteness and develop the prediction that upcoming material would regularly need to be accommodated in the parse post-break.

The second aim of the present study was to test this hypothesis in the context of direct OBJ/SUB garden path disambiguation. To illustrate, we can turn to example (5b) and consider the following updated hypotheses. Under conventional text formatting conditions (no preceding context with enjambment manipulations), intransitivity may be promoted in (5b). This would be consistent with the predictions of the Line Break Hypothesis, as was explained at the end of section 2.1, as well as with Kennedy’s et al. (1989) line break cue. On the other hand, if the critical region “While Anna dressed” was preceded by lineated text marked by successive enjambments, it is hypothesized that readers would not assume intransitivity. Instead, they could form the prediction, informed by prior context, that a complement is coming up (e.g. an OBJ argument of the verb).

A self-paced reading experiment was designed in which participants were exposed to multiline text. We manipulated the transitivity of an optionally transitive line-final verb as well as the completeness of lines preceding this region. The measures computed for analysis were line-by-line reading times as well as accuracy to a comprehension question. To the best of our knowledge, the combination of these manipulations is novel. Given the exploratory character of this research, we set out to test whether the hypotheses formulated in the previous paragraph would enjoy empirical support.

3. Methodology

3.1. Participants

Thirty-nine native speakers of English (21 Female; M_age=21.3; SD=2.08; Range=19-28) completed the study and were included in all statistical analyses (data from three more participants were excluded; for details, see section 3.4). Twenty-one of them were UK-born university students recruited through the Prolific platform (https://www.prolific.co/) and the remaining eighteen were students at the University of Cambridge. They all provided informed consent to participate in the study and received £15 as payment. This study has received ethical approval by the ethics committee of the Modern and Medieval Languages and Linguistics (MMLL) faculty at the University of Cambridge.

3.2. Materials

The critical items were 32 poem-like texts consisting of five lines. In a 2x2 experimental design, we manipulated Transitivity (transitive vs intransitive 3rd line verb) and Line Completeness (complete vs incomplete lines preceding the verb region). The resulting 4 conditions are shown in Table 1.

| TR-COM (Transitive – Complete) | TR-INCOM (Transitive – Incomplete) |
LINE BREAKS CAN MAKE YOU MISS OUT A COMPLEMENT

Table 1: Exemplification of the 4 experimental conditions (TR-COM; INT-COM; TR-INCOM; INT-INCOM) using a critical item. Comments in square brackets were not shown to participants.

<table>
<thead>
<tr>
<th>INT-COM (Intransitive – Complete)</th>
<th>INT-INCOM (Intransitive – Incomplete)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alice attended a talk</td>
<td>1. Alice once attended a talk</td>
</tr>
<tr>
<td>2. that the speaker named James gave</td>
<td>2. that the speaker named James gave</td>
</tr>
<tr>
<td>3. and because Alice heckled [enjambed]</td>
<td>3. gave and when Alice heckled [enjambed]</td>
</tr>
<tr>
<td>4. James who was sickly and frail</td>
<td>4. James who was sickly and quite frail</td>
</tr>
<tr>
<td>5. was a little mortified</td>
<td>5. was a bit mortified</td>
</tr>
</tbody>
</table>

Comprehension Question:
Who was it that was mortified?  
Options: Alice / James / Other(s)

Table 1: Exemplification of the 4 experimental conditions (TR-COM; INT-COM; TR-INCOM; INT-INCOM) using a critical item. Comments in square brackets were not shown to participants.

In the conditions labeled as Complete, the 1st and 2nd line contained structurally complete clauses, namely “Alice attended a talk” and “that the speaker named James gave”. Thus, these first two lines carried ostensibly grammatical and interpretable clauses, with no syntactic constituents being severed. In the Incomplete conditions, the line-final words “talk” and “gave” were transposed on the immediately subsequent line so that these successive clauses encountered at the beginning of the texts would be syntactically incomplete. This conspicuous scissoring of clauses at line endings (prospective enjambement) was designed to create an expectation that obligatory units would routinely be omitted and upcoming material would need to be incorporated into the parse post-leap.

This Line Completeness manipulation is important to consider as we turn to the analysis of the DC “because/when Alice heckled” found on line 3. Therein, an optionally transitive critical verb was placed in line-final position, as in *heckle O/OBJ*. In the Transitive conditions, the verb would take as its OBJ the proper name found at the beginning of line 4 (“James”), whereas in the Intransitive ones, this proper name would be the SUB of a MC encountered on the final line (“was a little/bit mortified”). Crucially, texts remained temporarily ambiguous until line 5 where the presence or absence of a new SUB candidate for the MC, namely the pronoun “he/she”, would determine whether the verb was transitive or intransitive, respectively. Importantly, the inclusion of structurally (in)complete lines prior to the presentation of the 3rd line ambiguous verb was intended to influence parsing decisions on its transitivity status.

For all stimuli, a multiple choice comprehension question was generated. The question for critical items enquired about the SUB of the MC verb on the 5th line, e.g. “Who was it that was mortified?”. The options were: 3rd-line candidate (“Alice”), 4th-line candidate (“James”) or “Other(s)”. The 32 critical stimuli were modelled on items used in two previous studies (Adams, Clifton, and Mitchell 1998, Mitchell et al. 2008). Additionally, 80 other five-line texts completed the full

---

2Given this displacement, minor lexical substitutions or insertions were considered for -INCOM conditions to control for line length (e.g. addition of the adverb “once” on the 1st line and replacement of the conjunction “because” with “when” on the 3rd). Accordingly, syllable count on each line remained constant (N=7) across items and within-item conditions.

3Reflexive absolute transitives (e.g. dress) and reciprocals (e.g. fight) were also used. Although verb subcategorization frequencies are important to consider, this was beyond the scope of the study. Future research is advised to explore differential effects based on transitivity biases and/or verb class groupings.

4If an anaphoric pronoun was present - thus rendering the verb transitive - care was taken to avoid global referential ambiguity. As such, the two potential antecedents for coindexation (e.g. “Alice” and “James”) would be differentiated based on gender so that only one candidate would satisfy that agreement criterion.
set of reading material, inclusive of distractors containing global ambiguity as well as unambiguous fillers. None of the stimuli contained any punctuation.

Four counterbalanced lists were prepared. Participants saw 8 items for each one of the four conditions, and each item was seen in only one of its four versions. The order in which stimuli appeared was fully randomized. The order of appearance of the response options to the comprehension question was pseudo-randomized; for half the stimuli the 3rd-line candidate would appear in left-most position on the screen, whereas for the rest it would appear in middle position on the screen. The fallback option “Other(s)” would always appear in right-most position.

3.3. Procedure

This web-based reading study employed the self-paced (line-by-line) moving-window paradigm (Just, Carpenter, and Woolley 1982). It was programmed using the javascript library JsPsych (de Leeuw 2015) and was hosted on a University of Cambridge student-run server.

To approximate lab-based experimental conditions, a remote testing method was used (Leong et al. 2022) which involved participants completing the study on a pc or laptop while being on live (audio/video) call with the main experimenter and first author. During the testing session, participants would start off with the main reading task, after having gone through 3 practice items. The main reading task was split in 5 blocks. The first 4 blocks contained 22 texts each, while the last one consisted of 24 texts. After each block, participants would take a short break and then proceed to complete a control task intended to assess their memory, attention and print exposure, among others (results on these tasks are not included in the present report).

Within the blocks of the main reading task, participants read the texts one line at a time. At the beginning of each trial, only dashes would be visible to mask all the lines. Participants had to press the right arrow key to reveal only a single line of text each time, making their way from the first to the fifth one with each key press. Subsequently, they would be directed to the comprehension question which they could answer by pressing a key corresponding to one of the three response options.

3.4. Data Analyses

Datasets from three individuals were not analyzed due to low accuracy on unambiguous filler items, namely more than 20% error on comprehension questions following Fernandez’s (2002) methodology. Trials where participants had responded with “Other(s)” were excluded. Lastly, trial exclusion due to extreme values in reading times was avoided, where possible. Instead, a combination of winsorizing along with log transformations was preferred (Nicklin and Plonsky 2020). If after transformations had been applied multivariate outliers were identified using Cook’s distance, such influential cases were discarded; data loss did not exceed 5%.

Reading times were entered as the dependent variable (DV) into linear mixed effects models (LMM) fit by maximum likelihood. The responses to the comprehension question were entered as a binomial DV into generalized LMMs. Transitivity and Line Completeness were fixed effects; participants and items were random effects (either intercepts or slopes depending on whether they improved the model fit). Analyses were performed in R using the lme4 package (Bates et al. 2015).

4. Results
Figure 1: Mean log-transformed reading times by Line Completeness and Transitivity (SEM error bars).

For analysis purposes, only line 3, 4 and 5 reading time data were entered into LMMs. With the reference level being Complete for Line Completeness and Intransitive for Transitivity, the model for line 3 reading times revealed a significant effect of Line Completeness (beta = 0.16, 95% CI [0.10, 0.22], t(1212) = 5.30, p < .001); that is, participants took longer to process this critical region with the ambiguous verb in the Incomplete conditions compared to Complete ones. For line 4, Line Completeness approached significance (beta = -0.05, 95% CI [-0.11, -0.002], t(1212) = -1.86, p = 0.063); this time, readers appear to have viewed this region somewhat speedily in the Incomplete conditions as opposed to Complete ones, although this difference is non-significant. In line 5, there was an effect of Line Completeness (beta = 0.21, 95% CI [0.13, 0.28], t(1212) = 5.14, p < .001) and Transitivity (beta = 0.15, 95% CI [0.07, 0.23], t(1212) = 3.84, p < .001). Crucially, these effects were qualified by a significant interaction between Line Completeness and Transitivity (p = 0.032).

To better understand the relationships indicated by the interaction, follow-up models were run. To address the first hypothesis concerning complete line contexts, only data from Complete conditions were considered. In this case, the effect of Transitivity was significant (beta = 0.15, 95% CI [0.07, 0.23], t(607) = 3.70, p < .001); that is, participants processed the disambiguating region for longer when the verb was transitive (TR-COM) compared to when it was intransitive (INT-COM). In addressing the second hypothesis concerning Incomplete conditions, non-significant estimates were obtained for Transitivity (p > .05). Thus, when lines preceding the verb region were incomplete, no facilitation was observed for either analysis. In fact, as indicated by the previously reported main effect of Line Completeness, Incomplete conditions were processed slower (Adj. M_{log scale} = 7.42) than Complete ones (Adj. M_{log scale} = 7.27) in line 5 (estimates averaged over the levels of Transitivity). Similarly, the main effect of Transitivity suggests faster processing in Intransitive conditions (Adj. M_{log scale} = 7.30) compared to Transitive ones (Adj. M_{log scale} = 7.39) in the final disambiguating region (estimates averaged over the levels of Line Completeness).

Table 2: Accuracy recorded in terms of percent correct for each condition.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>TR-COM</th>
<th>TR-INCOM</th>
<th>INT-COM</th>
<th>INT-INCOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>87.46%</td>
<td>85.9%</td>
<td>85.38%</td>
<td>74.50%</td>
</tr>
</tbody>
</table>

Regarding performance on the comprehension question, accuracy for each condition is shown in Table 2. The GLMM analysis revealed a significant effect of Line Completeness (beta = 0.78, 95% CI [0.35, 1.21], p < .001); as such, the odds of providing an accurate response were estimated to be higher in Complete conditions compared to Incomplete ones. Transitivity was not a significant predictor (p > .05). Notably, the interaction between Transitivity and Line Completeness reached significance (p = 0.049). To follow up on this interaction, the same modeling steps were taken as in the analysis of reading times. With data from Complete conditions considered, Transitivity was not significant (p > .05). When data from Incomplete conditions were considered, the effect of Transitivity was significant (beta = -0.80, 95% CI [-1.23, -0.37], p < .001). Hence, in contexts where preceding lines were structurally incomplete, the odds of an accurate response were higher when the verb was transitive (TR-INCOM) compared to when it was intransitive (INT-INCOM).

It should be noted that in the two Transitive conditions, the presence of a gendered pronoun (i.e. he/she) on the 5th line helped clarify the referent. As such, the higher accuracy observed in the two Transitive conditions could be explained if reliance on the gender cue is assumed. In the two Intransitive conditions, there was no such aiding information on the final line that could be utilized by readers; thus, accuracy was relatively lower. In order to explore whether there was a significant difference in performance in the absence of any aiding cues, a final model was run considering data from the two Intransitive conditions. Line Completeness was indeed a significant predictor (beta = 0.76, 95% CI [0.30, 1.23], p = 0.001); greater odds of an accurate response were estimated in the INT-COM condition compared to the INT-INCOM one. Hence, even though in both of these conditions the intransitive reading was imposed on line 5, we see better accuracy in the complete line context (INT-COM) and worse performance in the incomplete one (INT-INCOM).
5. Discussion

The present study had two main aims. The first aim was to test whether, in conventionally lineated texts (no enjambments), line breaks can help the reader avoid the direct OBJ misparse of an optionally transitive line-final verb; instead, the intransitive analysis was expected to be promoted as a function of the line break triggering early closure. The results provided support for this hypothesis: in the two conditions where lines preceding the verb region were complete, similar reading rates were observed for line 3 and 4, but not for line 5. The final region was read significantly faster when disambiguating material rendered the intransitive analysis felicitous (INT-COM) rather than the transitive one (TR-COM). Thus, participants experienced facilitation when the verb was intransitive.

This finding is consistent with the predictions of the Line Break Hypothesis (Hirotani, Terry, and Sadato 2016); the prosodic contour projected, as was determined by the presence of the 3rd line break, resulted in a syntactic boundary being postulated immediately following the critical verb. As such, the clausal ending assumed promoted the intransitive interpretation instead of the direct OBJ misanalysis. Additionally, readers could have relied on the line break cue (Kennedy et al. 1989). That is, they perceived the line break as a signal to conclude the clause, thus entertaining the intransitive analysis. In this case, the early closure approach could have been adopted probabilistically (e.g. based on experience with conventionally formatted, non-enjambed print) or it could have been triggered by spatial-temporal encoding parameters at the line end. Crucially, it is beyond the scope of this study to establish whether implicit prosody or the line break cue guided parsing; these two factors probably acted in conjunction in promoting early closure.

With regards to comprehension, the introduction of a line break that did not coincide with a clausal boundary (line 3 in TR-COM) did not impact on accuracy when compared to the condition where line breaks routinely marked clausal endings (INT-COM). Rather, accuracy was comparable in complete line contexts, even though reading time results suggested facilitation only when the verb was intransitive as opposed to transitive. As was mentioned in the Results section, the gendered pronoun on the final line in the Transitive conditions may have helped identify the referent. Given this imbalanced cue between Transitive and Intransitive conditions, no solid conclusions can be drawn based on the accuracy scores. This is a limitation arising from the way in which stimuli were designed to involve local rather than global ambiguity. In the latter case, if more than one response option matched the gender of the pronoun, it would not be possible to assess accuracy as there would be more than one grammatically acceptable interpretation. Future research using different types of information for disambiguation is needed to establish whether comprehension is also impacted.

The second aim of this study was to explore whether exposure to recurring enjambments, prior to the presentation of an optionally transitive line-final verb, would lead parsers to develop the prediction that lines would consistently be structurally incomplete, hence refraining from early closure. Consequently, intransitivity would not be promoted in this case. The reading time results suggest that intransitivity was indeed not promoted, but this was also the case for the transitive parse. Syntactically incomplete line contexts (INT-INCOM and TR-INCOM) led to a similar reading behavior for line 3, 4 and 5, without the Transitivity differentiation having a significant effect.

Specifically, the effect of Line Completeness observed for line 3 suggests that participants took significantly longer to view the verb region in both conditions where they were primed with structurally incomplete lines as opposed to complete ones. Therefore, prior to the ambiguity being resolved on line 5, parsers became sensitive to the two competing analyses upon encountering the verb. The inflated reading times observed could be due to readers experiencing uncertainty as to whether they should assume syntactic (and prosodic) continuity or discontinuity. Subsequently, the contents of line 4 were viewed somewhat faster in both structurally incomplete line contexts compared to complete ones. This could be due to readers employing a “fast forward” strategy (Koops van ’t Jagt et al. 2014) in search for disambiguating input. Regarding line 5, the follow-up models revealed that whether the verb was transitive or intransitive did not differentiate reading rate in incomplete line contexts; instead, the disambiguating region was read slower overall in both Incomplete conditions compared to Complete ones. Taken together, these findings highlight that the presence of enjambments is first and foremost disruptive for the parser. Moreover, having successive lines be structurally incomplete does not appear to favour either interpretation, transitive or intransitive, especially when compared to reading rate in Complete conditions. Crucially, no facilitation was observed for the transitive analysis which was thought to be in line with expectations. 
informed by prior context (i.e. an expectation that input found post-leap would routinely modify
the parse).

One may thus question whether participants developed any predictions with regards to the
transitivity of the verb in the Incomplete conditions or whether the Line Completeness manipu-
lation induced only irregular reading patterns. The significant difference in accuracy between the
two conditions where the verb was intransitive provides some evidence that a prediction was
formed. Unlike in Transitive conditions, in the absence of any aiding cues the odds of misinterpre-
tation were higher when the reader was primed with structurally incomplete lines (INT-INCOM)
compared to complete ones (INT-COM), though in both conditions disambiguating material on
line 5 rendered the intransitive analysis felicitous. Recall that these two versions of stimuli were
virtually identical lexically. The only difference was that the line-final words in the Intransitive
and Complete version were shifted onto the immediately subsequent line in the Intransitive and
Incomplete one; this process created severed syntactic constituents on successive lines. Repeated
exposure to fragmented clauses could have generated an expectation of structural incompleteness,
resulting in readers holding off closure in line 3 and banking on the line 4 candidate being the OBJ
of the critical verb. If the transitive analysis received any activation, even if briefly, then the lin-
gering trace of that interpretation (Christianson et al. 2001) could perhaps account for the accuracy
cost observed in the Intransitive and Incomplete condition; that cost was not observed in the In-
transitive and Complete one since no (con)textual feature prompted the reader to entertain transi-
tivity. Although further research is needed to establish the cause of this effect, it is provisionally
suggested that the lower accuracy observed when readers were presented with structurally incom-
plete lines is a consequence of prediction error.

6. Conclusion

The present study contributes to the literature by reporting on effects of lineation manipula-
tions, an underexplored factor in psycholinguistic research. Nevertheless, there are certain limita-
tions to the conclusions that can be drawn. Firstly, the line-by-line self-paced reading paradigm
can be informative only to an extent. Different segmentation procedures (e.g. word-by-word pre-
sentation) or experimental technologies (e.g. eye-tracking) can yield data of higher spatial-tempo-
ral precision. Additionally, the design of the stimuli meant that certain imbalanced cues were in-
evitably introduced and that the disambiguating region was the final segment readers viewed.
Thus, effects of interest emerged during wrap-up processes (although wrap-up need not be left to
the end of sentences; see Stowe et al. 2018). Care shall be taken to avoid these complications in
any further testing.

The findings of this study can be summarized in the following key points. More often than
not, readers expect line breaks to coincide with clause boundaries; this co-terminality may lead to
facilitation in processing. However, when that expectation is falsified so that the continuity of the
syntax conflicts with the discontinuity of the line, disruption is likely to be observed and erratic
reading patterns may emerge. Furthermore, readers are quick to make predictions based on prop-
ties of the line. Recurring mismatch between line breaks and clausal boundaries can give rise to an
anticipation of structural incompleteness. In turn, if parsers operate based on this prediction and
they end up being proven false, their comprehension may suffer. Overall, all the evidence present-
ed calls attention to the importance of the visuospatial arrangement of textual stimuli in reading
studies. The way in which text is formatted can affect syntactic analysis as well as interpretation.
Readers take into account such textual properties to guide parsing on a context-by-context basis.

References

Adams, Beverly Colwell, Charles Clifton, and Don C. Mitchell. 1998. Lexical guidance in sentence process-
Bates, Douglas, Martin Mächler, Ben Bolker, and Steve Walker. 2015. Fitting linear mixed-effects models
Christianson, Kiel, Andrew Hollingworth, John F. Halliwell, and Fernanda Ferreira. 2001. Thematic roles
Cutler, Anne, Delphine Dahan, and Wilma van Donselaar. 1997. Prosody in the comprehension of spoken


