Number attraction affects reanalysis in sentence processing

Suckow, Katja; van Gompel, Roger P.G.

Published in:
Language, Cognition and Neuroscience

DOI:
10.1080/23273798.2017.1346812

Publication date:
2018

Document Version
Peer reviewed version

This is an Accepted Manuscript of an article published by Taylor & Francis in Language, Cognition and Neuroscience on6 July 2017, available online:
http://www.tandfonline.com/ *10.1080/23273798.2017.1346812.*

Number attraction affects reanalysis in sentence processing

1st Corresponding author
Katja Suckow
Seminar für Deutsche Philologie
Georg-August-Universität Göttingen
Käte-Hamburger-Weg 3
37073 Göttingen
Germany
+49-551-391-4467
katja.suckow@phil.uni-goettingen.de

2nd author
Roger P.G. van Gompel
School of Social Sciences
University of Dundee
DD1 4HN Dundee
UK
+44-1382-366117
r.p.g.vangompel@dundee.ac.uk

Abstract

Many studies have shown evidence for number attraction effects in production. Recent cross-linguistic findings suggest that number attraction can also affect comprehension of ungrammatical sentences. We present an eye-tracking experiment that investigates number attraction during recovery from garden-path sentences. The sentences contrasted locally ambiguous with unambiguous structures containing a plural or a singular attractor noun before a singular verb. Reading time data from the experiment suggest that number attraction effects occur when the processor has difficulty finding a grammatical analysis: Sentences with a local ambiguity had longer regression-path times when there was a plural number attractor than when there was a singular number attractor. The attractor number did not affect the processing of the unambiguous sentences.

Keywords: sentence processing; number attraction; eye-tracking; garden-path sentences; reanalysis

Number attraction in production

Number information in English can highlight what pieces in a sentence belong together. For example, number information reflects the link between a subject with its verb in subject-verb agreement (e.g *The teacher$_{sing}$ describes$_{sing}$ the painting*. and *The teachers$_{plu}$ arrive$_{plu}$ at the platform.*) However, research on language production shows that speakers sometimes produce number agreement violations that render an utterance ungrammatical, e.g., **The key to the cabinets are on the table.* Here, the subject (*key*) and its verb are separated by the prepositional phrase *to the cabinets*. In such cases, speakers sometimes produce a verb (*are*) that erroneously agrees with the directly preceding noun phrase. Such disruptions of subject-verb agreement processes are generally referred to as *attraction effects*.

Numerous studies have found evidence for number attraction in production (Bock & Miller, 1991; Bock & Cutting, 1992; Franck, Vigliocco, & Nicol, 2002; Bock, Eberhard, & Cutting, 2004; Solomon & Pearlmutter, 2004; Eberhard, Cutting, & Bock, 2005; Franck, Lassi, Frauenfelder, & Rizzi, 2006). Bock and Miller (1991) and Bock and Cutting (1992) showed that speakers sometimes make systematic agreement errors in experimental settings when asked to complete sentence fragments containing noun phrases with prepositional phrases like *The key to the cabinets…* (Bock & Miller, 1991, p. 56). In addition, several studies (e.g., Bock & Miller, 1991; Bock & Cutting, 1992; Eberhard, 1997) have shown that there are significantly more agreement errors when the attractor noun (an attractor here is the noun appearing close before the verb that is not its subject) is plural (e.g., *cabinets*) and the actual subject is singular than when the attractor is singular (*cabinet*) and the head noun plural (*keys*).

There are multiple models that account for this number asymmetry effect: for example, the activation-based account (Bock & Eberhard, 1993; Bock et al., 2004) and the marking and morphing account (Bock, Eberhard, Cutting, Meyer, & Schriefers, 2001, Eberhard, Cutting, & Bock (2005). Both of these accounts are based on the assumption that the plural is marked in comparison to the singular. Marking is understood as such that the plural noun has an additional grammatical feature that the default singular noun lacks. This additional feature increases activation in contrast to the unmarked singular. According to the activation-based and marking and morphing accounts, the marking of the plural thus increases the activation of a plural noun compared to a singular noun and this is the reason why the plural can override the default singular information from the subject. As a result of the

override of the subject's number information, the following verb might erroneously agree with the plural number from the local noun. (Jakobson, 1957; Greenberg, 1966; Eberhard, 1997).

Other accounts of attraction assume either that these effects might be due to a faulty syntactic representation of the subject, because the number feature of the local noun percolates up through the syntactic tree structure (Franck et al., 2002) or that the number of the attractor noun causes a higher plural activation of the whole subject noun phrase (Eberhard et al., 2005).

Experimental findings in other languages (like Castillian Spanish: Martin, Nieuwland, & Carreiras, 2012, 2014; Slovak: Badecker & Kuminiak, 2007 and Russian: Malko & Slioussar, 2013) and attraction caused by grammatical features other than number (such as gender: Badecker & Kuminiak, 2007; Martin, Nieuwland, & Carreiras, 2012, 2014, and case: Slioussar & Cherepovskaia, 2014) show a similar pattern: especially marked items can cause asymmetrical attraction effects. This suggests that the additional marking of an item in comparison to its unmarked base form makes it more active and therefore, it is sometimes erroneously considered as a candidate for agreement.

Number attraction in comprehension

If number attraction affects comprehension in a similar way as production, one would expect that comprehenders sometimes erroneously analyse the local noun *cabinets* in sentences such as *The key to the cabinets is on the table* as the subject. Following the initial studies showing number attraction in production, several studies have also investigated number attraction in comprehension (Nicol, Forster, & Veres, 1997; Pearlmutter, Garnsey, & Bock, 1999; Pearlmutter, 2000; Wagers, Lau, & Phillips, 2009; Dillon, Mishler, Sloggett, & Phillips, 2013). Reviewing the comprehension literature on attraction, there are consistent attraction effects in ungrammatical sentences, while attraction effects in grammatical sentences appear more inconsistent. We will give an overview of some of these findings.

Nicol et al. (1997) observed number attraction effects in a study using an online maze task (In a maze task, participants read a sentence word-by-word with the additional task that after each word they have to decide which of two presented words are the grammatical continuations of the input seen so far) and an offline acceptability judgement task (after reading a sentence, participants rated its acceptability). Sentences with a singular subject and a local plural noun showed longer reaction times on a following singular verb (in the maze

task) and longer decision times at the end of the sentence (in the acceptability judgement task) than sentences with a singular local noun. This suggests that comprehenders tried to establish agreement between the verb and the local noun rather than the head noun. This effect was reported for both sentences where the local plural number attractor was in a prepositional phrase (*The author of the speeches is here now*.) and where it was embedded in a relative clause (*The author of the house who charmed the realtors was no longer willing to sell*.). Although Nicol et al. (1997) reported attraction effects in their online task, the maze task might not be entirely suitable to investigate comprehension processes. At each word, comprehenders have to make a choice about the grammatical continuation of the sentence. Not only does such a forced choice at each word disrupt comprehension, it might also entail a hidden production task. Thus, the attraction effect in the maze task might be partly due to the production of a continuation rather than the comprehension of the verb. Nicol et al. (1997) also reported end-of-sentence judgements, but they may reflect later processes involved in grammaticality decisions rather than online processes. Online methods like self-paced reading or eye-tracking may be more informative exactly where in the sentence readers experience difficulty due to number attraction and since these methods don't involve a secondary task requiring an explicit judgement, they might better reflect comprehension processes.

Pearlmutter et al. (1999) conducted another study that investigated attraction effects during comprehension. Using both self-paced reading and eye-tracking, they reported attraction effects with singular head nouns. They tested both grammatical and ungrammatical sentences in which the number of the attractor was either plural or singular (*The key to the cabinet(s) was / *were rusty from many years of disuse*.). Reading times for the grammatical conditions were longer when the singular verb was preceded by a plural than by a singular local noun. (In the self-paced reading experiment, this slow-down was observed at the word following the critical verb *rusty*, while in the eye-tracking experiment, it was observed in total times at the verb). In the ungrammatical conditions, reading times at the spillover region (*rusty*) were shorter when the plural verb *were* was preceded by a plural than by a singular local noun. These findings suggest that number attraction in grammatical sentences results in a processing slow-down, whereas number attraction in ungrammatical sentences facilitates processing. However, in a third, self-paced reading experiment, Pearlmutter et al. (1999) observed a reverse attraction effect with grammatical sentences that had plural head nouns (*The keys to the cabinet(s) were rusty from many years of disuse*.): at the post verb region *rusty*, the matching conditions (*The keys to the cabinets were*...) had longer reading times than the mismatching conditions (*The keys to the cabinet were*…). It is unclear why the effects

from plural head nouns were the opposite from those of singular head nouns in the other experiments. While these two studies reported attraction effects during the comprehension of grammatical studies, more recent studies have failed to replicate the findings of Pearlmutter et al. (1999).

Wagers et al. (2009), Dillon et al. (2013), Tanner, Nicol, & Brehm (2014), Lago, Shalom, Sigman, Lau, & Phillips (2015) and Tucker, Idrissi, & Almeida (2015) reported consistent attraction effects in the comprehension of ungrammatical sentences, but not of grammatical sentences. In five self-paced reading experiments, Wagers et al. (2009) investigated attraction effects in comprehension with grammatical and ungrammatical sentences using prepositional phrases and object relative clauses. (*The key(s) to the cell(s) unsurprisingly was/were rusty from many years of disuse... . The musician(s) who the reviewer(s) praise(s) so highly will probably win a Grammy.*) Consistent with Pearlmutter et al. (1999), in all experiments number attraction affected the processing of ungrammatical sentences such that reading times were shorter when the attractor noun matched the verb in number than when it mismatched. However, no attraction effects were observed in the grammatical conditions: regardless of whether the head noun was singular or plural, reading times after a plural local noun did not differ from reading times after a singular noun.

Using eye-tracking, Dillon et al. (2013) reported similar results for sentences such as *The new executive who oversaw the middle manager(s) apparently was / *were dishonest about the company's profits*. Number attraction affected the processing of ungrammatical sentences: with a singular head noun, there were shorter total reading times with a local plural attractor at the critical verb and at the following word in comparison with a local singular attractor. However, similar to Wagers et al. (2009), they did not find attraction effects with grammatical sentences. The same pattern was also observed in two ERP experiments by Tanner et al. (2014): The P600 following the verb onset in ungrammatical sentences with a singular head was weaker when the local noun was plural (*the chemist with the test tubes are…*) relative to when it was singular (*the chemist with the test tube are…*), suggesting that a local noun that matched the verb in number reduced syntactic processing difficulty. In four self-paced reading experiments investigating number attraction in English and Spanish, Lago et al. (2015) consistently observed attraction effects with ungrammatical sentences, whereas only one experiment showed an attraction effect with grammatical sentences. This attraction effect with grammatical sentences was not replicated in another experiment with the same stimuli. These findings for Spanish are consistent with Tucker et al. (2015) who investigated number attraction in Arabic. Using self-paced reading and testing grammatical and

ungrammatical sentences, they found no attraction in grammatical sentences, but in line with the findings from English (Wagers et al., 2009) and Spanish (Lago et al., 2015), there was a significant effect for ungrammaticals: plural verbs in ungrammatical sentences were read faster when the attractor was plural than singular. In sum, all these studies consistently showed attraction facilitation for ungrammatical sentences.

The observed processing facilitation with ungrammatical sentences might be the result of error-driven processes that are employed when comprehenders have trouble finding a grammatical representation of the sentence. If the sentence is ungrammatical because the number of the head noun does not match that of the verb, comprehenders may consider the number marking of the attractor noun instead. If, however, the sentence is grammatical and easy to process, comprehenders do not need to look for an alternative interpretation. The head noun is immediately retrieved when processing the verb without consideration of the number of the attractor noun, so no attraction effect is observed for these grammatical sentences.

Summarising, the presented research has shown that attraction affects the production and comprehension of ungrammatical sentences, however it remains unclear whether and how attraction affects the comprehension of grammatical sentences. In the following, we will discuss how the memory retrieval model can account for the attraction effect in comprehension.

Attraction as a memory effect?

Badecker & Kuminiak (2007) and Staub (2009) claimed that attraction in production might be the result of an error that occurs during subject retrieval processes. In agreement with this, Wagers et al. (2009) proposed that the faster processing of ungrammatical sentences with a plural attractor in comparison to ungrammatical sentences with a singular attractor is due to memory retrieval processes. They argued that the observed attraction effects during comprehension can be explained with a cue-based retrieval mechanism (Van Dyke & Lewis, 2003; McElree, Foraker, & Dyer 2003; Lewis & Vasishth, 2005; McElree 2006; Van Dyke & McElree, 2006; Van Dyke, 2007; Van Dyke & McElree, 2011; Engelmann, Jäger & Vasishth, submitted). This account assumes that linguistic chunks such as the subject are stored in a content-addressable memory system and can be directly accessed when it matches the retrieval cues of the verb (e.g., when their number marking or grammatical role match). When a sentence is ungrammatical due to a number mismatch between a subject and its verb, the attractor noun may sometimes be retrieved instead because it is local. This erroneous retrieval of the local noun is more likely to be noticed and result in disruption when the attractor's

number does not match the verb's number. It is less likely to be noticed (resulting in less disruption) when the retrieved attractor and the verb match in number. (The observation that unsuitable candidates will sometimes be retrieved due to partial cue matches is often referred to as an intrusion effect in the literature, e.g., in Sturt, 2003; Vasishth, Bruessow, Lewis, & Drenhaus, 2008.) Wagers et al. (2009) suggested that one possibility is that the cue-based retrieval of the attractor is part of a reanalysis process that occurs because comprehenders predict the grammatical features of the verb and when this prediction is not met, they recheck whether they have missed any noun phrases that could be the subject of the verb. If there is such a noun phrase but it disagrees with the verb, then that causes difficulty, but if it agrees with the verb, then there is no such difficulty. In contrast, when the sentence is grammatical, the processor does not retrieve the attractor noun because their initial prediction of the features of the verb is confirmed. According to Wagers et al.'s (2009) argumentation, attraction effects are more likely to be observed when normal sentence processing is disrupted, such as in ungrammatical sentences.

Experiment

This experiment aims to test Wagers et al.'s (2009) claim that attraction effects are due to an error-driven process. Rather than using ungrammatical sentences, we used garden-path sentences, where people can recover from a perceived ungrammaticality.

As mentioned in the introduction, there is evidence for attraction during the comprehension of ungrammatical sentences in the form of processing facilitation (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015). Interestingly, the adoption of an incorrect syntactic analysis as observed with locally ambiguous garden-path sentences also results in an ungrammatical sentence. However, in garden-path sentences, readers can construct a correct grammatical representation of the sentence by revising their analysis; when a disambiguating word indicates that their initial interpretation is wrong, readers abandon their initial analysis and adopt the correct alternative (in a serial parsing model) or rerank their analyses of the sentence (in a parallel model). This experiment investigates whether attraction effects are stronger with garden-path sentences when comprehenders have difficulties understanding the structure of a sentence, as compared to syntactically unambiguous sentences. To test this, we compared garden-path (1a) with non-garden-path sentences (1b).

1. (a) ambiguous / plural attractor

   After Peter cheated the client of the agents has to focus on minor details.

   (b) unambiguous / plural attractor

   After Peter cheated, the client of the agents has to focus on minor details.

Research has shown that in locally ambiguous sentences such as (1a), readers initially analyse *the client of the agent* as the direct object of *cheated*, but at *has to*, they need to reanalyse this interpretation such that it is the subject of the second clause *the client of the agent has to focus on minor details* (e.g., Frazier & Rayner, 1982; Ferreira & Henderson, 1991; Pickering & Traxler, 1998, Van Gompel, Pickering, Pearson, & Jacob, 2006). Pickering and Traxler (1998) compared the reading times between ambiguous sentences without a comma and unambiguous sentences with a comma: *As the women edited(,) the magazine about fishing amused all the reporters*. They showed that readers experienced more difficulty following the disambiguation *amused* in the ambiguous condition without the comma than in the condition with the comma, where the sentence is disambiguated after *edited*. On the basis of these previous findings, we expect a slowdown for our sentences at or after the disambiguating verb *has to* in the ambiguous conditions (1a without comma) in comparison to the unambiguous conditions (1b with a comma).

During recovery from the garden-path, readers might erroneously consider the number of the attractor noun and match it with that of the verb. In the temporarily ambiguous condition (1a), readers will have to reanalyse the sentence structure at *has to*. In order to do that, readers will have to do two things successfully: (1) find the source of ambiguity (*cheated* can either be used as a transitive or intransitive verb) and (2) find the subject of the verb *has to* (the subject is *the client*). During reanalysis of the sentence structure, the search for the subject of the verb might be more difficult when the number of a plural attractor overwrites the singular subject information. When this happens, a number mismatch between the plural subject and the verb should result in difficulty because readers notice the mistake and have to check the real number of the subject.

In order to test number attraction, the second factor in the experiment was the number of the attractor noun before the verb (*has to*): the attractor was either singular (2a/b, *the agent*) or plural (1a/b *the agents*).

2. (a) ambiguous / singular attractor

   After Peter cheated the client of the *agent* has to focus on minor details.

(b) unambiguous / singular attractor

After Peter cheated, the client of the *agent* has to focus on minor details.

If attraction does indeed affect reanalysis processes, this should be observed with plural attractors when the actual subject and verb are singular. Previous findings from ungrammaticals (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015), from production studies (Bock & Miller, 1991; Bock & Cutting, 1992; Eberhard, 1997) and predictions of the marking and morphing account (Bock & Eberhard, 1993; Bock, Eberhard, Cutting, Meyer, & Schriefers, 2001) show that attraction is usually not observed with singular attractors. Since we were mainly interested in the effects of attraction on repair processes, this experiment tested the effect of a plural attractor on a singular verb only.

Assuming that attraction effects are mainly due to error-driven processes (e.g., Wagers et al., 2009), the number information at the verb should result in shorter reading times for singular attractors than for plural attractors in garden-path sentences (without comma). In contrast, there should be no or much weaker attraction effects in the unambiguous conditions (with comma).

Participants

Forty undergraduate students from the University of Dundee participated in this eye-tracking experiment. All of them were non-dyslexic English native speakers who received course credits for their participation.

Materials

Forty experimental sentences were created for the experiment, exemplified in (1, 2). The sentences started with a subordinate clause (*After Peter cheated*) and were followed by the main clause (*the client of the agent has to focus on minor details*). The verb in the subordinate clause (*cheated*) could be intransitive or transitive; in this experiment it was always intransitively used. In the unambiguous conditions the subordinate clause and the main clause were separated by a comma, while there was no comma between the clauses in the ambiguous conditions. The intransitive verb was followed by a complex NP-of-NP-noun phrase, which preceded the disambiguating verb *has to* (this region contained the verb phrase *has to* in all experimental sentences). While the first noun phrase was always singular (*the client*), the

number of the second noun in the complex noun phrase was manipulated: it was either singular or plural (*agent vs agents*). Thus, the experiment had four conditions by crossing the variables ambiguity (temporarily ambiguous vs. unambiguous sentence) and number of the local number attractor before the disambiguating verb (singular vs. plural).

Each sentence was followed by a Yes/No comprehension question. For half the items, the comprehension question asked about the content of the initial subordinate clause and for the other half, it asked about the content of the main clause. When the question was about the main clause, Yes questions asked whether the head noun was the subject of the main clause (e.g., *Did the agent focus on minor details*?) and No questions asked whether the attractor noun was the subject (e.g., *Did the client focus on minor details?*). The experimental sentences were presented with filler sentences that had a variety of structures that were also followed by a question.

Design

The experiment had a 2 × 2 design with ambiguity as the first variable. The second variable was the number information of the noun preceding the verb (attractor number: *agent* vs. *agents*). We constructed four lists with 10 items from each condition. Each of these lists contained one condition from each critical item. In addition to the critical items, each list contained 105 filler sentences. The order of the sentences was randomised; this randomised order was the same across the four lists. At least one filler sentence appeared between the critical sentences.

Apparatus and Procedure

The experiment was carried out using the Experiment Builder Program from SR Research on a PC. An Eyelink 1000 Desktop Mount recorded participants' eye movements at a 1000 Hz sampling rate. The experiment was controlled by the Experiment Builder software on a separate PC.

Before the start of the experiment, participants read a short instruction in which they were asked to read and understand the sentences presented on the screen. They were instructed to press a button when they finished reading the sentence and then a comprehension question appeared. They were asked to move as little as possible during the experiment to ensure that the eye-tracker could keep track of the eye movements.

Before the presentation of the first sentence, a calibration process started. Breaks for the participants were scheduled after every twenty sentences, after which there was a recalibration. Additional calibrations were executed when needed (e.g. when the tracker couldn't detect the eye anymore or the participant moved their head.)

Each sentence was presented in the following order: first a calibration circle appeared in the centre of the screen so that the experimenter could check the current calibration. Next, a fixation-cross appeared on the left side of the screen and participants had to look at it. When the eye-tracker detected the fixation on the cross, the cross disappeared and was replaced by the sentence. Participants read the sentence carefully and after they finished reading it, they had to press a key. The sentence was replaced by a Yes/No comprehension question. Participants received feedback when they answered the question incorrectly. There was no feedback if they answered the comprehension question correctly.

Analysis

For the analyses, ANOVAs were conducted with subjects (F1) and items (F2) as random variables. Ambiguity and number of the local noun were treated as within subjects and within items fixed variables. In addition, subject group was a fixed between-subjects variable in the by-subject analyses and item group a between-items variable in the by-item analyses to eliminate the variance caused by random differences between the groups as described by Pollatsek and Well (1995). In addition, MinF' statistics were computed as suggested by Raajimakers, Schrijnemakers, & Gremmen (1999) and Clark (1973).

Various reading measures (defined below) were analysed for three different areas of interest. The vertical lines in (3) indicate the areas of interest for the eye-movement analyses.

3. After Peter cheated the client of the agent | has to | focus on | minor details.

Areas of interest were (1) the critical region *has to*, which contained the auxiliary *has*, (2) the post-critical region *focus on*, which consisted of the word(s) following *has* and (3) the final region *minor details*, which was the remainder of the sentence. Each of the three areas of interest was at least six characters long (if the first word in the region had fewer than six characters, then the region was extended to the next word until the length condition of six characters was satisfied). A space between words was counted as a character.

Four different eye-movement measures were analysed. *First fixation duration* was defined as the length of the very first fixation in the specific area of interest provided that this

fixation was not preceded by a fixation to the right. *First-pass time* is the duration from entering an area of interest for the first time until leaving it into any direction, again provided that this fixation was not preceded by a fixation to the right. *Regression-path time* is the duration of fixations from first entering the area of interest until a fixation to the right of the interest area, provided that this fixation was not preceded by a fixation to the right. This measure includes all fixations (and saccades) after leaving the interest area to the left and thus includes fixations in preceding regions. *Total reading time* is the sum of all fixations in a region of interest. If successive fixations were in the same interest area, the saccades between fixations were included.

Results

Table 1 shows a summary of the means for the four reading measures across the areas of interest and Table 2 shows the comprehension accuracy in percentages. Table 3 shows the comprehension accuracy for comprehension questions that asked whether the attractor noun was the subject of the main clause verb *has to*.

"(Table 1 about here)"
"(Table 2 about here)"
"(Table 3 about here)"

Critical region (has to): There was a main effect of ambiguity in first fixation durations ($F1(1, 36) = 8.93$, $p < .01$; $F2(1, 36) = 11.11$, $p < .01$; $MinF'(1, 71) = 4.95$, $p < .01$), first-pass times ($F1(1, 36) = 23.97$, $p < .001$; $F2(1, 36) = 15.62$, $p < .001$; $MinF'(1, 69) = 9.49$, $p < .001$), regression-path times ($F1(1, 36) = 25.53$, $p < .001$; $F2(1, 36) = 43.35$, $p < .001$; $MinF'(1, 67) = 16.07$, $p < .01$) and total reading times ($F1(1, 36) = 62.75$, $p < .001$; $F2(1, 36) = 80.99$, $p < .001$; $MinF'(1, 71) = 35.36$, $p < .001$). The ambiguous conditions had longer reading times than the unambiguous conditions in all four reading time measures.

Furthermore, the by-item analyses suggested a main effect of attractor number in first-pass time ($F2(1, 36) = 4.38$, $p < .05$), but this was not significant by subjects ($F1(1, 36) = 2.05$, $p = .16$) or in the MinF' statistic ($MinF'(1, 64) = 1.4$, $p = .16$). Reading times were slightly longer (15 ms) when the attractor was plural than when it was singular. To explore whether this by-items effect was driven either by the ambiguous or the unambiguous conditions, we carried out simple effect analyses but found no attractor number effect for the

ambiguous conditions by subjects (F1 < 1.03), a marginal by-items effect (F2(1, 36) = 3.84, p = .06) and no effect in MinF' (MinF' < 1)). The attractor effect in the unambiguous conditions was also not significant (Fs < 1 – including MinF'). There was no main effect of attractor number in first fixation duration (Fs < 1), regression-path time (Fs < 2.46) or total reading times (Fs < 1.34).

Most interestingly, in regression-path times there was an interaction between attractor number and ambiguity (F1(1, 36) = 4.87, p < .05; F2(1, 36) = 5.03, p < .05; MinF'(1, 72) = 2.47, p < .01). Simple effect analyses showed that the ambiguous conditions had longer regression-path times with a plural attractor than with a singular attractor (F1(1, 36) = 5.26, p < .05; F2(1, 36) = 5.68, p < .05, MinF'(1, 72) = 2.73, p < .005). There was no difference between the singular and the plural attractor in the unambiguous conditions (Fs < 0.29). There was no interaction between attractor number and ambiguity in first fixation duration, first-pass time and total reading time (Fs < 1).

Post-critical region (focus on): There was a significant ambiguity effect in regression-path time (F1(1, 36) = 33.85, p < .001; F2(1, 36) = 52.74, p < .001; MinF'(1, 69) = 20.62, p < .001) and in total reading time (F1(1, 36) = 27.79, p < .001; F2(1, 36) = 22.35, p < .001; MinF'(1, 71) = 12.39, p < .001). Comparison of the means showed that the ambiguous conditions had longer reading times than the unambiguous conditions in both measures.

There was no main effect of ambiguity in first fixation duration and in first-pass time (Fs < 1). There was also no main number effect from the attractor in first fixation duration, first-pass time, regression-path time and total reading time (Fs < 1). There was also no interaction between these factors in any of the four reading time measures at the post-critical region (Fs < 1).

Final region (minor details): Analyses of variance showed an ambiguity effect in first-pass time which was significant by subjects (F1(1, 36) = 5.02, p < .05) but only marginally significant by items (F2(1, 36) = 3.38, p < .10) and significant in MinF' (MinF'(1, 69) = 2.02, p < .05). The unambiguous conditions had longer reading times than the ambiguous conditions. In first-pass times, there was an interaction between ambiguity and number that was significant by subjects (F1(1, 36) = 4.17, p < .05) but not significant by items (F2(1, 36) = 1.86, p = .18) and not in MinF' (MinF'(1, 63) = 1.29, p = .22).

The analysis of regression-path times showed a significant ambiguity effect at the final region (F1(1, 36) = 19.27, p < .001; F2(1, 36) = 32.26, p < .001; MinF'(1, 68) = 12.06, p <

.001). Comparison of the means showed that the ambiguous conditions had longer reading times than the unambiguous conditions.

There was an interaction between ambiguity and attractor number for total reading times which was significant by subjects ($F1(1, 36) = 4.26$, $p < .05$) but only marginally significant by items ($F2(1, 36) = 2.86$, $p < .10$) and in MinF' ($MinF'(1, 69) = 1.71$, $p = .06$). However, simple effect analyses contrasting singular and plural attractors in both the ambiguous and unambiguous conditions did not show significant effects ($Fs < 2.46$).

There was no ambiguity effect in first fixation duration ($Fs < 1$) and in total reading times ($Fs < 2.44$) at the final region. Also there was no effect of attractor number in any of the four measures in the final region ($Fs < 1.24$). Finally, there was no interaction in first fixation duration, first-pass and regression-path time ($Fs < 1.10$).

Comprehension question accuracy rate: Comprehension accuracy across the critical conditions in the experiment ranged between 80% and 87%, suggesting that participants comprehended the stimuli successfully. Analyses of the comprehension errors showed a main effect of ambiguity ($F1(1, 36) = 8.64$, $p < .01$; $F2(1, 36) = 5.16$, $p < .05$; $MinF'(1, 68) = 3.23$, $p < .001$). The ambiguous conditions had a higher error rate than the unambiguous conditions. The interaction was not significant by subjects $F1(1, 36) = 2.45$), but marginally significant by items ($F2(1, 36) = 4.06$, $p = .051$) and not significant in MinF' ($MinF'(1, 68) = 1.53$, $p = .10$). There was no effect of noun phrase number ($Fs < 1.70$) in the comprehension errors.

A further analysis of a no-question-type which asked whether the attractor was the subject of the verb (*Did the agent focus on minor details*? - No) showed an effect of ambiguity by subjects ($F1(1, 36) = 4.48$, $p < .05$), but not by-items $F2(1, 8) < 1$ and also not in MinF' ($MinF`(1, 10) < 1$), no effect of number ($Fs < 1$) and no interaction ($Fs < 1$). There was also no difference between the plural and the singular conditions for the ambiguous sentences ($Fs < 1$) (see Table 3).

General Discussion

The eye-tracking experiment presented here investigated number attraction effects in garden-path structures, specifically, the question of whether these effects are affected by error-driven processes that occur when comprehenders have difficulties constructing a grammatical analysis. For this, sentences were presented either with or without a local ambiguity and the noun directly preceding the main, disambiguating verb was either singular or plural.

The experiment showed a strong effect of ambiguity in multiple measures and regions (first fixation duration: critical region, first-pass time: critical and final region, regression-path time: critical, post-critical and final region and total reading time: critical and final region.) This is consistent with previous findings (e.g., Pickering & Traxler, 1998) and suggests that readers initially misanalysed sentences with a temporary ambiguity and then had to start a reanalysis process.

Although the direction of first-pass times in the critical region was consistent with a main effect of attractor number, this effect was not significant by items and in minF'. Furthermore, the difference was numerically quite small and simple effect analyses did not show an effect of attractor noun number in either the ambiguous or the unambiguous conditions. The direction of the means may suggest a number attraction effect in both the ambiguous or unambiguous conditions, or alternatively, the small difference may be due to a spill-over effect from the previous region, which differed in length between the plural (*agents*) and singular (*agent*) conditions. This would be in line with Wagers et al. (2009), who showed that longer processing times for plural nouns spilled over to the following region in a self-paced reading study that investigated attraction. The absence of a main effect of attraction would be in agreement with previous studies that have found little or no effect of attractor number with unambiguous grammatical sentences (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015).

Most critically, there was an interaction between ambiguity and attractor number marking. In the ambiguous conditions, there were longer regression-path times at the critical region *has to* when the attractor was plural (it mismatched the number of the following verb) than when it was singular (it matched the number of the verb). In contrast, there was no number effect of the attractor noun in the unambiguous conditions. This interaction suggests that attraction has a stronger effect on garden-path sentences, that is, when readers have to revise their initial analysis. When readers have difficulties building a grammatical analysis, they need to recheck their initial analysis. Encountering the main verb in the ambiguous conditions, readers discover that the direct object analysis of the noun phrase containing the head noun and attractor (*the client of the agent(s)*) is ungrammatical and that they need to reanalyse the sentence structure. To do this, they need to find the subject of the disambiguating verb (*has to*). The longer regression-path times in the plural attractor condition suggest that comprehenders temporarily consider this subject to be plural, resulting in a number mismatch effect. There are two potential explanations for the temporary consideration of the plural.

First, during reanalysis, the attractor noun might erroneously be retrieved due to its recency to the verb. Because the attractor has just been processed it is more activated in memory and thus might be considered the subject. If the attractor is plural, detection of the number mismatch between the attractor and the singular verb causes processing disruption, as observed in regression-path times for the critical region. In contrast, if the attractor is singular, then there is no number mismatch, so the erroneous subject-verb agreement is unlikely to be detected and processing difficulty should not arise. This would result in an incorrect sentence interpretation because the wrong noun is retrieved as the subject of the verb. However, the error rates for the comprehension questions that asked whether the attractor was the subject of the verb showed no evidence for this. Following the temporarily ambiguous sentences, error rates for questions such as *Did the agent focus on minor details?* (answer no) were no higher when the attractor was singular (and participants are predicted to analyse the attractor as the subject) than when it was plural (where the attractor as the subject is ruled out by the number mismatch with the verb). This suggests that readers did not analyse the attractor as the subject in the singular attractor condition any more than in the plural condition.

A second, more plausible explanation is suggested by the marking and morphing account (Eberhard, Cutting, & Bock, 2005). According to this account, the plural number feature is more marked than the singular number feature. As a consequence, when readers have to reactivate the subject of the verb, either when constructing the subject analysis during reanalysis (in a serial model) or when reranking the subject analysis above the object analysis (in a parallel model), the plural number feature of the attractor noun might overwrite the singular feature of the subject, resulting in an erroneous representation of the whole complex noun phrase as plural. This results in a number mismatch between the misrepresented plural subject and the singular verb, triggering regressive eye-movements back to check the actual number information of the subject. Critically, this explanation does not assume that readers incorrectly interpret the attractor noun as the subject of the verb. Regardless of whether the attractor is singular or plural, the complex noun phrase is correctly analysed as the subject, but when the attractor is plural, the number of the whole noun phrase is incorrectly represented, resulting in a number mismatch with a singular verb.

Reading times in the unambiguous conditions were unaffected by the number of the attractor noun, which is in line with previous findings (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015). Because the processing of subject-verb agreement is not disrupted by reanalysis (or reranking of the analyses) during verb

integration, number attraction has no clear effect: in unambiguous sentences, readers do not need to reactivate the complex noun phrase.

This account of our current findings is consistent with previous studies investigating ungrammatical sentences, which found evidence for facilitation when an attractor noun matched the following verb in number (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015). When the sentence is ungrammatical because the number of the actual subject does not match that of its verb (as in *The key to the cell(s) are*…), readers may need to reprocess the sentences because it is ungrammatical. When the attractor noun is plural (*cells*) the whole complex noun phrase is sometimes represented as plural, and therefore processing is relatively easy. In contrast, when the attractor noun is singular (*cell*) the whole noun phrase is represented as singular and due to the mismatch with the plural verb reprocessing will be difficult and fail.

As we mentioned in the Introduction, our experiment did not include conditions with plural head nouns, as theories of attraction do not predict attraction effects in such cases (e.g., Bock & Eberhard, 1993; Bock, Eberhard, Cutting, Meyer, & Schriefers, 2001), and indeed, previous studies (e.g., Bock & Miller, 1991; Bock & Cutting, 1992; Eberhard, 1997, Wagers et al, 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015) generally have not found evidence for attraction with plural head nouns. One possibility we need to consider is whether the difficulty in the ambiguous condition with a plural attractor occurred because a plural noun introduces more discourse entities than a singular noun, making the retrieval of the subject of a singular verb more confusing. However, this seems unlikely, as verbs agree with noun phrases, not with individual entities within these noun phrases (e.g., a verb cannot agree with one of the agents in the noun phrase *the agents*). In addition, if "the client of the agents" is less plausible than "the client of the agent", then that should have resulted in a main effect of attractor number. Any plausibility differences do not explain the critical interaction between attractor number and ambiguity that we observed. Furthermore, any plausibility differences due to a singular vs. plural noun would most likely occur at this noun (*agent(s))* rather than at the verb. Finally, this explanation is also inconsistent with the findings from ungrammatical sentences, which take *less* time to process when the attractor noun is plural (*the chemist with the test tubes are*) than when it is singular (*the chemist with the test tube are*).

Finally, in contrast to claims by Van Dyke & Lewis (2003), Lewis & Vasishth (2005), Van Dyke & McElree (2006), Van Dyke (2007) and Van Dyke & McElree (2011), the current experiment did not find any evidence that retrieval processes are susceptible to similarity-

based interference. According to interference accounts, retrieval interference (number interference etc.) should occur when the target and distracter nouns share retrieval cues. Thus, these accounts predict processing difficulty when the local noun *matches* the verb, that is, they predict the opposite of an attraction effect. We did not find any sign of interference in any of the measures. One possibility is that in the unambiguous sentences, the local noun has such a low activation relative to the subject that it barely interferes and the effect of the number of the local noun is not observable in the reading times. In the ambiguous sentences, however, the number of the local noun did affect the reading times, but the direction of the means was opposite to the prediction made by similarity-based interference: regression-path times in the garden-path sentences were *shorter* when the number of the two nouns matched than when they mismatched. This may suggest that subject-verb dependency processes are not affected by interference, at least not during reanalysis in garden-path sentences.

In sum, we have presented an eye-tracking experiment that showed an effect of number attraction during reanalysis processes. The results suggest that readers sometimes consider an erroneous plural representation of the sentence subject during reanalysis; a plural attractor noun aggravated processing disruption during reanalysis. We conclude that number attraction affects the comprehension of grammatical sentences during repair processes.

References

Badecker, W., & Kuminiak, F. (2007). Morphology, agreement and working memory retrieval in sentence production: Evidence from gender and case in Slovak. *Journal of Memory and Language, 56*, 65-85.

Bock, K., & Cutting, J. C. (1992). Regulating mental energy: Performance units in language production. *Journal of Memory and Language, 31*, 99-127.

Bock, K., & Eberhard, K. M. (1993). Meaning, sound and syntax in English number agreement. *Language and Cognitive Processes, 8*(1), 57–99.

Bock, K., Eberhard, K. M., & Cutting, J. C. (2004). Producing number agreement: How pronouns equal verbs. *Journal of Memory and Language, 51*, 251-278.

Bock, K., Eberhard, K. M., Cutting, J. C., Meyer, A. S., & Schriefers, H. (2001). Some attractions of verb agreement. *Cognitive Psychology, 43*, 83–128.

Bock, K., & Miller, C. A. (1991). Broken agreement. *Cognitive Psychology, 23*, 45–93.

Dillon, B., Mishler, A., Sloggett, S., & Phillips, C. (2013). Contrasting intrusion profiles for agreement and anaphora: Experimental and modelling evidence. *Journal of Memory and Language, 69*, 85-103.

Eberhard, K. M. (1997). The marked effect of number on subject-verb agreement. *Journal of Memory and Language , 36* (2), 147–164. doi: 10.1006/jmla.1996.2484

Eberhard, K. M., Cutting, J. C., & Bock, K. (2005). Making syntax of sense: Number agreement in sentence production. *Psychological Review, 112*, 531-559.

Engelmann, F., Jäger, L. & Vasishth, S. (submitted). The determinants of retrieval interference in dependency resolution: Review and computational modeling.

Ferreira, F., & Henderson, J. (1991). The misinterpretation of noncanonical sentences. *Journal of Memory and Language, 25*, 725–745.

Franck, J., Lassi, G., Frauenfelder, U. H., & Rizzi, L. (2006). Agreement and movement: A syntactic analysis of attraction. *Cognition, 2006*, 173-216.

Franck, J., Vigliocco, G., & Nicol, J. (2002). Subject-verb agreement errors in French and English: The role of syntactic hierarchy. *Language and Cognitive Processes, 17*(4), 371-404.

Frazier, L., & Rayner, K. (1982). Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences. *Cognitive Psychology, 14*, 178-210.

Greenberg, J. (1966). Language universals. The Hague: Mouton.

Jakobson, R. (1957). Shifters, verbal categories, and the Russian verb (Russian language project report). Cambridge, Mass.: Harvard University, Department of Slavic Languages and Literatures.

Lago, S., Shalom, D., Sigman, M., Lau, E., & Phillips, C. (2015). Agreement processes in Spanish comprehension. *Journal of Memory and Language, 82*, 133–149.

Lewis, R. L., & Vasishth, S. (2005). An activation-based model of sentence processing as skilled memory retrieval. *Cognitive Science, 29*, 375-419.

Malko, A., & Slioussar, N. (2013). Attraction errors in gender agreement: Evidence from Russian. In S. Franks (Ed.), *Formal Approaches to Slavic Linguistics: The Third Indiana Meeting 2012* (pp. 162–175).

Martin, A. E., Nieuwland, M. S., & Carreiras M. (2014). Agreement attraction during comprehension of grammatical sentences: ERP evidence from ellipsis. *Brain & Language 135*, 42-51.

Martin, A. E., Nieuwland, M. S., & Carreiras M. (2012). Event-related brain potentials index cue-based retrieval interference during sentence comprehension. NeurImage, 59, 1859-1869.

McElree, B, Foraker, S., & Dyer, L. (2003). Memory structures that subserve sentence comprehension. *Journal of Memory and Language*, 48, 67-91.

McElree, B. (2006). Accessing recent events. In B.H. Ross (Ed.). The psychology of learning and motivation (Vol, 46, pp. 155-200). San Diego: Academic Press.

Nicol, J. L., Forster, K. I., & Veres, C. (1997). Subject-verb agreement processes in comprehension. *Journal of Memory and Language, 36*, 569-587.

Pearlmutter, N. J. (2000). Linear versus hierarchical agreement feature processing in comprehension. *Journal of Psycholinguistic Research, 29*, 89-98.

Pearlmutter, N. J., Garnsey, S. M., & Bock, K. (1999). Agreement processes in sentence comprehension. *Journal of Memory and Language, 41*, 427-456.

Pickering, M. J., & Traxler, M. J. (1998). Plausibility and recovery from garden paths: An eye-tracking study. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*, 940–961.

Pollatsek, A., & Well, A. D. (1995). On the use of counterbalanced designs in cognitive research: a suggestion for a better and more powerful analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*(3), 785-794.

Raajimakers, J. G. W, Schrijnemakers, J. M. C., & Gremmen, F. (1999). How to deal with "Language-as-the-Fixed-Effect Fallacy": Common Misconceptions and Alternative Solutions. *Journal of Memory and Language, 41* (1), 416-426.

Slioussar, N., & Cherepovskaia, N. (2014). Case errors in processing: Evidence from Russian. In C. Chapman, O. Kit, & I. Kŭcerova (Eds.), Formal Approaches to Slavic Linguistics: The First Hamilton Meeting 2013. Ann Arbor, MI: Michigan Slavic Publications.

Solomon, E. S., & Pearlmutter, N. J. (2004). Semantic integration and syntactic planning in language production. *Cognitive Psychology, 49*, 1-46.

Staub, A. (2009). On the interpretation of the number attraction effect: Response time evidence. *Journal of Memory and Language 60*, 308-327.

Sturt, P. (2003). The time-course of the application of binding constraints in reference resolution. *Journal of Memory and Language, 48*, 542-562.

Tanner, D., Nicol, J., & Brehm, L. (2014). The time course of feature interference in agreement comprehension: Multiple mechanisms and asymmetrical attraction. *Journal of Memory and Language, 76*, 195–215.

Tucker, M. A., Idrissi, A., & Almeida, D. (2015). Representing number in the real-time processing of agreement: self-paced reading evidence from Arabic. *Frontiers in Psychology*, doi: 10.3389/fpsych.2015.00347.

Van Dyke, J. A. (2007). Interference effects from grammatically unavailable constituents during sentence processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(2), 407-430.

Van Dyke, J. A., & Lewis, R. L. (2003). Distinguishing effects of structure and decay on attachment and repair: A cue-based parsing account of recovery from misanalyzed ambiguities. *Journal of Memory and Language, 49*, 285-316.

Van Dyke, J. A., & McElree, B. (2006). Retrieval interference in sentence comprehension. *Journal of Memory and Language, 55*, 157-166.

Van Dyke, J. A., & McElree, B. (2011). Cue-dependent interference in comprehension. *Journal of Memory and Language, 65*, 247–263.

Van Gompel, R.P.G., Pickering, M.J., Pearson, J., & Jacob, G. (2006). The activation of inappropriate analyses in garden-path sentences: Evidence from structural priming. *Journal of Memory and Language, 55*, 335-362.

Vasishth, S., Bruessow, S., Lewis, R., & Drenhaus, H. (2008). Processing polarity: How the ungrammatical intrudes on the grammatical. *Cognitive Science, 32*, 685-712.

Wagers, M. W., Lau, E. F., & Phillips, C. (2009). Agreement attraction in comprehension: Representations and processes. *Journal of Memory and Language, 61*, 206-237.

A Appendix: sentence stimuli

Sentences were constructed to either be ambiguous (without comma) or unambiguous (with comma). The noun phrase directly preceding the disambiguating verb *has to* was either singular (without an s) or plural (with an s). The slashes "/" in the sentences indicate the areas of interest that were analysed in the eye-tracking experiment.

1. After Adam phoned(,) the clerk of the manager(s) / has to / finish the / paperwork.
2. While Sally assisted(,)thelawyeroftheclient(s)/hasto/findthe/documents.
3. When Frank helped(,) the supplier of the grocer(s) / has to / ask for / more money.
4. After Jane interviewed(,) the representative of the councillor(s) / has to / get more / information.

5. After Ann heckled(,) the follower of the preacher(s) / has to / leave the / building.
6. After Will advised(,) the assistant of the scientist(s) / has to / resolve / a bad situation.
7. After Joe overtook(,) the chauffeur of the shopkeeper(s) / has to / brake all / of a sudden.
8. When Lee taught(,) the student of the teacher(s) / has to / listen / to the recordings.
9. After Kate investigated(,) the relative of the witness(es) / has to / deal with / the proceedings.
10. When Boris kissed(,) the intern of the accountant(s) / has to / think about / the repercussions.
11. While Ben followed(,) the solicitor of the actor(s) / has to / find the / documents.
12. After Jessica interrogated(,) the accomplice of the criminal(s) / has to / go directly / to court.
13. When Al attacked(,) the bodyguard of the dancer(s) / has to / find an / escape route.
14. After Ian monitored(,) the co-worker of the mechanic(s) / has to / vacuum / the carpet.
15. As Juliet approached(,) the nurse of the patient(s) / has to / welcome / the visitors.
16. While Tom sketched(,) the trainee of the painter(s) / has to / prepare / the materials.
17. After Jane left(,) the detective of the tycoon(s) / has to / write down / the conversation.
18. After Chris supervised(,) the employee of the manager(s) / has to / organise / the papers.
19. As Dan cursed(,) the helper of the technician(s) / has to / correct / the mistake.
20. While Jen checked(,) the apprentice of the architect(s) / has to / find faults / in the plans.
21. While Matthew watched(,) the teammate of the player(s) / has to / control / the set-piece.
22. After Juan booed(,) the admirer of the artist(s) / has to / ignore / the outburst.
23. When Shirley interrupted(,) the fan of the singer(s) / has to / stop playing / the record.
24. As Alex called(,) the secretary of the executive(s) / has to / work on / the important files.
25. After Virginia answered(,) the cousin of the farmer(s) / has to / think it / all over again.
26. When Laura paid(,) the associate of the executive(s) / has to / open a / new account.
27. While Jim inspected(,) the superior of the soldier(s) / has to / review / the formation.
28. Before Dave left(,) the chauffeur of the millionaire(s) / has to / go to the / city centre.
29. After Peter cheated(,) the client of the agent(s) / has to / focus on / minor details.
30. While Emily served(,) the companion of the hiker(s) / has to / look for / the toilets.
31. When Michael counselled(,) the prisoner of the warden(s) / has to / formulate / an appeal.
32. When Jacob chased(,) the robber of the pensioner(s) / has to / jump out / of the window.
33. After Anna rang(,) the collaborator of the researcher(s) / has to / meet with / the professor.
34. When Claire visited(,) the examiner of the graduate(s) / has to / think about / the marks.
35. While Charlie painted(,) the friend of the artist(s) / has to / look at / the picture.
36. While Frank applauded(,) the critic of the performer(s) / has to / write down / some comments.
37. When Dick questioned(,) the killer of the teenager(s) / has to / admit to / the awful truth.
38. While Bernard coached(,) the instructor of the gymnast(s) / has to / perform / the routine.
39. After Steve attacked(,) the pilot of the passenger(s) / has to / perform an / emergency landing.
40. Before James examined(,) the mentor of the speaker(s) / has to / revise / the argumentation.

Table 1: *Means of the reading time measures in ms (standard errors in brackets)*

measure/condition	**critical**	**post-critical**	**final**
First fixation duration			
ambiguous / singular attractor	245 (6)	212 (4)	238 (8)
ambiguous / plural attractor	250 (6)	211 (4)	229 (6)
unambiguous / singular attractor	229 (5)	215 (4)	236 (6)
unambiguous / plural attractor	232 (5)	215 (4)	236 (6)
First-pass time			
ambiguous / singular attractor	331 (10)	267 (8)	360 (17)
ambiguous / plural attractor	342 (10)	272 (8)	369 (14)
unambiguous / singular attractor	282 (8)	267 (8)	410 (17)
unambiguous / plural attractor	301 (9)	267 (8)	368 (13)
Regression-path time			
ambiguous / singular attractor	609 (43)	1002 (75)	2588 (116)
ambiguous / plural attractor	747 (52)	930 (64)	2537 (111)
unambiguous / singular attractor	420 (28)	590 (32)	2038 (78)
unambiguous / plural attractor	389 (21)	583 (36)	2050 (76)
Total reading time			
ambiguous / singular attractor	674 (22)	530 (16)	570 (25)
ambiguous / plural attractor	701 (25)	537 (18)	604 (23)
unambiguous / singular attractor	468 (14)	456 (13)	585 (23)
unambiguous / plural attractor	471 (15)	461 (14)	548 (19)

Table 2: *Percentages of comprehension question accuracy*

Condition	**correct responses in %**
ambiguous / singular attractor	80 (20)
ambiguous / plural attractor	85 (15)
unambiguous / singular attractor	87 (13)
unambiguous / plural attractor	86 (14)

Table 3: *Comprehension question accuracy for each condition when question asked whether the attractor noun was the subject of the verb: "Did the agent focus on minor details?" (No)*

Condition	**correct responses in %**
ambiguous / singular attractor	62 (38)
ambiguous / plural attractor	63 (37)
unambiguous / singular attractor	65 (35)
unambiguous / plural attractor	69 (32)