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Phonological Phrase Boundaries Constrain the Online Syntactic Analysis of Spoken Sentences

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Two experiments tested whether phonological phrase boundaries constrain online syntactic analysis in French. Pairs of homophones belonging to different syntactic categories (verb and adjective) were used to create sentences with a local syntactic ambiguity (e.g., [le petit chien *mort*], in English, the *dead* little dog, vs. [le petit chien] [*mord*], in English, the little dog *bites*, where brackets indicate phonological phrase boundaries). An expert speaker recorded the sentences with either a maximally informative prosody or a minimally informative one. Participants correctly assigned the appropriate syntactic category to the target word, even without any access to the lexical disambiguating information, in both a completion task (Experiment 1) and an abstract word detection task (Experiment 2). The size of the experimental effect was modulated by the prosodic manipulation (maximally vs. minimally informative), guaranteeing that prosody played a crucial role in disambiguation. The authors discuss the implications of these results for models of online speech perception and language acquisition.

Keywords: phrasal prosody, syntactic ambiguity, online sentence processing, prosodic disambiguation

In order to assign a meaning to an incoming sentence, a listener must minimally be able to pick out the individual words and build larger syntactic phrases out of them. One of the fundamental questions of language processing research, then, concerns how these phrases are constructed in real time. One of the primary methodologies used to address this question is to study the processing of sentences containing temporary ambiguities. Such sentences allow the researcher to examine how these ambiguities are resolved and thus isolate the mechanisms involved in structure building more generally.

The general view of parsing is that comprehenders build structure incrementally as they hear or read a sentence. In some situations, when faced with temporarily ambiguous sentences that allow multiple structures to be built, the parser encounters problems in assigning structure. This parsing process consists minimally of three components: (a) the *generation* of syntactic structure, including alternative structures at a point of ambiguity; (b) the *selection* of one structure; and (c) the *reanalysis* if the selected structure appears to be incorrect (see, e.g., Boland & Blodgett, 2001). Listeners have been shown to rely on several sources of information to parse spoken sentences, such as syntactic principles (see, e.g., the late closure strategy in Frazier, 1978), properties of individual words (Ford, Bresnan, & Kaplan, 1982; Pritchett, 1988; Tanenhaus, Carlson, & Trueswell, 1989), discourse and referential context (Altmann, 1988; Altmann & Steedman, 1988; Crain & Steedman, 1985; Steedman & Altmann, 1989), or statistical information (Jurafsky, 1996; MacWhinney, 1987; Mitchell & Cuetos, 1991).

Phrasal prosody is another obvious candidate for constraining syntactic analysis, and several experiments have shown that adults exploit it to resolve syntactic ambiguities (Beach, 1991; Blasko & Hall, 1998; Clifton, Carlson, & Frazier, 2002; Ferreira, Horine, & Anes, 1996; Frazier, Carlson, & Clifton, 2006; Kjelgaard & Speer, 1999; Marslen-Wilson, Tyler, Warren, Grenier, & Lee, 1992; Nagel, Shapiro, Tuller, & Nawy, 1996; Schafer, Speer, Warren, & White, 2000; Schepman & Rodway, 2000; Stirling & Wales, 1996;

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Weber, Grice, & Crocker, 2006). Many of these experiments have tested the influence of major prosodic breaks, or *intonational phrases*, and shown that participants can exploit them to resolve syntactic ambiguities, both in offline tasks (grammaticality judgment, explicit judgment about the syntactic structure of potentially ambiguous fragments, comprehension tasks) and online tasks (usually the cross-modal naming paradigm). The impact of smaller prosodic units, or *phonological phrases,* remains controversial, with some authors suggesting that only intonational phrase boundaries have an effect on syntactic processing (Marcus & Hindle, 1990; Price, Ostendorf, Shattuck-Hufnagel, & Fong, 1991), whereas others propose that both intonational and phonological phrases affect syntactic parsing (Clifton et al., 2002; Kjelgaard & Speer, 1999; Schafer, 1997). Clifton et al. (2002) suggested that the relevant dimension is not the size of the prosodic boundaries per se, but rather their relative size with respect to other prosodic boundaries within the same sentence. Another potentially confounding factor is whether the prosodic boundaries of various sizes were felicitous, or not, across different experiments (Millotte, Wales, & Christophe, 2007).

The present study investigates the influence of felicitous phonological phrase boundaries on syntactic parsing in French. We selected a specific kind of local syntactic ambiguity that rests on the fact that two homophones can belong to different syntactic categories (e.g., a verb and an adjective). Consider the following French sentences:

1a. *Le petit chien mord la laisse qui le retient* [The little dog bites the leash that holds it back]. (verb sentence)

1b. *Le petit chien mort sera enterré demain* [The dead little dog will be buried tomorrow]. (adjective sentence)

The first four words have the same pronunciation (i.e., / l ə p ə t i ʃ j ɛ̃ m ɔ ʀ /). But the fourth word is a verb in Sentence 1a and an adjective in Sentence 1b. These sentences differ both in their syntactic structure and in their prosodic structure, as is shown in the following transcriptions (CP = complementizer phrase, NP = noun phrase, VP = verb phrase, S = sentence, PP = phonological phrase, IPh = intonational phrase).

Syntactic bracketing:

2a. [[Le petit chien]$_{NP}$ [*mord* [la laisse[qui le retient]$_{CP}$]$_{NP}$]$_{VP}$]$_{S}$

2b. [[Le petit chien *mort*]$_{NP}$ [sera enterré [demain]$_{PP}$]$_{VP}$]$_{S}$

Prosodic bracketing:

3a. [[Le petit chien]$_{PP}$ [*mord* la laisse]$_{PP}$[qui le retient]$_{PP}$]$_{IPh}$

3b. [[Le petit chien *mort*]$_{PP}$ [sera enterré demain]$_{PP}$]$_{IPh}$

There is both a syntactic constituent boundary and a phonological phrase boundary placed before the ambiguous word when it is a verb (2a and 3a), whereas these boundaries follow the ambiguous word when it is an adjective (2b and 3b). Thus, in these sentences, when the ambiguous word is processed, only the prosodic context can help listeners to establish its grammatical category. Note that the prosodic boundaries between a long subject noun phrase and the following verb phrase are considered to be either mandatory or highly probable in all theories of intonation (e.g., Nespor & Vogel, 1986; Selkirk, 1982; Vaissière, 1997). This has recently been confirmed experimentally by Millotte et al. (2007), who used similar sentences, read by several native speakers of French, and presented them to listeners in an offline completion task: Sentences were cut just after the ambiguous word, and participants had to freely complete the sentences in writing. The authors observed a powerful influence of prosody: Participants typically selected the appropriate syntactic category in about 70% of cases, a performance well above chance level (50%).

The Millotte et al. (2007) experiment thus shows unambiguously that the kind of phrasal prosody investigated here can influence participants' syntactic processing. However, it does not allow us to establish when in the parsing process prosody intervenes. It could be that when the ambiguous word is processed and not followed by disambiguating lexical information, both possible words are activated (the adjective and the verb). In the absence of any available information as to which word to choose, the parser might then fall back on phrasal prosody. In other words, phrasal prosody might function as a last-resort strategy, when all else fails. Alternatively, phrasal prosody could delimit syntactic constituents in the very first stages of syntactic parsing, possibly even before lexical access is fully completed (Christophe, Millotte, Bernal, & Lidz, 2008). In order to disentangle these alternative views of the role of phrasal prosody in parsing, we move to an online methodology.

In Experiment 1, we replicate the results of Millotte et al. (2007) with an expert speaker speaking in one of two prosodic modes, either maximally informative or minimally informative. Then, in Experiment 2, we use the same sentences with an online task, abstract word detection, to establish when in the parsing process prosody intervenes.

Experiment 1: Completion Task

In this experiment, participants listened to the beginnings of ambiguous sentences that were cut right after the ambiguous word (i.e., after *mord* or *mort* in the examples) and had to complete them in writing. We expect more adjective completions for adjective sentences and more verb completions for verb sentences (as in Millotte et al., 2007). An expert speaker either emphasized the prosodic differences between verb and adjective sentences (maximally informative prosody), or she made them as inconspicuous as possible (minimally informative prosody), most notably by minimizing the pitch excursions, making the melody flatter (see Figure 1). Any effect triggered by phrasal prosody should be modulated by the strength of the prosodic cues. In other words, we expect the difference between adjective and verb sentences to be greater when prosodic cues are more reliable.

Method

Participants. Thirty-six native speakers of Parisian French took part in this experiment, 18 in each prosodic condition (maximally informative vs. minimally informative). All were students in Parisian universities and were paid for their participation. The results from 1 additional participant were not included because he became aware of the structure of the ambiguous sentences during the course of the experiment.

Material. Twenty pairs of experimental sentences were created, with one member containing the adjective and the other the verb (see the Appendix). Sentences from a pair were phonemically identical, that is, they contained the same phonemes, until the end of the ambiguous word.[1] The only difference between them was a syntactic difference that was reflected in the prosodic structure. There was a phonological phrase boundary just before the ambiguous word in verb sentences, whereas it was placed after the ambiguous word in adjective sentences. Experimental sentences were recorded by an expert speaker (Anne Christophe) with a maximally informative prosody and a minimally informative one. All sentences had a natural intonation[2]; the difference between conditions was only a question of degree.

In order to assess prosodic differences between conditions, acoustical analyses were performed on the segments placed around the critical ambiguous region. Pitch contours and mean durations are indicated in Figure 1 for adjective and verb sentences in both prosodic conditions. There were two phonological phrase boundary positions (marked by the vertical black lines in the figure): just before the ambiguous word in verb sentences and just after it in adjective sentences.

In French, intonation is characterized by a sequence of rising pitch movements demarcating phonological phrase boundaries (Jun & Fougeron, 2002).[3] The final full syllable of a word at the end of a phonological phrase typically bears a rise in fundamental frequency (Vaissière & Michaud, 2005) together with longer duration and possibly a higher intensity (see, e.g., Di Cristo, 1998; Jun & Fougeron, 2002). Phonological phrases that are not placed at the end of an intonational phrase typically exhibit either a low–high or a low–high–low–high melody, depending on their length (see Di Cristo, 1998; Fougeron & Keating, 1997; Pasdeloup, 1990; Welby, 2006, 2007), whereas the last phonological phrase from an intonational phrase typically ends in a low tone.

Pitch analyses were conducted on the vowels around the prosodic boundaries (maximum F0 on the target vowels).[4] As mentioned above, nonfinal phonological phrases exhibit either a low–high or a low–high–low–high melody in French. Congruent with this fact, the pitch analysis revealed a pitch rise at the end of the phonological phrases (see also Di Cristo, 2000; Welby, 2003, 2006).[5] Before the first boundary (in verb sentences), the pitch contour tended to be ascending at the end of the phonological phrase (rise of 30 Hz between "pet*i*t" and "chi*en*" in both prosodic conditions): marginally different from 0, $t(19) = 2$, $p = .06$, for the maximally informative condition, and significantly different from 0, $t(19) = 4.2$, $p < .001$, for the minimally informative condition. When the same words were in the middle of a phrase (in adjective sentences), we observed a descending pitch contour in the maximally informative condition (corresponding to the middle part of the low–high–low–high pattern), -33 Hz, $t(19) = 4.5$, $p < .001$, and a flat contour in the minimally informative condition, -3 Hz, nonsignificantly different from 0, $t(19) < 1$. For the second boundary position (in adjective sentences), we also obtained an ascending pitch contour in phrase-final position: $+69$ Hz between "chi*en*" and "m*o*rt" in the maximally informative condition, significantly different from 0, $t(19) = 6.7$, $p < .001$; $+24$ Hz in the minimally informative condition, significantly different from 0, $t(19) = 3.2$, $p = .005$. When these words were on the opposite sides of the boundary (in verb sentences), we observed a flat contour: $+13$ Hz between "chi*en*" and "m*o*rd" in both prosodic conditions, nonsignificantly different from 0, $t(19) = 1$, $p = .3$, for the maximally informative condition, and $t(19) = 1.5$, $p = .15$, for the minimally informative condition. Thus, we consistently observed an ascending pitch contour at the end of phonological phrases as opposed to a flat or descending pitch contour in other places. Differences in pitch contour between adjective and verb sentences were greater with the maximally informative prosody than with the minimally informative one: for the first boundary, $t(39) = 2.2$, $p < .03$; for the second boundary, $t(39) = 2.8$, $p < .01$.

Duration analyses were also conducted on the different segments placed in the ambiguous regions. There was no pause in the acoustic signal, either before or after the ambiguous word. We observed significant phrase-final lengthening, as expected from the literature (see, e.g., Delais-Roussarie, 1995, for French). In the maximally informative condition, we obtained a significant rhyme lengthening of 56% before the first phonological phrase boundary: The rhyme /ɛ̃/ was longer in the verb sentence "[le petit chi*en*] [mord . . .]" than in the adjective sentence "[le petit chi*en* mort]. . ." (226 vs. 145 ms), $t(19) = 2.1$, $p < .001$. Before the second phonological phrase boundary, the phrase-final lengthening

[1] To check whether pairs of ambiguous words were truly homophonous, we ran a control experiment in which 13 French listeners performed a two-alternative forced-choice task on the homophones. The ambiguous words were spliced out from the experimental sentences in both prosodic conditions and presented auditorily to participants. They had to decide whether each word was an adjective or a verb (alternatives were presented visually on the computer screen, using short disambiguating sentences, such as *il est mort* [he is dead] for the adjective and *il mord* [he bites] for the verb). The results showed that participants were overall not significantly different from chance in deciding whether they heard an adjective or a verb: For verb sentences, they gave 55% of verb responses (nonsignificantly different from chance performance at 50%), $t(11) = 1.6$, $p = .1$, whereas they gave 49% of verb responses to adjective sentences (nonsignificantly different from chance), $t(11) < 1$. This result holds for each prosodic condition: maximally informative prosody, 54% of verb responses to verb sentences, $t(11) = 1.1$, $p = .3$, and 46% of verb responses to adjective sentences, $t(11) = 1.8$, $p = .1$; minimally informative prosody, 57% of verb responses to verb sentences, $t(11) = 1.7$, $p = .1$, and 53% of verb responses to adjective sentences, $t(11) < 1$.

[2] We conducted a control experiment to evaluate the naturalness of both prosodic conditions (maximally and minimally informative). Twelve French participants performed a pronunciation acceptability task (similar to the one used by Kjelgaard & Speer, 1999) on ambiguous sentences. They read a sentence on a computer screen and then heard it. They gave their evaluation by choosing a number on a scale of 1 (*bad, odd, or inappropriate pronunciation*) to 7 (*very good, adequate, or appropriate pronunciation*). Results showed that sentences were judged to be well pronounced overall (mean of 6.1). Ambiguous sentences obtained the same results in the maximally informative prosody condition (mean of 6.1) and in the minimally informative one (mean of 6.0). Thus, both the maximal and the minimal prosody sounded natural (no difference between the two prosodic conditions), $t(11) < 1$. In addition, participants also judged control sentences that were recorded with no prosodic manipulation (sentences used in Experiment 2). These sentences obtained a mean score of 6.2, not different from ambiguous sentences, $t(11) < 1$.

[3] Phonological phrases have been variously labeled by different researchers: In French, they are often called *accentual phrases* (see, e.g., Jun & Fougeron, 2002; Welby, 2006), but researchers also referred to *syntagme prosodique* (Vaissière, 1997), *unité rythmique* (Di Cristo & Hirst, 1993), or *rhythmic group* (Delais-Roussarie, 1995). In this article, we use the more universal term, *phonological phrases*, and we refer to the definition given by Nespor and Vogel (1986).

[4] The same pattern was observed by using the mean fundamental frequency across the target vowels.

[5] Phrase-final rising in French was also called *continuation mineure* by Delattre (1966) and *intoneme continuatif mineur* in Rossi (1985).

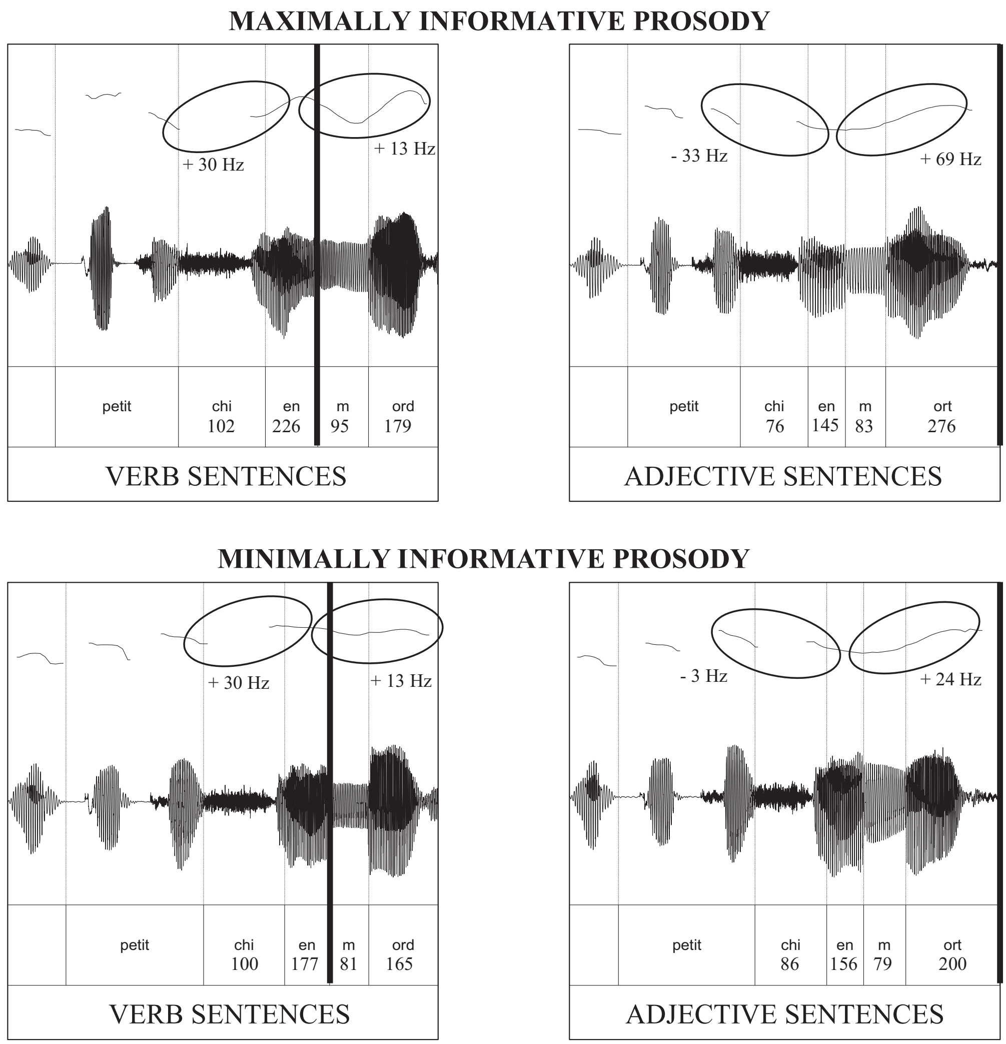

Figure 1. Mean duration of the different segments and pitch contours in the ambiguous regions (phonological phrase boundaries are represented with thick black lines). Verb sentences are on the left side and adjective sentences are on the right, with maximally informative prosody at the top of the figure and minimally informative prosody at the bottom. Ellipses delimit areas where pitch analyses were performed. Note that the waveforms and the pitch contours are those corresponding to the experimental sentences of the item /mɔʀ/, but the numbers (for duration and pitch) correspond to mean values across all stimuli.

was 54%: The rhyme /ɔʀ/ was longer in the adjective sentence "[le petit chien m*ort*]. . ." than in the verb sentence "[le petit chien] [m*ord*. . .]" (276 vs. 179 ms), $t(19) = 8.9$, $p < .001$. In the minimally informative condition, lengthening was significant but of lesser magnitude: 14% before the first boundary (177 vs. 156 ms), $t(19) = 4.6$, $p < .001$, and 21% before the second boundary position (200 vs. 165 ms), $t(19) = 4.9$, $p < .001$. Analyses also revealed significant phrase-initial lengthening (as expected from the literature, see, e.g., Fougeron & Keating, 1997) but in the maximally informative condition only. The onset of the ambiguous word was longer when it was phrase-initial in verb sentences, relative to when it was in the middle of a phonological phrase in adjective sentences: lengthening of 14% in the maximally informative condition (95 vs. 83 ms), $t(19) = 3$, $p < .001$; no difference in the minimally informative condition (81 vs. 79 ms), $t(19) < 1$. Significantly greater lengthening was observed with the maximally informative prosody than with the minimally informative one. Phonological phrase boundaries were thus clearly marked by pitch variations and lengthening, and these prosodic cues were more salient in the maximally informative prosody condition.[6]

For the completion experiment, all sentences were cut just after the end of the ambiguous word (at a zero crossing of the amplitude signal). In addition, 10 unambiguous distractor sentences were cut anywhere in a sentence, at a word boundary. For each prosodic

[6] Similar analyses were performed on energy (root-mean-square values), but no differences were found, either between verb and adjective sentences in each prosodic condition or between prosodic conditions. Moreover, it is probable that the amount of coarticulation varied between sentence types and/or between prosodic conditions, but the measurement of coarticulation is difficult to do in acoustical analyses.

condition, two lists of sentences were created so that each member of a given pair appeared in a different list. Each list contained 10 verb sentences and 10 adjective sentences. Half of the participants listened to List 1, and the other half listened to List 2.

Procedure. Each participant was tested individually in a quiet room. Printed instructions informed participants that they were to listen to sentence beginnings and that they had to complete them in writing, giving the first completion that came to mind. A trial began with the auditory presentation of a sentence beginning; participants could listen to it as many times as they wished (by pressing the space bar). They then wrote the sentence beginning on a response sheet and completed the sentence. They pressed a key to obtain the next trial. The auditory stimuli were stored at a sampling rate of 16 kHz and presented through a ProAudioSpectrum Pro 16-bit (Media Vision) soundboard. Before the experiment began, participants performed a two-item training, with nonambiguous sentences. The whole procedure was controlled by the Expe program (Pallier, Dupoux, & Jeannin, 1997).

Results

We coded whether participants interpreted the ambiguous word as an adjective or as a verb. In some instances, participants gave a completion such that the ambiguous word did not exactly match the adjective or the verb. When the completion could unambiguously be interpreted as either an adjective or a verb (e.g., the verb *salent*, third person plural present tense—[*they*] *salt*—was completed as *salaient*, third person plural past tense—[*they*] *salted*), this response was coded in the analysis (1.1% of the total number of responses, that is 8 responses out of 720). When it could not, the response was discarded (39 responses out of 720, 5.4% of the total number of responses).

Figure 2 presents the mean number of adjective and verb responses for adjective and verb sentences, in both maximally informative and minimally informative prosody. Because adjective and verb responses were almost complementary (with the exception of the discarded responses), we used only the mean number of verb responses in the statistical analyses. Two analyses of variance (ANOVAs) were conducted, one with participants and one with items as random factors. The by-participants ANOVA included two between-subjects factors, prosody (maximally vs. minimally informative) and counterbalancing (List 1 vs. List 2), and one within-subject factor, sentence type (verb vs. adjective sentences). The by-item analysis included two within-item factors, prosody and sentence type.

The analysis showed a significant main effect of sentence type, $F_1(1, 32) = 75.1$, $p < .001$; $F_2(1, 19) = 16.6$, $p < .01$; and min$F'(1, 28) = 13.6$, $p < .01$, that reflected the fact that participants gave more verb completions for verb sentences than for adjective sentences (and vice versa for adjective completions). The interaction between sentence type and prosody was also significant, $F_1(1, 32) = 21.6$, $p < .001$; $F_2(1, 19) = 7.1$, $p < .02$; and min$F'(1, 32) = 5.3$, $p < .03$, reflecting the fact that the effect of sentence type was stronger in the maximally informative condition (effect size = 3.5), $F_1(1, 16) = 88$, $p < .001$, and $F_2(1, 19) = 21.6$, $p < .001$, than in the minimally informative condition in which it reached significance in the subjects analysis only (effect size = 1.1), $F_1(1, 16) = 7.4$, $p = .02$, and $F_2(1, 19) = 2.3$, $p = .1$. No other interaction reached significance and the counterbalancing factor did not show any significant effect (Fs < 1).

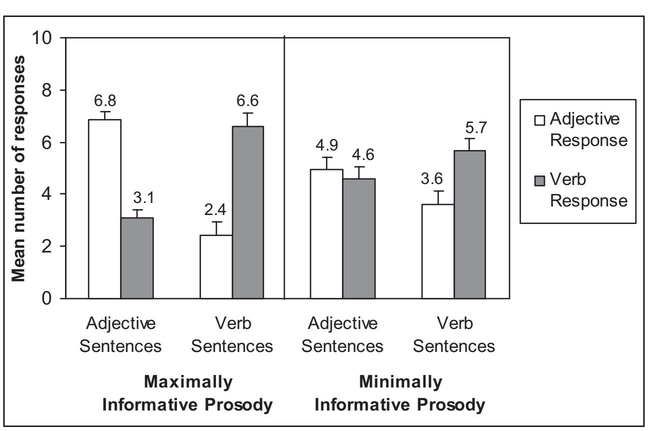

Figure 2. Mean number of adjective and verb responses given to adjective and verb sentences in both prosodic conditions (out of 10 possible responses for each sentence type). Error bars represent the standard error of the mean.

Discussion

In this experiment, two sentence beginnings that contained the same phonemes but had different syntactic and prosodic structures did not receive the same syntactic analysis. Participants assigned different syntactic categories to the ambiguous words, depending on their prosodic context. They correctly gave more verb than adjective completions when processing verb sentences and more adjective than verb completions for adjective sentences. This experiment thus fully replicates the results obtained by Millotte et al. (2007), who had used sentences produced by naive speakers who were unaware of the local ambiguities. It is interesting to note that the size of the experimental effect was modulated by the strength of the prosodic cues (maximally vs. minimally informative), suggesting that phrasal prosody has a graded influence on processing. The more reliable prosodic cues are, the greater their influence on participants' interpretation of the sentences.

When in the parsing process did participants use these prosodic cues? Was it during the initial stages of syntactic analysis, or rather as a mean of resolving the ambiguity when it was noticed by the processor? An offline experiment does not allow us to distinguish between these two hypotheses. To further specify the time course of prosodic analysis and its influence on syntactic processing, we used the same sentences with an online task.

Experiment 2: Word Detection Task

We designed an abstract word detection task to investigate the potential online use of phonological phrase boundaries during syntactic analysis. Participants had to respond to either the verb or the adjective in the locally ambiguous sentences presented above. Because these words were homophonous, we instructed participants to detect abstract lexical entries rather than specific word forms. Thus, for verbs, the target was specified visually in its infinitive form (e.g. *mordre* [to bite]). Participants were instructed to respond to this verb, independently of the specific phonological form it could take in the spoken sentence (e.g., *mordra*—third person singular future tense, *mordons*—first person plural present tense, etc.). Adjectives were presented in short sentence frames, pronoun–copula–adjective (e.g., *il est mort* [he is dead]). Participants found it easy to perform this abstract word detection task.

Each ambiguous sentence appeared with both target types, verb and adjective. For instance, a verb sentence was preceded by a verb target and participants had to press a response button as soon as they heard the target word. The same verb sentence could also be preceded by an adjective target and participants had to refrain from responding: In that case, they did nothing and had to wait for the next trial. If prosodic cues disambiguate the test sentences, then the locally ambiguous sentences should be better processed when prosody is maximally informative, relative to when it is minimally informative (with faster reaction times and/or fewer errors). In addition, pairs of control sentences were constructed that contained the same verb and adjective target words in nonambiguous positions: Only one syntactic form was possible, either verb or adjective, for semantic or syntactic reasons. These control sentences provide a baseline against which we can evaluate the ambiguous sentences.

Method

Participants. Fifty-six native speakers of Parisian French took part in this experiment, 28 in each prosodic condition (maximally informative vs. minimally informative). Six additional participants were tested, but their data were not included in the final analysis for the following reasons: not a native speaker of French (2 participants), technical problem (1 participant), and more than 70% errors on control sentences (3 participants).

Material. We used the same 20 pairs of experimental sentences as in Experiment 1 (recorded in both prosodic conditions). For each pair of sentences, we created a pair of nonambiguous control sentences, one containing the adjective target and the other the verb target (see the Appendix). Control sentences were produced naturally, with no attempt to either emphasize or minimize prosodic cues (see Footnote 2). The same control sentences were used in both prosodic conditions. For example, we created the four following sentences for the ambiguous word /mɔʀ/.

Verb sentences:

Ambiguous: *Le petit chien mord la laisse qui le retient* [The little dog bites the leash that holds it back].

Control: *Parfois on se mord la langue quand on mange trop vite* [Sometimes one bites one's tongue when one eats too fast].

Adjective sentences:

Ambiguous: *Le petit chien mort sera enterré demain* [The dead little dog will be buried tomorrow].

Control: *Maintenant qu'il est mort, les batailles d'héritage vont commencer* [Now that he is dead, inheritance conflicts are going to begin].

For each item (in a given prosodic condition), a given participant heard all four sentences (two ambiguous and two control sentences) only once. Because sentences were presented either with the appropriate target (e.g., verb target, verb sentence: matching condition) or with the nonappropriate target (e.g., adjective target, verb sentence: mismatching condition), each item appeared in eight possible conditions, of which each participant heard only four. Between-subjects counterbalancing ensured that all items were presented in all conditions equally often. The items presented to a given participant were split into two blocks so that each member of an ambiguous pair appeared in a different block (e.g., if the adjective sentence was in the first block, then the verb sentence was in the second block). Order of presentation of the blocks was counterbalanced between participants. Overall, each participant listened to 80 experimental sentences, half ambiguous and half unambiguous, half containing verb targets and half adjective targets, and half presented with an appropriate target and half with an inappropriate target.

The frequencies of the verbs and adjectives were computed using the Lexique 3 database (www.lexique.org). Lemma frequencies were used (i.e., frequency of all forms of a given word, for instance all forms of the verb *durer* [to last]), because the frequencies of individual forms were not always available. Adjectives and verbs did not differ in frequency (42.2 for adjectives vs. 42.7 for verbs), $t(19) < 1$. In addition, we estimated the frequencies of the specific forms of verbs and adjectives by having 10 French adults rate the target words, using a scale from 1 (*not frequent at all*) to 7 (*very frequent*). For instance, they estimated the frequency of the adjective *mort* [dead] in *il est mort* [he is dead] and the frequency of the verb *mordre* [to bite] in *il mord* [he bites]. The average frequency was 4.8 for verb targets and 5.1 for adjective targets, $t(19) < 1$. They also estimated the plausibility of each target word given the beginning of the sentence (e.g., they judged the plausibility of the adjective *mort* [dead] in *le petit chien mort* [the dead little dog] as well as the plausibility of the verb *mord* [he bites] in *le petit chien mord* [the little dog bites]), again using a scale from 1 to 7 (half the participants did the frequency estimation first, half did the plausibility estimation first). The average plausibility was 5.3 for verb targets and 5.1 for adjective targets, $t(19) < 1$. The items were therefore balanced on average. In any case, a plausibility bias cannot generate a spurious prosodic effect given the experimental design. Any frequency or plausibility difference should influence participants' responses equally in both prosodic conditions.

In addition to the ambiguous and control sentences, there were 50 distractor sentences requiring a response. Ten contained a verb target, 10 an adjective target, and 30 a noun target. Adjective and verb targets were potentially ambiguous words placed toward the end of the sentences in an unambiguous position. Noun targets were unambiguous monosyllabic or bisyllabic words placed anywhere in the sentence. To detect a noun target, participants were presented with the target word preceded by an article (e.g., *une nuit* [a night]). Finally, there were 30 foil sentences to which participants were not supposed to respond. Targets to detect were nouns, verbs, and adjectives. Among these 30 sentences, 10 contained no word similar to the target, and 20 were foils that contained a word starting with the same first syllable as the target (or the same first phonemes for monosyllabic targets). In 10 of these 20 foil sentences, the word that resembled the target was of the appropriate syntactic category; in the other 10 it was not.

Procedure. Each participant was tested individually in a quiet room. A trial began with the visual presentation of the target word (e.g., *mordre* [to bite] or *il est mort* [he is dead]) for 1.5 s. The screen was left blank for another second, then a sentence was played. The trial ended 2.5 s after the participant's response or after the end of the auditory presentation, and a new trial began immediately. Response times were measured from the onset of the target word. Speed and accuracy were emphasized in the instructions. The auditory stimuli were stored at a sampling rate of 16 kHz and were presented directly through a ProAudioSpectrum Pro 16-bit soundboard. Before the experiment began, participants performed a 15-item training with feedback on reaction times and accuracy. The whole procedure was controlled by the Expe program (Pallier et al., 1997).

Results

We measured the false alarms generated by the foil sentences. Participants made 0.9% false alarms to the sentences that contained no word similar to the target, 5.7% to foil sentences containing a word starting with the same first syllable (or first phonemes) as the target word when this catch word was not of the appropriate syntactic category, and 20.9% to foil sentences containing a catch word of the correct syntactic category. This suggests that listeners were building online expectations about the syntactic category of the next word and used these expectations to constrain the monitoring task.

Mean reaction times for correct responses (hits) and percentage of misses are displayed in Figure 3, for both prosodic conditions. Only responses to the matching condition (sentences presented with the appropriate target) are included in these analyses (i.e., detection of verb targets in verb sentences and detection of adjective targets in adjective sentences). Responses to the mismatching condition (sentences presented with an inappropriate target) were counted as false alarms and were not included in data in Figure 3 (i.e., detection of verb targets in adjective sentences and detection of adjective targets in verb sentences). Two ANOVAs were conducted on the mean reaction times, one with participants and one with items as the random factor. The by-participants analysis included three between-subjects factors, prosody (maximally vs. minimally informative), order (Block 1 first vs. Block 2 first), and counterbalancing and two within-subject factors, ambiguity (ambiguous vs. control sentences) and sentence type (adjective vs. verb sentences). The by-item analysis included three within-item factors, prosody, ambiguity and sentence type.

The analysis showed a significant main effect of ambiguity, $F_1(1, 48) = 88.3$, $p < .001$, and $F_2(1, 19) = 17.5$, $p < .001$, with slower reaction times for ambiguous sentences than for control sentences (660 vs. 500 ms). There was also a significant main effect of prosody, $F_1(1, 48) = 9.9$, $p = .003$; $F_2(1, 19) = 40.9$, $p < .001$; and $\min F'(1, 57) = 5.2$, $p = .03$, reflecting the fact that participants responded faster in the maximally informative condition than in the minimally informative one (515 vs. 645 ms). There was no significant main effect of sentence type (Fs < 1). The interaction between ambiguity and prosody was significant, $F_1(1, 48) = 6.3$, $p = .02$; $F_2(1, 19) = 7.7$, $p = .01$; and $\min F'(1, 59) = 3.5$, $p = .07$, reflecting the fact that the ambiguity effect was greater in the minimally informative condition (202 ms), $F_1(1, 24) = 63.1$, $p < .001$, and $F_2(1, 19) = 22.0$, $p < .001$, than in the maximally informative condition (117 ms), $F_1(1, 24) = 27$, $p < .001$, and $F_2(1, 19) = 5$, $p = .04$.[7] No other interactions were significant. Counterbalancing and order showed no significant main effect and did not interact with the other factors.[8]

To further evaluate the role of prosody in the very early stages of processing, we analyzed the responses given before participants had access to the disambiguating lexical information. Only responses given between the beginning of the target word and 150 ms after its end entered this analysis (the 150-ms delay corresponds to the average motor reaction time). When participants

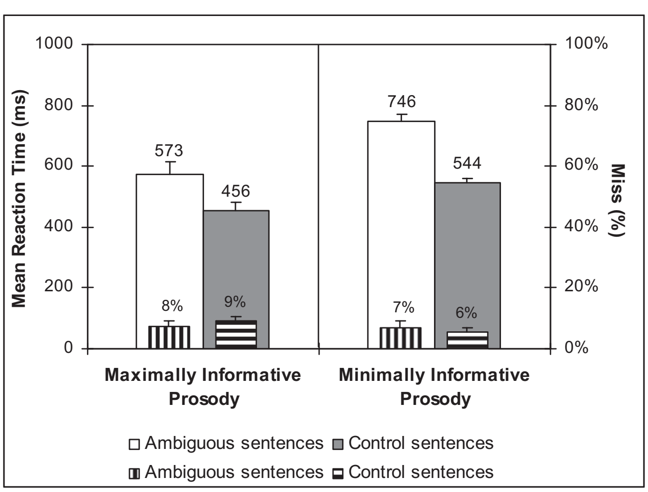

Figure 3. Mean reaction times (on hits) and percentage of misses for each experimental sentence type (ambiguous vs. control sentences) in each prosodic condition (maximally vs. minimally informative prosody). Only performances on matching conditions are included in this figure (that is, responses to sentences presented with the appropriate target). Error bars represent the standard error of the mean.

[7] The prosody effect was significant for ambiguous sentences (173 ms), $F_1(1,48) = 11.1$, $p < .01$, and $F_2(1, 19) = 27.2$, $p < .001$, as well as for control sentences (88 ms), $F_1(1, 48) = 5.8$, $p < .05$; $F_2(1, 19) = 9.6$, $p < .01$; and $\min F'(1, 64) = 3.6$, $p = .06$. This effect on control sentences was not a prosodic effect per se, because exactly the same control sentences were used in both prosodic conditions (same acoustic stimuli). Participants from the minimally informative group were globally slowed down by the difficult-to-process ambiguous sentences.

[8] Misses and false alarms were analyzed with the same ANOVAs. The misses analysis revealed a significant main effect of sentence type with more misses for adjective than for verb sentences (10.5% vs. 4%), $F_1(1, 48) = 25.9$, $p < .001$, and $F_2(1, 19) = 8.0$, $p = .01$, an effect due to some deviant items in which the target was placed in an idiomatic expression and triggered large miss rates (five items had a miss rate over 40%). The false alarms analysis showed a significant main effect of ambiguity, $F_1(1, 48) = 218$, $p < .001$, and $F_2(1, 19) = 93.5$, $p < .001$, with more false alarms for ambiguous than for control sentences (54.6% vs. 30.7%). The main effect of prosody was significant but only in the item analysis, $F_1 < 1$, and $F_2(1, 19) = 7$, $p = .02$, indicating a tendency to make more false alarms in the minimally informative condition than in the maximally informative one (45% vs. 40%). There was a main effect of sentence type, significant in the subject analysis only, $F_1(1, 48) = 5.6$, $p = .02$, and $F_2(1, 19) = 1.2$, $p = .3$, as well as a significant interaction between ambiguity and sentence type, $F_1(1, 48) = 5.6$, $p = .02$, and $F_2(1, 19) = 2.2$, $p = .2$. Participants tended to make more false alarms for adjective sentences than for verb sentences (45% vs. 40%), and the ambiguity effect was slightly greater for adjective sentences than for verb sentences (29% vs. 19%). This slight advantage for verb sentences may be because in these sentences, the phonological phrase boundary was placed before the ambiguous word; thus, participants had access to the relevant prosodic information before they processed the ambiguous word. In contrast, in adjective sentences the phonological phrase boundary followed the ambiguous word.

triggered their response, the only difference between the beginnings of the two locally ambiguous sentences was a prosodic difference (just as in Experiment 1). We measured the mean number of adjective and verb interpretations. Even responses to sentences presented with the inappropriate target (mismatching condition) are included in this analysis. For adjective sentences preceded by an adjective target, a correct detection (within the interval of time defined above) was coded as an adjective interpretation; for adjective sentences preceded by a verb target, an incorrect detection or false alarm (within the same time interval) was coded as a verb interpretation, and vice versa for verb sentences.[9] Thirty-nine percent of all responses were fast responses as specified above. The mean number of adjective and verb responses per type of ambiguous sentence and prosodic condition are displayed in Figure 4.

The ANOVAs contained the factors prosody (maximally vs. minimally informative) as a between-subjects factor (respectively within-item) and response type (verb vs. adjective interpretations) and sentence type (verb vs. adjective sentences) as within-subject factors (respectively within-item). There was a significant effect of sentence type, $F_1(1, 48) = 40.7$, $p < .001$, and $F_2(1, 19) = 13.1$, $p = .002$, with more fast responses to adjective sentences than to verb sentences (4.4 vs. 3.4): Ambiguous words were longer in adjective sentences in which they occupied a phrase-final position, which possibly gave participants more time to respond (410 vs. 346 ms), $t(19) = 6.9$, $p < .001$. There was also a significant main effect of prosody, $F_1(1, 48) = 5.9$, $p = .02$; $F_2(1, 19) = 34$, $p < .001$; and minF' $(1, 64) = 5.0$, $p = .03$, with more responses given in the maximally informative condition than in the minimally informative one (4.5 vs. 3.3). This effect can also be partly due to the fact that ambiguous words were significantly longer in the maximally informative condition than in the minimally informative one (404 vs. 351 ms), $t(19) = 5.9$, $p < .001$. The response type factor showed no significant main effect, $F_1(1, 48) = 1.3$, $p = .3$, and $F_2 < 1$, nor did it interact with prosody (Fs < 1).

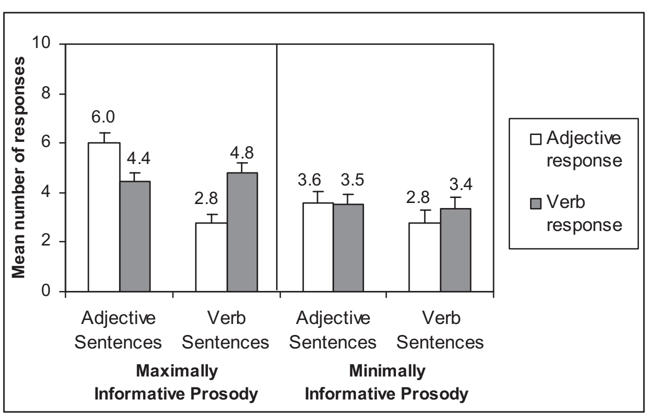

Figure 4. Mean number of adjective and verb responses given to ambiguous sentences for each prosodic condition (out of 10 possible responses for each bar). Only fast responses were counted (given before the end of the ambiguous word + 150 ms). Adjective responses correspond to hits on adjective sentences (matching condition) and false alarms on verb sentences (mismatching condition). Verb responses correspond to hits on verb sentences (matching condition) and false alarms on adjective sentences (mismatching condition). Error bars represent the standard error of the mean.

Crucially, the interaction between response type and sentence type was highly significant, $F_1(1, 48) = 39.5$, $p < .001$; $F_2(1, 19) = 29.2$, $p < .001$; and min$F'(1, 47) = 16.8$, $p < .001$: Adjective sentences tended to receive more adjective responses than verb sentences (4.8 vs. 4.0), $F_1(1, 48) = 12.6$, $p < .001$, and $F_2(1, 19) = 2.6$, $p = .1$, whereas verb sentences obtained more verb responses than adjective responses (4.1 vs. 2.8), $F_1(1, 48) = 20.9$, $p < .001$, and $F_2(1, 19) = 6.8$, $p < .05$. The triple interaction between response type, sentence type, and prosody was also significant, $F_1(1, 48) = 18.8$, $p < .001$, and $F_2(1, 19) = 39.2$, $p < .001$, reflecting the fact that the above mentioned Response Type $\times$ Sentence Type interaction was greater in the maximally informative condition (effect size = 3.68), $F_1(1, 24) = 42.7$, $p < .001$, and $F_2(1, 19) = 48.8$, $p < .001$, than in the minimally informative condition, in which it did not reach significance (effect size = 0.68), $F_1(1, 48) = 2.8$, $p = .1$, and $F_2(1, 19) = 2.8$, $p = .1$. Finally, the counterbalancing and the order factors showed no significant main effects and did not interact with the other factors.

Discussion

The reaction time analysis showed that the size of the ambiguity effect (difference between ambiguous and control sentences) was modulated by the quality of the prosodic cues: The ambiguity was reduced when the stimuli were recorded with a well-marked prosody in the maximally informative prosody condition. Thus, prosodic cues were exploited by listeners in this online task, even though listeners had the option of delaying their response until they heard the disambiguating words, right after the ambiguous word. The analysis of fast responses, given before participants had access to the lexical disambiguating information, supported this conclusion: Listeners were able to decide whether the target word was a verb or an adjective online, even before they had heard the following words. Crucially, the quality of the prosodic cues modulated the size of the disambiguation effect, confirming that prosody played an active role in participants' responses. Thus, in this experiment, phonological phrase boundaries were exploited to bias the online syntactic analysis of temporarily ambiguous sentences.

General Discussion

The experiments described in this article show that French adults exploit phonological phrase boundaries online to resolve local syntactic ambiguities. Both in offline and online tasks, listeners were able to distinguish between two sentence beginnings that were phonemically identical and differed only syntactically and prosodically. They were able to give significantly more adjective responses than verb responses to an ambiguous target that was placed in an adjective position and vice versa for a target that was placed in a verb position. The amount of disambiguation was modulated by the quality of the prosodic cues (maximally vs. minimally informative), therefore ensuring the active role of prosody in disambiguation. In addition to showing that intermediate prosodic phrases disambiguate syntactic structure, this article also

[9] In this time interval, it was impossible to label the misses and the correct rejection responses. Because these responses obtained no reaction time, we could not establish when a decision was reached (before or after the end of the ambiguous word). A speeded forced-choice task ("yes" or "no" responses) should be used to refine these analyses.

introduces a new technique for studying (some aspects of) online syntactic processing. The abstract word detection task presented in Experiment 2 proved easy to perform for participants and yielded fast reaction times, so that a sizeable proportion of responses were given before the end of the ambiguous word.

The present experiments show that prosodic cues inform the first stages of syntactic processing, either by boosting the activation of one syntactic parse over others or by favoring the generation of only one syntactic parse, when several are possible on the basis of the available lexical information. In addition, the present results also have implications for lexical access processes. Indeed, the homophonous adjectives and verbs appeared to be accessed faster and more accurately than would be expected if lexical access operated on the basis of phonemic information alone (see also Cutler & van Donselaar, 2001; Davis, Marslen-Wilson, & Gaskell, 2002; Salverda, Dahan, & McQueen, 2003). Two alternative processes may account for homophone resolution in our experiments. First, it is possible that both homophones (the verb and the adjective) are equally activated initially but that the one that can be integrated within the current syntactic structure wins the competition very quickly. Second, one homophone could directly be more activated than the other, depending on the preceding prosodic–syntactic context. In that view, a listener would build syntactic structure online, on the basis of all the information that is available at any point in time, including the words that have already been recognized as well as prosodic phrasing. At any point in time, the processor may then build up expectations as to the most probable syntactic category of incoming words and use these expectations to constrain lexical search. The results from the foil sentences in Experiment 2 support this idea: We observed that participants made significantly more false alarms when they heard a word that began with the same phonemes as the target word and that was of the same syntactic category (compared with a condition in which the catch word was not of the appropriate syntactic category). This indicates that listeners are building online expectations about the syntactic category of incoming words and rejecting lexical candidates that do not match this syntactic category.

In conclusion, this study demonstrates that phonological phrase boundaries constrain online syntactic parsing in adults. It also extends previous work on intermediate phrases (Clifton et al., 2002; Kjelgaard & Speer, 1999; Schafer, 1997; Schafer & Jun, 2002). The next step is to investigate the use of phrasal prosody in language acquisition (Morgan, 1986; Morgan & Demuth, 1996). It has already been shown that phonological phrases helps infants and adults to segment spoken sentences into words (Christophe, Mehler, & Sebastian-Galles, 2001; Christophe, Peperkamp, Pallier, Block, & Mehler, 2004; Gout, Christophe, & Morgan, 2004; Millotte, 2005). In light of the present results and the literature, it thus seems reasonable to postulate that phonological phrases might facilitate syntactic acquisition (Christophe, Guasti, Nespor, Dupoux, & van Ooyen, 1997; Christophe, Guasti, Nespor, & van Ooyen, 2003; Christophe et al., 2008). More precisely, phrasal prosody may allow infants to recover some information about the syntactic structure of spoken utterances, even before they have access to a full-fledged lexicon, just as it helps adults to resolve syntactic ambiguities. To simulate syntactic processing in the absence of a content-word lexicon, Millotte, Wales, Dupoux, and Christophe (2006) had adults listen to jabberwocky sentences, in which phrasal prosody and function words were preserved whereas all content words were replaced by nonwords. The results showed that participants were able to use the prosodic context (together with the function words) to infer the syntactic category of target nonwords: They responded quickly and accurately in an abstract nonword detection task similar to Experiment 2. In summary, phrasal prosody appears to constrain online syntactic analysis and homophone resolution. As such, it might well be used very early on in the first steps of language acquisition.

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(*Appendix follows*)

Appendix

Experimental Materials

For each ambiguous item, written in capitals, four experimental sentences are indicated: two ambiguous sentences and two control sentences. Ambiguous sentences were used in both experiments (they were cut right after the ambiguous word in the completion experiment, Experiment 1). Control sentences were used in the detection experiment only (Experiment 2).

Experimental sentences (80 sentences) are mentioned in the following order: ambiguous sentences (verb and adjective target) and control sentences (verb and adjective target).

Item Sentence

1. *Je trouve que la fumée DANSE joliment en s'échappant du feu de bois.*

1. *Je trouve que la fumée DENSE qui s'échappe de ce bâtiment laisse imaginer le pire.*

1. *Mon cousin DANSE dans le lac des cygnes.*

1. *Ce brouillard DENSE m'empêchait d'avancer sur la route.*

2. *Les pommes DURENT plus longtemps que les bananes si on les conserve à l'abri de la lumière.*

2. *Les pommes DURES font de meilleures tartes que les golden, par exemple.*

2. *L'entracte DURE plus longtemps que prévu.*

2. *C'est un coup DUR que vous venez de vivre.*

3. *Cet artiste GRAVE le bois et ses œuvres sont très prisées.*

3. *Cet artiste GRAVE médite en contemplant le paysage.*

3. *Quand on GRAVE son nom sur un tronc d'arbre, on l'abîme.*

3. *Ce n'est pas GRAVE donc ne t'inquiète pas.*

4. *Assise sur un banc, la jeune femme LACE les souliers de son petit garçon.*

4. *Assise sur un banc, la jeune femme LASSE reprend sa respiration.*

4. *Les enfants sont fiers quand ils LACENT pour la première fois leurs chaussures.*

4. *Je suis vraiment LASSE d'attendre depuis des heures.*

5. *Je crois que cet homme LACHE son boulot parce qu'il est trop stressant.*

5. *Je crois que cet homme LACHE refuse de voir la vérité en face.*

5. *Certains enfants ne veulent pas qu'on leur LACHE la main quand il y a des inconnus dans la pièce.*

5. *Il est tellement LACHE qu'il n'osera jamais s'opposer à sa belle-mère.*

6. *J'ai appris que cet homme LOUCHE depuis qu'il a eu un accident de voiture.*

6. *J'ai appris que cet homme LOUCHE doit comparaître devant la justice.*

6. *Il existe des personnes qui LOUCHENT depuis leur naissance.*

6. *Je trouve un peu LOUCHE que ma voisine ait toujours les mêmes notes que moi.*

7. *Le petit chien MORD la laisse qui le retient dans l'espoir de se libérer.*

7. *Le petit chien MORT sera enterré demain dans le jardin de ses maîtres.*

7. *Parfois on se MORD la langue quand on mange trop vite.*

7. *Maintenant qu'il est MORT, les batailles d'héritage vont commencer.*

8. *Je trouve que le petit tambourin ROMPT l'harmonie de la musique.*

8. *Je trouve que le petit tambourin ROND a une très bonne sonorité.*

8. *Quand une femme décide de divorcer, elle ROMPT les liens qui l'unissait à son mari.*

8. *Au football, on joue avec un ballon ROND alors qu'il est ovale au rugby.*

9. *Elle trouve que les enfants SALENT beaucoup trop leur repas.*

9. *Elle trouve que les enfants SALES font la honte de leurs parents.*

9. *Je fais partie de ces gens qui SALENT leur repas sans y avoir goûté avant.*

9. *Il y a des gens qui veulent qu'on fasse le SALE boulot à leur place car ils se croient supérieurs.*

10. *Ces gros nuages SOMBRENT derrière les montagnes.*

10. *Ces gros nuages SOMBRES promettent un orage violent.*

10. *Une personne qui SOMBRE dans l'alcoolisme a besoin d'aide.*

10. *Il fait tellement SOMBRE qu'on ne sait plus où mettre les pieds.*

11. *De drôles de bruits COURENT dans l'hôtel quant à la venue d'une célébrité.*

11. *De drôles de bruits COURTS sont frappés à ma porte comme une sorte de code.*

11. *Ce sportif COURT tous les matins pour s'entraîner.*

11. *L'entretien fut COURT mais très productif.*

12. *Ce politicien INTEGRE les minorités dans son projet de développement urbain.*

12. *Ce politicien INTEGRE sera certainement élu aux prochaines législatives.*

12. *Il faut que j'INTEGRE mes nouvelles données dans mon modèle psycholinguistique.*

12. *C'était un homme très INTEGRE et tous ses voisins l'admiraient.*

13. *Ce grand écrivain CELEBRE la naissance de Victor Hugo avec son nouveau livre.*

13. *Ce grand écrivain CELEBRE fera une dédicace demain dans une grande librairie.*

13. *La date qui CELEBRE la prise de la Bastille est le 14 juillet.*

13. *Mon amie sera CELEBRE si elle continue de travailler dur.*

14. *Manger cette tartelette COMPLETE délicieusement ce repas.*

14. *Manger cette tartelette COMPLETE ne me va pas car je n'ai plus faim.*

14. *Ce premier timbre en euro COMPLETE ma collection.*

14. *Ma sœur a lu les œuvres COMPLETES de Chateaubriand.*

15. *Cette petite lumière DIFFUSE une agréable sensation de calme.*

15. *Cette petite lumière DIFFUSE ne fatigue pas les yeux.*

15. *J'écoute une radio qui DIFFUSE des concerts tous les soirs.*

15. *Elle éprouve une douleur trop DIFFUSE pour la localiser avec précision.*

16. *Ce petit clown DISTRAIT les enfants malades dans les hôpitaux.*

16. *Ce petit clown DISTRAIT n'a pas vu qu'il avait oublié son nez rouge.*

16. *La télévision DISTRAIT beaucoup les enfants maintenant.*

16. *Ce professeur est tellement DISTRAIT qu'il a perdu les copies de ses étudiants.*

17. *Ce président ILLUSTRE la réussite sociale et professionnelle.*

17. *Ce président ILLUSTRE voyage énormément pour ses affaires.*

17. *C'est un tableau qui ILLUSTRE bien les paysages de Bretagne.*

17. *C'était un ILLSUTRE inconnu avant de faire carrière au cinéma.*

18. *Maintenant, certaines montres PRECISENT même la pression atmosphérique.*

18. *Maintenant, certaines montres PRECISES permettent les mesures à la milliseconde près.*

18. *Des exemples qui PRECISENT notre idée sont très utiles pour se faire comprendre de tous.*

18. *J'ai une idée PRECISE de ce que je veux faire plus tard.*

19. *Cette belle femme CAPTIVE l'attention du public.*

19. *Cette belle femme CAPTIVE craint pour sa vie.*

19. *Cet homme qui CAPTIVE toujours son auditoire m'impressionne beaucoup.*

19. *La jeune princesse était retenue CAPTIVE par sa méchante belle-mère.*

20. *Avant d'agir, ce diplomate REFLECHIT peu aux conséquences de ses actes.*

20. *Avant d'agir, ce diplomate REFLECHI pèse toujours le pour et le contre.*

20. *Je sais que tu REFLECHIS beaucoup avant de dire quelque chose.*

20. *Comme je suis quelqu'un de REFLECHI, je ne veux pas m'engager à la légère.*

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