The Interpretation of Ambiguous Trimorphemic Words in Sentence Context

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Abstract

Many trimorphemic words are structurally and semantically ambiguous. For example, *unlockable* can either be *un-lockable* (can't be locked) or *unlock-able* (can be unlocked). Which interpretation is preferred and whether prior sentence context affects the initial interpretation is not clear from prior research. The present experiment embedded ambiguous trimorphemic words in sentence context and manipulated whether prior context disambiguated the meaning or not and examined the pattern of fixation durations on the ambiguous word and the remainder of the text. The results indicated that the *unlock-able* interpretation was preferred; moreover, prior context did not exert a significant effect until the eyes had initially exited from the target word.

Most research on the role of morphology in word recognition has been focused on whether morphemic analysis is involved in visual word identification. We think the bulk of the evidence indicates that the answer is "yes". For example, in isolated word recognition (e.g., Taft & Forster, 1975; Taft, 1988), the frequency of the root of a prefixed or suffixed English word influences lexical decision time (when the frequency of the whole word is controlled). Similarly, in sentence contexts, the frequency of the root of English prefixed words (Niswander-Klement & Pollatsek, 2006) and the frequencies of both the first and second constituents of long Finnish compound words influence the gaze duration on the word in sentence context (Hyönä & Pollatsek, 1998, Pollatsek, Hyönä, & Bertram, 2000). Thus, fixation times on *disarray* are longer than those on *disorder* (*array* is lower frequency than *order*) even though the prefixed words themselves are matched on frequency (Niswander-Klement & Pollatsek, 2006). These results thus indicate that morphemic components are influencing the word identification process.

For words with both a prefix and a suffix, however, there is the additional question of in which order readers attach the affixes to the root morpheme. For example, for a word like *unlockable*, if one first attaches the prefix to the root morpheme to get the *left-branching* structure *unlock-able*, the word means "can be unlocked" whereas if one first attaches the suffix to get the *right-branching* structure un-lockable, it means "can not be locked" (see Figure 1).

Insert Figure 1 about here

Words like *unXable* are unique in English in having two legal structures. In contrast, *relockable* only has one legal structure, the right-branching *relock-able*. That is because the prefix *re* only applies to verbs so that *re-lockable* is an inadmissible structure. In contrast, a word like *unsinkable* must have the left-branching structure, *un-sinkable*, because you can't *unsink* something. However, this still leaves open the question of how people process trimorphemic words. One possibility is that for structurally unambiguous words like *relockable*, readers do not initially attach the affixes in the "legal" way but still come up with the appropriate meaning "able to be relocked" because no other combination makes sense. A second possibility is that such polymorphemic words are looked up through their whole form; however, this seems problematical for such trimorphemic words, many of which have zero frequency in many English word corpuses.

Libben (2003) explored the issue of how trimorphemic words are analyzed using a lexical decision task with dashes being placed at one of two morphological boundaries (e.g., *re---fillable* vs. *refill---able*). Surprisingly, he found that RTs for both types of unambiguous words (e.g., right-branching and left-branching) were faster when the dashes appeared between prefix and root, even if they produced an ungrammatical parse (e.g., *re---fillable*). For ambiguous words, such as *unlockable*, however, the cost of breaking at the prefix and breaking at the suffix was not significantly different. A similar pattern of data was obtained in an offline task (Libben, 2006) in which participants drew a line to mark what they believed to be the major morphological constituent boundary. Participants actually incorrectly parsed left-branching words (e.g., *re|lockable*) over half the time, whereas their error rates for right-branching stimuli were only 7% (e.g., *unthink|able*). The ambiguous stimuli were also segmented at the prefix over half the time (e.g., *un|lockable*). These data indicate a strong prefix-root separation preference.

These data indicate that the legality of the structure does not play a dominant role in how people analyze trimorphemic words, and suggest that there is quite a strong preference for right-branching structures. They are consistent with a prefix-stripping mechanism operating at an early stage such as proposed by Taft and Forster (1975). Presumably a motivation for such a mechanism is that the prefix is encountered first and can be more easily recognized as a unit than the suffix.

These studies, however, may be uncovering shallow or more form-based stages of word recognition, as there was no necessity in either of the experiments for the participants to access the meaning of the trimorphemic word. In an attempt to address this problem, de Almeida and Libben (2005) investigated the role of prior sentence context on processing Libben's (2003) ambiguous trimorphemic stimuli. Relevant for our present purposes was Experiment 2: an online cross-modal lexical decision task in which sentences as in (1) were presented aurally. Participants had to make a lexical decision for a bimorphemic string such as *lockable* (compared to an unrelated bimorphemic control) at the offset of the ambiguous word *unlockable.*

(1a) *When the zookeeper tried to lock the birdcage he noticed that the birdcage was unlockable* (right-branching biasing)

(1b) *When the zookeeper tried to unlock the birdcage he noticed that the birdcage was unlockable* (left-branching biasing)

De Almeida and Libben reasoned that, if context determined parsing preferences online, priming to *lockable* would be greater in (1a) than in (1b) because *lockable* is a constituent of *un-lockable* but not of *unlock-able*. However, as there was significant priming in both contexts but no significant difference in priming between the two sentential contexts, their data indicated that context had little effect on parsing preferences. However, the experiment did not clarify the issue of how people interpreted the meaning of the word nor what their final structural preference was. Thus, we think that the issue of whether a left-branching or right-branching hypothesis is preferred for trimorphemic words – when they are read for meaning – as well as whether prior context influences such parsing preferences is still open.

The present experiment explored how trimorphemic words are processed in normal sentence context. We employed only ambiguous trimorphemic words of the form *unXable*, as these are the only ones in which the meaning is ambiguous, and thus allow one the best chance both of understanding when a structure is decided upon (because the different structures have different meanings) and whether the prior sentence context influences the initial computation of the structure on meaning. Our paradigm is a variation of the eye-tracking paradigm that Duffy, Morris and Rayner (1988) employed for monomorphemic lexically ambiguous words. They employed either 'biased' (e.g., *port*) or 'balanced' (e.g., *coach*) ambiguous words. (For the former, one meaning was much more frequent than the other; for the latter, the frequencies of the two meanings were approximately equal.) They also manipulated the sentence context prior to the ambiguous word: either disambiguating (supporting the less frequent meaning of the word), or neutral. When the prior context was neutral, the succeeding context similarly supported the less frequent meaning.

They observed an interaction between prior context and the nature of the ambiguity. For the biased words, fixation times on the word were longer when the prior context disambiguated it; however, there were fewer regressions back to the ambiguous word. Thus disambiguating prior context apparently forced the reader to access the less frequent meaning (taking more time), whereas with neutral prior context, the more frequent meaning was typically encoded and this had to be repaired when subsequent context made that interpretation untenable. In contrast, disambiguating prior context shortened fixation time on the balanced words, suggesting that it reduced competition between the two meanings, allowing the meaning consistent with the prior context to be accessed more quickly.

The present experiment employed prior contexts that were biasing either towards one meaning of the ambiguous word or the other. However, it differs from Duffy et al. (1988) in one crucial way: we employed two sets of biasing contexts: one to the left-branching interpretation (*unX-able*) and the other to the right-branching interpretation (*un-Xable*). This allowed us to determine which structure, if either, was the dominant one. When the prior biasing context is consistent with the non-dominant structure, there should be significant costs in processing the ambiguous word relative to when the prior context was neutral, whereas when the prior context is consistent with the dominant structure, there should be little or no disruption in processing the ambiguous word relative to a neutral prior context. However, if the subsequent context makes clear that the less preferred meaning is what was intended, then there should be significant disruption in processing when the prior context is neutral. In sum, we should be able to determine which interpretation is dominant. Moreover, whether context effects occur on fixation times on the target word should allow us to determine whether the context affects the initial encoding of the ambiguous word.

Method

Participants. Twenty-eight members of the University of Massachusetts community participated; all were native speakers of English with normal or corrected-to-normal vision. They were either given extra course credit or paid $7 for their participation.

Apparatus. Eye movements were measured with an SR Research Eyelink 1000 system. Viewing was binocular but eye movements were recorded from the right eye only. Following calibration, gaze-position error was less than 0.5°. Fixation locations were sampled every millisecond. All sentences were displayed on two or three lines on the screen with a maximum of 85 characters per line. All letters were lowercase (except when capitals were appropriate) and in mono-spaced Courier font. Participants were seated 61 cm from a 19-inch Vision Master Pro 545 color monitor. At this distance, 3.15 characters equalled 1 degree of visual angle.

Materials. Sixteen two-sentence passages were created, each featuring an un-X-able word. Four versions were created for each of these passages (see Table 1 for an example and for the 16 target words). In Version 1, the preceding context biased towards left-branching, whereas in Version 2, it biased towards right branching. In both, the trimorphemic word was followed by a context congruent with the same bias. In Versions 3 and 4, the context preceding the trimorphemic word was neutral with regards to biasing towards either parse. However, in Version 3 the ensuing context was compatible with a left-branching parse and in Version 4 with a right-branching parse. A counterbalanced design was employed in which each of the 16 trimorphemes was read only once by each participant. The 16 experimental passages were embedded in a pseudo-random order within a set containing 64 filler 2-sentence passages. (The materials can be downloaded from: http://expsy.ugent.be/research/Rdocuments/downloads/trimorphemic.pdf.)

Insert Table 1 about here

Procedure. Participants were given a description of the experimental procedure and asked to read sentences on the monitor. They were told that they would be asked questions about the sentences and were instructed to read for comprehension. Participants stopped sentence presentation by pressing a button. The initial calibration of the eye-tracking system required about 5 minutes. Each participant read 10 practice 2-sentence passages to become familiar with the procedure. Comprehension questions were asked after 25% of the trials, and the accuracy answering them was 90%. The experiment lasted about 30 minutes.

Results

For the purpose of the eye movement analyses, the text was divided into four regions: region 1 was the first sentence; region 2 was the part of the second sentence prior to the target word; region 3 was the target word (including the space before it); and region 4 was the text after the target word. We will focus on three fixation duration measures. The first is the duration of the first fixation in a region. The second is *gaze duration*, the sum of all fixation durations on a region between when the region is first fixated on until the region is exited (either to the right or left). This measure, for regions containing more than one word is sometimes called *first pass time*. The third measure is *go-past time* (also referred to as *regression-path duration*), which is the sum of all fixation durations on a region until it is exited to the right[1]. It differs from gaze duration by including both regressive fixations to prior regions and any fixations on the region that occur on the region after these regressions. Thus, go-past time presumably not only includes time to encode the material but also time to repair misunderstandings.

Analyses were carried out using a linear mixed-effects (lme) model specifying participants and items as crossed random effects (e.g. Baayen, 2007). One of the advantages of these analyses is that they result in considerably less loss of statistical power in unbalanced designs due to missing values than the traditional analyses of variance across participants and items (*F1* and *F2* ANOVA analyses; see Baayen, Davidson, & Bates, 2008). The significance values and standard errors reported reflect both participant and item variability. The *p*-values were estimated by using posterior

[1] These three measures are conditional on the region being fixated on the first pass through the text. Thus, if the region is skipped over on the first pass through the text, that trial is not counted in the average.

distributions for the model parameters obtained by Markov-Chain Monte Carlo sampling. The regression weights can be interpreted as follows. If you have a value of −50 for *context*, this means that the intercept is 50 ms shorter in the model for biasing context than for neutral context. Likewise, a value of 300 for *use* means that the intercept was 300 ms longer in the model when the correct meaning was *unlock-able* than when it was *un-lockable*. Although we report main effects of the intended meaning of the target word in Tables 2-4, we will not comment on them, as these effects are hard to interpret because the meanings of the sentences were different.

As the first sentence (Region 1) was different across conditions, the eye movement measures on it are irrelevant. There were no differences between the conditions approaching significance in Region 2 (the second sentence prior to the target word). The fitted means and regression weights of the lme models for the fixation durations are reported in Table 2. As the text was identical in all conditions, the lack of any significant effect in Region 2 indicates that there was no parsing and assignment of meaning to the target word prior to fixation of the target word.

Insert Table 2 about here

The first meaningful differences occurred in Region 3; however, as seen in Table 3, they did not occur early, indicating that the process of assigning structure and meaning to these ambiguous trimorphemic words takes appreciable time. The eye movement measure that reflects the earliest effects is the first fixation duration on the word, and the only effect on this measure that was close to significant was a 22 ms (facilitative) main effect of having a prior biasing context (*SE*=12). However, as this (and all other effects) disappeared in the gaze duration measure, this first fixation effect probably reflects Type

I error (see Table 3).

Insert Table 3 about here

In contrast, the somewhat later measure, go-past duration, indicated quite large effects of prior context on processing time. As indicated earlier, go-past time includes both durations of regressions back from the region of interest and possible refixations on the region after a regression. The 101 ms interaction between context and intended meaning was significant, *SE*=46, p<.05. The 68 ms inhibiting effect of prior context for the apparently non-dominant *un(Xable)* meaning was significant, *SE*=32, but the facilitating 32 ms effect of prior context for the apparently dominant *(unX)able* meaning was not (*SE*=33).

As seen in Table 3, the effects in go-past time[2] were closely mirrored by the pattern of regressions back to prior regions of the text. However, although the main effect of context on regression probability was marginally significant (with more regressions back to prior text when the prior text constrained the meaning of the target word), *b*=.51, *SE*=.28, p<.10, the interaction of constraint and prior context was not. This suggests that the significant go-past effect was not only due to readers regressing more, but also to spending somewhat more time when they did.

To summarize, there was little, if any, effect of either the intended meaning or the prior context on either first fixation duration or gaze duration on the trimorphemic word. However, there were substantial effects that occurred slightly later that were consistent with the pattern observed by Duffy et al. (1988). First, when the meaning consistent with the entire passage is the apparently non-dominant *un(Xable)* meaning, having a prior

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[2] The lme on the Regression Probability involved a logistic transformation. To increase interpretability, the inverse logistic transformation of the parameters is reported.

context consistent only with this meaning slowed processing soon after the word was encountered. That is, with a neutral prior context, the apparently dominant *(unX)able* meaning was apparently encoded by the reader, but when the prior context made this meaning unlikely, it took extra time to get to the non-dominant *un(Xable)* meaning. In contrast, when the meaning consistent with the passage is the apparently dominant *(unX)able* meaning, this meaning was the one encoded regardless of whether the prior context is biasing or neutral; however, when the prior context supported this dominant meaning, it may have attenuated conflict between accessing the two meanings and speeded processing a bit.

There were clear differences in Region 4 consistent with the above analysis. As with Region 3, there were no significant effects on either the first fixation duration or gaze duration. Instead the differences are most clearly reflected in the most global measure, the go-past time, which in this case is equal to the time spent on the passage after first fixating Region 4. As seen in Table 4, there were large facilitative effects of biasing prior context, and the 322 ms interaction with Intended Meaning was significant, SE=149, $p<.05$. Contrast analyses showed a significant 298 ms facilitating effect of prior context for the apparently non-dominant *un(Xable)* meaning, SE=106, $p<.01$, and a non-significant inhibiting 22 ms effect of prior context for the apparently dominant *(unX)able* meaning, SE=107, $p>.05$. As with Region 3, we examined the probability of regressing from Region 4 to prior regions, but only the 80 ms main effect of intended meaning was significant, SE=.22, $p<.001$. Thus, although the difference between gaze on the region and go-past time is dependent on a regression back to the prior text, this pattern of data indicates that the effects on go-past time are largely due to more time spent trying to sort out the meaning when one has regressed rather than more regressions back to the prior text.

We did not report total fixation time on Regions 3 and 4 because they added little of interest. The pattern for Region 4 was the same as for gopast but a bit smaller because it doesn't include regressions back to Region 3; the interaction was 180 ms ($t=1.57$, $SE=114$, $p=.12$). There was virtually no interaction effect (18 ms, $t<1$) on total time on Region 3; however, this measure is hard to interpret as it includes refixations on the target word after regressing from the target word and refixations back from Region 4.

Insert Table 4 about here

We conducted further analyses to explore why there was considerable variability among items. One hypothesis is that, although the *(unX)able* meaning is generally the dominant meaning, the *unX* word may sometimes be fairly infrequent and thus neither meaning may be dominant for those words. Frequency counts from standard databases seemed quite unreliable (e.g., *unwrap* was not a word in a major corpus), so instead we used the number of 'Google hits' as the frequency measure (Blair, Urland & Ma, 2002); the median value for the *unX* words was 842,000 and they ranged from 34,800 to 33,500,000 (see Table 5). The log of this frequency explained a sizeable amount of the variability between items in the go-past measures. For go-past3, it correlated −.09 with the difference in the *(unX)able* condition, .60 with the difference in the *un(Xable)* condition, and −.42 with the interaction term. Conversely, for go-past4, it correlated −.05 with the difference in the *(unX)able* condition, −.48 with the difference in the *un(Xable)* condition, and .29 with the interaction term. Thus, a low frequency for *unX* had only a slight effect on go-past3 when *(unX)able* was the ultimate meaning, but a large effect in attenuating the negative difference in the *un(Xable)* condition (i.e., making the prior biasing context easier to understand). Conversely, on go-past4, when *un(Xable)* was the ultimate meaning, a low frequency *unX* reduced the interference effect in the neutral condition by making it more likely that the *un(Xable)* meaning was taken as the meaning originally.

Insert Table 5 about here

Discussion

The present results are evidence for a preference towards a left-branching structural interpretation for ambiguous trimorphemic words in normal reading. Moreover, our analyses indicate that this preference is likely due to the generally higher frequency of *unX* than of *Xable*. This hypothesis is consistent with earlier studies that have demonstrated reliable component frequency effects on fixation times on longer compound and prefixed words (e.g., Hyönä & Pollatsek, 1998, Niswander-Klement & Pollatsek, 2006). That is, these earlier studies indicate that components of such words are active before full recognition of the word and the frequency of the components are influencing the eventual identification of the word. Although one can not automatically extend these findings to non-ambiguous multi-morphemic words, there is a plausibility argument for why the same processes would be at work in processing in many of those words. That is, for a word like *unsinkable*, *unsink* would be less frequent than *sinkable* and thus lead to the correct parse and for a word like *relockable*, *relock* (like *unlock*) will be higher frequency than *lockable*, also leading to the correct interpretation. However, the details of how these unambiguous trimorphemic words are processed in context will need to be settled by future experiments.

The pattern we observed is contrary to the right-branching preference observed by Libben (2003, 2006) with isolated words. There are two possible explanations for the difference. One is that the right-branching preference observed by Libben was an artifact of the tasks employed (which did not require the word to be processed for meaning). The other is that these tasks were dominated by an early stage of processing which is, for the most part, outweighed by a later stage that favors a left-branching structure in normal reading.

It is important to note, however, that the left-branching preference we observed is almost certainly probabilistic bias rather than the result of an algorithm being employed by the word processing system that always generates the left-branching interpretation as the default. First, although the effect sizes on go-past times consistent with a bias towards a left-branching interpretation were quite large, they were also quite variable. Second, the post-hoc analyses suggested that the strength of the bias was related to the frequency of the *un-X* component. Furthermore, as this frequency is fairly low, it is likely to be quite variable, both across items and people. However, this pattern could be consistent either (a) with a model in which both interpretations are computed and then there is a competition between them that is influenced by factors such as the frequency of the possible components or (b) that factors such as the frequency of components guide the selection of a single interpretation.

We feel that the time-course of the context effects in the present experiment (i.e., the first significant effects were on go-past times) favors the latter hypothesis. In Duffy et al (1988), prior context chiefly affected gaze durations and even first fixation durations on their monomorphemic ambiguous target words. Thus, their data suggest a process in which context affected the initial selection of meaning and did so in a way that either lengthened or facilitated the process (for biased and balanced ambiguous words, respectively). In contrast, we found that prior context had virtually no effect on gaze duration on the target word; instead, it influenced go-past time which indexes further processing initiated by a regression back to prior text. This is more consistent with an effect in which the initial decision on the meaning of the word has been computed solely on the basis of properties of the word itself, and then it is realized that this is inconsistent with prior text and the problem needs to be corrected. Our effect on go-past time is crucially different from spillover effects in that it occurs early enough to prevent the reader from progressing on to the next word.

Obviously, the conclusion that one context effect is on the process of lexical access and the other is "post-lexical" on the basis of timing has to be tentative. For example, the frequency of a word influences fixation time on the content word immediately following the frequency-manipulated word, suggesting that some of the initial encoding of a word's meaning continues after it has been left. In addition, it is possible that the prior contexts of Duffy et al. were more constraining than ours, which was why they had an earlier effect. However, we think that the most parsimonious explanation for our later-acting effects of prior context is that the morphological parsing system operates independently of the prior context of the utterance. Moreover, this conclusion is consistent with de Almeida and Libben's data, which also indicated that the initial interpretation of ambiguous trimorphemic words was not influenced by prior context.

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Table 1

Sample sentences illustrating each of the four conditions in the experiment

1. Ultimate meaning is unX(able) – Prior Biasing Context

The zookeeper needed to get the new bird out of its cage.

As the cage was unlockable, his key quickly opened it and he removed the bird.

2. Ultimate meaning is un(Xable) – Prior Biasing Context

The zookeeper wanted to make sure the new bird stayed in its cage.

As the cage was unlockable, he needed to fasten the door with wire instead.

3. Ultimate meaning is unX(able) – Prior Neutral Context

The zookeeper inspected the new bird and its cage.

As the cage was unlockable, his key quickly opened it and he removed the bird.

4. Ultimate meaning is un(Xable) – Prior Neutral Context

The zookeeper inspected the new bird and its cage.

As the cage was unlockable, he needed to fasten the door with wire instead.

Table 2

Eye movement Measures on Region 2

(The second sentence prior to the Trimorphemic Word)

Eye Movement Measure	Ultimate Meaning is un(Xable)			Ultimate Meaning is (unX)able		
	Prior Biasing Context	Prior Neutral Context	Difference	Prior Biasing Context	Prior Neutral Context	Difference
First Fixation Duration (ms)	190	202	+12	193	194	+1
Gaze Duration (ms)	486	488	+2	501	466	-45
Go-Past Time (ms)	488	495	+7	502	487	-15

Note: ° $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 3

Eye movement Measures on Region 3 (the Trimorphemic Word)

Eye Movement Measure	Ultimate Meaning is un(Xable)			Ultimate Meaning is (unX)able		
	Prior Biasing Context	Prior Neutral Context	Difference	Prior Biasing Context	Prior Neutral Context	Difference
First Fixation Duration (ms)	247	269	+22°	250	246	-4
Gaze Duration (ms)	337	338	+1	322	343	+21
Go-Past Time (ms)	457	388	-69*	378	410	+32
Probability of Regressing from Region	0.22	0.12	-0.10*	0.15	0.15	0.00

Note: ° $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4

Eye movement Measures on Region 4 (the following text)

Eye Movement Measure	Ultimate Meaning is un(Xable)			Ultimate Meaning is (unX)able		
	Prior Biasing Context	Prior Neutral Context	Difference	Prior Biasing Context	Prior Neutral Context	Difference
First Fixation Duration (ms)	248	229	-19	246	241	-5
Gaze Duration (ms)	1635	1774	+139	1620	1650	+30
Go-Past Time (ms)	1952	2250	+298**	2298	2274	-24
Probability of Regressing from Region	0.19	0.25	+0.06	0.40	0.35	-0.05

Note: ° p < .10, * p < .05, ** p < .01, *** p < .001

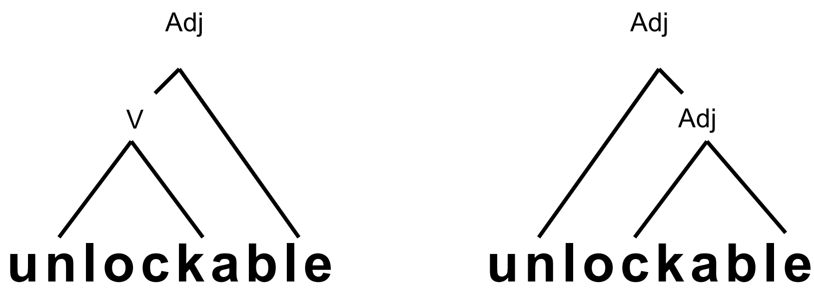
Table 5

Google Frequency Counts for the Target Words and Their Constituents

un-X-able	log google hits	un-X	log google hits	X-able	log google hits
unbendable	4.662	unbend	5.149	bendable	5.960
unbuttonable	2.688	unbutton	5.621	buttonable	3.190
uncoilable	2.671	uncoil	4.994	coilable	4.009
uncorkeable	1.820	uncork	5.279	corkable	1.863
undressable	3.037	undress	6.427	dressable	4.037
unfastenable	3.021	unfasten	5.410	fastenable	4.283
unfoldable	4.352	unfold	6.965	foldable	6.571
unglueable	1.740	unglue	4.542	glueable	3.594
unhookable	2.880	unhook	5.646	hookable	4.382
unleashable	2.782	unleash	6.179	leashable	2.542
unlockable	6.076	unlock	6.898	lockable	1.863
unpackable	3.668	unpack	7.525	packable	6.334
unrollable	3.644	unroll	6.620	rollable	5.664
untieable	3.093	untie	6.843	tieable	2.639
unwindable	3.658	unwind	5.728	windable	5.004
unwrappable	3.312	unwrap	6.061	wrapable	2.516

Figure Caption

Figure 1: The two possible structural configurations for the ambiguous trimorphemic word *unlockable.*



"able to be unlocked" *"not able to be locked"*

(a) LEFT-BRANCHING **(b) RIGHT-BRANCHING**