

Japanese and English speakers are not sensitive to the Sonority Sequencing Principle in word segmentation

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Abstract

The current study investigates the role of experience independent knowledge, the Sonority Sequencing Principle (SSP), in word segmentation tasks for native Japanese and English speakers. Our results from two experiments, word segmentation tasks, consistently showed that the SSP did not bias word segmentation for speakers of both languages, which contradict previous findings (Ettlinger et al., Ren, 2010). We claim that the SSP, if relied upon at all, is not sufficient or even particularly useful during word segmentation. Moreover, the somewhat similar patterning of Japanese and English listeners in our experiments suggests that phonetic factors might have a much larger role during word segmentation.

1 Introduction

In a natural language setting, pauses do not necessarily divide the words in speech. Language learners employ various cues, whether it be language dependent or independent, to extract words from speech strings in the target language. Recently, the Sonority Sequencing Principle (SSP), which is widely considered to be a language independent phonological universal, has been argued to be used by listeners during word segmentation (Ettlinger et al., 2012; Ren, 2010), and during speech perception (Berent et al., 2007). In this study, we focus on the former claim by looking at whether English and Japanese listeners rely on the SSP during word segmentation. We focus on these two language groups because we further wanted to test the effect of SSP during word-segmentation on listeners with differing language particular experience with complex onset clusters.

2 Background

The importance of experience-based knowledge in word segmentation tasks is well known in the literature (Jusczyk et al., 1999; Mattys et al., 1999; Saffran et al., 1996); however, little has been done to test whether experience-independent cues play a role. The SSP, which is generally accepted to be a language universal, was tested by two studies, Ettlinger et al. (2012) and Ren (2010). Both claimed that when participants were presented with a string of artificial stimuli and asked to listen to the words, the sequence was segmented adhering to the SSP. For example, when a string like “...*mrteilzafa*...” was presented (where, “*mrtei*” and “*zafa*” are the actual stimuli that appear in different randomizations in the string), listeners were less likely to parse “*zafa*” as a word compared to “*zafa*”. In contrast, when a string like “...*mrteidneku*...”, consisting of “*mrtei*” and “*neku*”, was presented, listeners were more likely to parse “*neku*” as a word than “*neku*”. That is, words with falling sonority onsets appear to be dispreferred,

while those with rising sonority were more preferable. The current study aims to (a) confirm whether the effect is replicable on English speakers, using a different set of stimuli, and (b) test whether such bias is available for Japanese speakers whose language prohibits complex onset clusters.

3 Experiment 1

A word segmentation experiment was conducted using PsychoPy software (Peirce, 2007) having 22 native Japanese and 30 native English speakers as participants.

3.1 Methods

There were two phases in the experiment, familiarization and test. In the familiarization phase, participants heard one of the two strings of speech for 15 minutes and were instructed to listen to words. Each string is composed of 5 novel CCVCV disyllabic words and there was a total of two separate strings. One string contained: *bnife*, *kfami*, *dgusa*, *vteko*, *lzotfu*, and the other: *nbife*, *fkami*, *gdusa*, *tveko*, *zlotfu*. All stimuli were recorded using a speech synthesizer, MacinTalk (Apple, Cupertino, CA). The order of stimuli in the string was pseudo-random such that the same stimuli never appeared consecutively.

The first syllable of each word had a complex onset cluster that varied in the SSP scores {2, 1, 0, -1, -2}. The SSP scores were calculated by the number of tiers between the two consonants according to the sonority hierarchy (scale) shown below (Selkirk, 1984; Clements 1990). For example, *bnife* was given a score of 2 since the plosive /b/ and nasal /n/ are two tiers away from each other. A positive score refers to rising sonority and a negative score a falling sonority. The familiarization phase was followed by a test phase. Here, participants were asked to listen to both full words with a complex onset (e.g. *bnife*) and part words with a simple onset (e.g. *nife*) separately and asked to answer “yes” or “no” if they believe they heard those words.

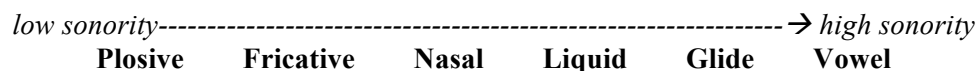


Figure 1. Sonority hierarchy

3.2 Hypotheses

If SSP is universal knowledge and is available to speakers of any language, then it should impact word segmentation. Therefore, if the argument presented by Ettliger et al. (2012) and Ren (2010) is correct, then we anticipated more “yes” responses for clusters with positive SSP scores than negative scores. More precisely, we predicted that the number of “yes” responses would be positively correlated with the SSP score. Furthermore, the “yes” responses for simplex onset without the SSP score information should be negatively correlated with the SSP score if exposure to a string of words had caused the participants to store definite segments in their memory. Although SSP is assumed to be a language universal and should be available for both Japanese and English speakers, language experience was hypothesized to play a role as well. Since there are no complex onset clusters in Japanese, Japanese speakers may be less sensitive to SSP than English speakers.

3.3 Results

The “yes” responses for all participants were not predictable by the SSP score. The results for

Japanese and English speakers did not show a consistent increment in “yes” responses for the complex tokens as the SSP score increased and there was no positive correlation between the number of “yes” responses and the SSP score even though the SSP was anticipated to be a better predictor as the score increased (Fig. 2).

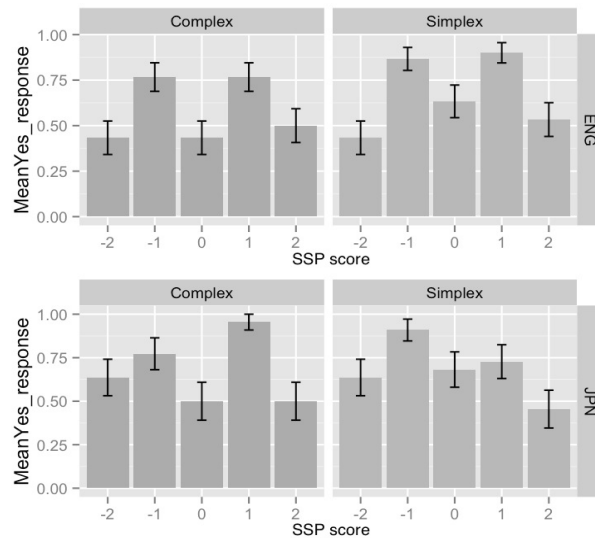


Figure 2: Mean “yes” response by SSP score for English (top) and Japanese (bottom) speakers. Left column: complex onsets. Right column: simplex onsets

4 Experiment 2

Exp 2 was another word segmentation experiment to test whether a small difference in design between Exp 1 and previous experiments yielded the discrepant results. It was conducted with 16 native English participants.

4.1 Methods

The stimuli and the familiarization phase were the same as Exp 1. However, the design was a forced choice task, resembling Ettliger et al. (2012), that presented two stimuli, complex (e.g. *bnife*) and part-word simplex with coda (e.g. *nifek*). In the test phase following the familiarization, participants were asked to choose which of the two sounded more like a word. Choosing the complex onset word is the correct response for each test item.

4.2 Results

If the SSP biased word segmentation, listeners should be more accurate with higher (rising) sonority sequences than lower (falling) sonority sequences. For Exp 2 results, mean percent accuracy was calculated for each SSP score. Again, there was no observable positive correlation between the SSP score and the accuracy (Fig 3). Participants showed no evidence of employing the SSP during word segmentation and none of the SSP scores reached accuracy over 60%.

5 Discussion

Both Exp 1 and Exp 2 showed that the SSP did not bias word segmentation. From the Exp 2 results, we can reasonably claim that the experimental method was not at fault for causing dissimilar results from

Ettlinger et al.'s (2012) study. One possible explanation as to why SSP did not play any role in word segmentation is because fundamentally, the SSP is a principle concerning syllable formation. The sonority rises as it moves closer to the nucleus and the sonority falls as it moves away from it. The SSP does not necessarily predict the arrangement at the word level. However, the current findings cannot yet make a strong claim that the SSP does not play any role on account of results from previous studies and also because of the possibility that other cues may have overridden the existing SSP cue for the stimuli used here. Further investigation is needed to find out precisely the degree to which SSP plays a role, if any, and its interaction with other word segmentation cues.

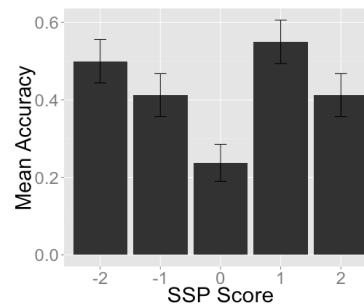


Figure 3: English participant's mean percent accuracy by SSP score for Experiment 2.

6 Conclusion

The effect SSP has on word segmentation should be reconsidered. Our experiments consistently showed that this putative universal does not guide word segmentation for either Japanese or English speakers, and the different language-dependent experiences with respect to onset clusters do not make a difference. Our findings suggest that SSP by itself, even if utilized by listeners, is too weak a cue to guide word segmentation. Furthermore, the somewhat similar patterning of Japanese and English listeners in our experiments suggests that phonetic/acoustic factors might have a much larger role during word segmentation.

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