NATIVE AND NON-NATIVE PROCESSING OF LEXICAL STRESS 
IN ENGLISH WORD RECOGNITION

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ABSTRACT

Listeners may use native language processing strategies in second language listening, causing them to use certain cues differently from native speakers of that language. Three studies were conducted to investigate Dutch and Australian listeners' use of lexical stress information in Australian English. Two cross-modal fragment priming studies revealed no major differences in Dutch and Australian listeners' use of stress. However, a two-alternative forced choice experiment showed more sensitive stress processing by Dutch listeners. Discussion focuses on whether English listeners use stress more than previously believed and on the extent to which Dutch listeners use their native language processing strategies when listening to a second language.

1. INTRODUCTION

When listeners attend to their native language, they process it in the way that provides the most useful information for word recognition. Native speakers of different languages may learn to process prosodic information differently, according to the usefulness of such processing in activating words. Although both Dutch and English are stress-timed languages, there is evidence that Dutch and English listeners use lexical stress differently.

English presents a different case from Dutch because stress information largely coincides with vowel quality information in English. When an English syllable is stressed, its vowel is full (e.g., photo), whereas unstressed syllables often undergo vowel reduction (e.g., photography). This redundancy of cues makes it efficient for English listeners to rely more on the vowel quality information and not to attend to the suprasegmental stress information.

Experimental evidence suggesting that English listeners do not use stress information to constrain lexical access includes Cutler's [1] cross-modal associative priming study. Cutler used segmentally matched but semantically unrelated pairs of words such as FORbear/forBEAR to demonstrate that presentation of one of the words (e.g., FORbear) primed lexical decisions to an associate (e.g., ancestor) as strongly as it primed decisions to an associate of the paired word (e.g., tolerate). This suggested that English listeners do not use lexical stress in the same way as segmental structure to constrain lexical access, a result supported by several other studies (Cutler and Clifton, [2]; Fear, Cutler and Butterfield, [3]).

Dutch does not promote the strategy of attending to vowel quality over stress information, because unstressed syllables in Dutch do not undergo vowel reduction as commonly as in English. This means there are more unstressed syllables with full vowels in Dutch than in English. Thus, stress remains a useful source of information, and it has been demonstrated that Dutch listeners do in fact use stress cues in word activation (van Donselaar and Cutler, [4]; Koster and Cutler, [5]). Van Donselaar and Cutler [4] used a fragment priming task to demonstrate that Dutch listeners could use the stress pattern of an auditorily presented word fragment to constrain activation of the whole word. Specifically, visual lexical decisions to a word such as OCTOPUS were significantly faster after listeners had heard a fragment matching the target both phonemically and in stress pattern (e.g., OCto from OCTopus), relative to responses following a phonemically nonmatched control fragment (e.g., euFO). Responses after a fragment matching the target phonemically but with a different stress pattern (e.g., okTO from oKTober) were inhibited relative to the control condition. This suggests that Dutch listeners are sensitive to stress in their native language and that they use it to constrain word activation.

There has been considerable interest in the extent to which one's native language processing strategies are used in processing a second language. Cutler and colleagues have demonstrated a large range of native language effects in the processing of phonemic variation (Costa, Cutler and Sebastian-Galles, [6]), morae (Otaka, Hatano, Cutler and Mehler, [7]; Cutler and Otake, [8]) and syllabic structure (Cutler, Mehler, Norris and Segui, [9]) when listening to a second language. If it is true that Dutch listeners use lexical stress to constrain lexical access in Dutch and that English listeners do not make use of lexical stress cues in English, it is possible that Dutch listeners attending to English may be able to make use of stress cues that native English listeners do not. To test this hypothesis, two cross-modal lexical decision studies similar to that of van Donselaar and Cutler [4] were conducted, investigating Dutch and English listeners' processing of lexical stress in English. The current studies used cross-modal fragment priming instead of the associative priming task Cutler [1] used to study English native listening, because activation of words with the same onset as the input is believed to be stronger than activation of words semantically related to the input. Based on previous studies of Dutch and English listeners' use of stress in their native languages, it was expected that Dutch listeners would use the stress pattern of the auditory prime to constrain access of the target, and that English listeners would not, instead showing only segmental priming effects.

To investigate more conscious processing of lexical stress, the fragment priming studies were supplemented by an off-line two-alternative forced choice task, in
which listeners had to process the stress pattern of an auditory fragment to select which of two words it came from. It is possible that if listeners knew which cues to attend to in the signal, they would be better able to use stress to constrain word access.

2. FRAGMENT PRIMING STUDIES

2.1. Participants

Sixty-one native speakers of Australian English and 56 native speakers of Dutch participated in the first (monosyllabic) priming experiment, and 48 native speakers of Australian English and 56 native speakers of Dutch participated in the second (bisyllabic) priming experiment. Australian speakers were psychology undergraduates from the University of Melbourne and the University of New South Wales, and Dutch speakers were drawn from the Max Planck Institute for Psycholinguistics’ subject pool. No participant took part in both experiments, and all participants had normal hearing and normal-to-corrected vision.

2.2. Materials

For the first fragment priming experiment, pairs of English words were found with the same unreduced first syllable and following phoneme but with mismatching stress patterns (e.g., MUsic, muSEUM). A pretest was run to discard pairs which contained a word that Dutch listeners were unlikely to know, yielding 21 pairs. Two control words were found for each pair, and two versions of each word were recorded in semantically non-constraining sentence contexts by a speaker of Australian English. Forty-two additional sentences with the same structure were recorded for use as fillers. All sentences were then truncated at the end of the phoneme immediately following the first syllable of the target or control word (e.g., MUs from MUsic; muS from muSEUM).

Computer image files of each of the target words and of 42 filler nonwords was created, using large uppercase font in the centre of the screen.

The materials of the second fragment priming experiment differed only in that the target words were longer. They matched phonemically on the first two syllables, but one member of the pair had primary stress on the first syllable (e.g., CONference), whereas the other had secondary stress on the first syllable and primary stress on the third (confirMAtion). Truncation was performed at the end of the second syllable of each target or control word, yielding bisyllabic fragment primes (e.g., CONfer and confir).

2.3. Procedure

On each target trial, participants made lexical decisions to a visual target (e.g., MUSEUM) immediately following auditory presentation of a sentence ending in 1) a phonemically- and stress-matched fragment (e.g., muS); 2) a phonemically-matched but stress-mismatched fragment (e.g., MUs); or 3) a control fragment (e.g., MONs). Target trials were quasi-randomly interspersed with filler trials of the same structure but in which a nonword was presented as the visual target. The speed and accuracy of participants’ lexical decisions were recorded by computer.

Each participant saw both words of every pair as visual targets, one following the control fragment and the other following either the stress-matched fragment or the stress-mismatched fragment. To ensure an equal distribution of target words in each condition and to counterbalance for ordering effects, trials were organised into eight lists and participants were randomly assigned to one of these lists for testing.

2.4. Results

Analyses of variance were carried out on both the monosyllabic and bisyllabic priming data. All effects reported as significant were found significant with a p-value of less than 0.05. In the monosyllabic priming task, there was no significant difference between Dutch and Australian listeners’ patterns of responses. As shown in Figure 1, listeners responded significantly faster after phonemically- and stress-matching fragments than after control fragments, significantly faster after phonemically matching but stress-mismatching fragments compared with controls, and significantly faster after stress-matching fragments compared with stress-mismatching fragments.

![Graph](image)

Figure 1. Lexical decision latencies after monosyllabic fragments with matching and mismatching stress and after control fragments

The bisyllabic priming task yielded a significant difference between Dutch and Australian listeners’ pattern of responses. As shown in Figure 2, both groups of listeners responded significantly faster after phonemically- and stress-matching fragments than after control fragments, however only Dutch listeners responded faster after phonemically matching, stress-mismatching fragments relative to control. Both Dutch
and Australian listeners responded significantly faster after stress matches than after stress mismatches.

![Figure 2. Lexical decision latencies after bisyllabic fragments with matching and mismatching stress and after control fragments](image)

2.5. Discussion

Dutch and Australian listeners both made use of segmental information in the monosyllabic fragment priming task, showing facilitatory priming after phonemically-matching fragments with both stress mismatch and stress match. They were also faster after stress matching fragments than after stress mismatching fragments, indicating sensitivity to stress information in the fragments.

The pattern of results in the stress mismatching condition is surprising for both language groups, first because a similar experiment with Dutch listeners attending to Dutch stimuli showed an inhibitory rather than a facilitatory effect following stress mismatches [4], and secondly because previous research with English listeners has suggested that they are not sensitive to stress cues in English [1]. Contrary to expectations, Australian listeners reacted faster after stress-matched than after stress-mismatched primes in both the mono- and bisyllabic studies. It is noteworthy that the priming patterns they show do not resemble native speaker performance in either Dutch or Spanish, two other languages previously tested using this paradigm. In lexical decision tasks in their native tongues, Dutch and Spanish listeners showed an inhibition effect after fragments that mismatched the target in stress pattern (Soto-Faraco, Sebastian-Galles and Cutler [10]). The slower reaction time after stress mismatch in those studies was taken to reflect the effort of reactivating a word after a stress mismatch had inhibited its activation. With the inhibition effect absent, the current study cannot claim such a clear constraining effect of stress mismatch on the lexicon.

Although neither Dutch nor Australian listeners demonstrated inhibitory priming in these studies, it is not necessarily the case that stress mismatch had no inhibitory effect at all. Responses after stress mismatched fragments were slower than after stress matched fragments. It could be that both a facilitatory effect of phonemic similarity and a weaker or later-acting inhibitory effect of stress mismatch are at play in the performance of both language groups.

It has already been argued that segmental information is more useful than lexical stress information in English. If this is the case, an efficient lexical access strategy would be to give priority to spreading activation of segmentally similar lexical entries over an inhibitory effect of stress mismatch. It is implausible that such a mechanism would be under conscious control, so the discrepancy between Dutch listeners' native priming pattern and their performance on Australian English could instead reflect the difficulty of manipulating a second language lexicon. Weaker or slower-spreading activation of phonemically similar words could delay inhibitory processing of lexical stress.

Although Australian listeners demonstrated a different pattern of responding in the mono- and bisyllabic fragment priming tasks, the results are not inconsistent with the explanation that segmental information may be given priority in lexical access. Bisyllabic fragment primes provide stronger phonemic support for word candidates with the same onset as the input, thus any inhibitory stress processing could be initiated earlier, cancelling out the segmental facilitation in the bisyllabic fragment priming task.

3. TWO-ALTERNATIVE FORCED CHOICE STUDY

3.1. Participants

In order to evaluate Dutch and Australian listeners' processing of lexical stress in an off-line task, 22 native speakers of Australian English from the University of New South Wales and 26 Dutch speakers from the Max Planck Institute for Psycholinguistics participated in the two-alternative forced choice study.

3.2. Materials and Procedure

The target word fragments (e.g., MUs) from the monosyllabic priming study were spliced from their sentence contexts, generating two versions of each of the 42 fragments.

Participants listened to the fragments and on each trial indicated which word of the target pair (e.g., MUSIC/MUSEUM) was the source of the fragment, by circling that word on the response sheet provided. Each fragment was presented twice, once with the correct response printed in the leftmost position and once in the rightmost position on the response sheet. Order of presentation of the 108 trials was randomised. A generous pause of 4.5 seconds was given between each trial to allow participants sufficient time to make their response.
3.3. Results
Analyses of variance were carried out. All effects reported as significant were significant with a p-value of less than 0.05. As shown in Figure 3, both Dutch and Australian listeners were significantly more likely to respond with the first syllable stress word after hearing the fragment from that word than after hearing the fragment from the second syllable word. This difference was stronger in the Dutch listeners since there was a significant interaction of language group and stress condition.

![Figure 3. Identification of fragments from first and second syllable stress words](image)

3.4. Discussion
Although there were many first syllable stress responses to the first syllables of second-syllable stress words, both Dutch and Australian listeners were more likely to respond with a first syllable stress word when they had in fact heard a first syllable stress fragment. This corroborates the conclusion from the fragment priming experiments that English native speakers are sensitive to stress and that they can use it in lexical access.

Dutch listeners again showed sensitivity to lexical stress in English, this time to a greater extent than English natives. They did not show a disadvantage due to second language listening compared with the Australian native speakers. The generous time allowed for responding may have allowed them more time to process stress than in the fragment priming tasks.

4. GENERAL DISCUSSION
Both Dutch and English listeners showed sensitivity to the stress pattern of auditory word fragments. It is proposed that when processing English words, facilitatory activation of phonemically similar lexical entries takes precedence over later-acting or weaker stress processing. Further studies into the strength and time course of segmental and lexical stress processing are necessary to test the plausibility of this hypothesis.

There was some evidence that Dutch listeners were more sensitive to stress than English native listeners, suggesting that they were able to apply the stress processing learned in their native language to their benefit in listening to English. The evidence for this advantage, however, is limited, and further cross-linguistic studies are needed to establish the extent to which Dutch and English listeners differ in their processing of lexical stress.

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6. REFERENCES