NIELS O. SCHILLER, Cambridge, MA (USA)

MASKED PRIMING OF SUBLExICAL UNITS: SEGMEMTS VS. SYLLABLES

ABSTRACT

The role of sublexical units in speech production is investigated. In the present study three experiments are reported which tested the effect of visually masked primes on the naming latencies of pictures and words in Dutch. Target words were bisyllabic Dutch nouns (Experiments 1 and 2) or verbs (Experiment 3) that either had clear syllable boundaries and began with a CV syllable (e.g., ke.tel 'kettle') or a CVC syllable (e.g., ka.kus 'cactus'), or had a syllable boundary that was ambiguous, in which case they began with a CV(C) syllable (e.g., ke[t]ing 'chain'). In the syllable match condition, targets were preceded by primes that were identical to their first syllable, e.g., ke### - KETEL. In the syllable mismatch condition, the prime was either shorter or longer than the target word's first syllable, e.g., ke.t### - KETEL. A neutral condition was designed to determine the nature of the priming effects (facilitation or inhibition), e.g., #&$$# - KETEL. All related primes facilitated the naming of the targets significantly, but the priming effects were independent of the syllabic structure of prime and target. It may be concluded that the syllable does not play a functional role during phonological encoding in Dutch speech production. Since the size of the facilitation effect increased when the overlap between prime and target was increased, the priming effects can be accounted for by a segmental overlap hypothesis.

1. Introduction

Psycholinguistic evidence suggests that the syllable may be a functional unit in the processing of speech, at least in some languages. In speech perception, there is ample evidence that sublexical units such as the syllable can be crucial in speech perception and recognition (see E. Dupoux 1993 for a recent review). In speech production, the evidence for the functional role of syllables is much weaker. Speech errors that comprise more than one segment cannot unambiguously be attributed to syllables since most of them are confounded with morphemes. However, there are some speech errors that are clearly syllabic (for English see D. MacKay 1970, for Dutch see S. Nootboom 1969). The number-of-

---

1 In this paper, ambisyllabic consonants appear between square brackets and syllable boundaries are marked by dots.
syllables effect (S. Klapp, W. Anderson, and R. Berrian 1973) on pronunciation latency cannot clearly be attributed to syllables either, since for bisyllabic words two nuclei have to be encoded whereas for the monosyllables only one nucleus has to be encoded phonologically.

Under laboratory conditions certain aspects of syllable structure and syllabification have been investigated with metalinguistic tasks revealing evidence for the syllable as a psycholinguistic unit in speech production in different languages (for English see D. Fallows 1981, R. Treiman 1983; for Dutch see N. Schiller, A. Meyer, and W. Levelt 1997, L. Wheeldon W. Levelt 1995; for French see A. Content, R. Kearns and U. Frauenfelder, submitted).

Recently, two studies have been reported in the literature that found clear syllabic effects in speech production using on-line tasks. L. Ferrand, J. Segui and J. Grainger (1996) studied the effect of masked syllable primes in naming tasks with French materials. They obtained reliable facilitation effects in picture, word, and nonword naming when prime and target shared the first syllable relative to a condition where they shared a string of segments of equal length that was either longer or shorter than the first syllable. In a visual lexical decision task - i.e. a task that could be performed without producing the phonological form of the target word - the effect disappeared. L. Ferrand et al. (1996) concluded that the observed syllable priming effect must arise at the level of the output phonology and that the syllable is a functional unit in French speech production. Recently, L. Ferrand, J. Segui and G. Humphreys (1997) replicated the syllable priming effect with the word naming task in English.

Under the assumption that the masked priming paradigm taps into early stages of phonological encoding the results of L. Ferrand et al. (1996, 1997) stand in contradiction with speech production models that assume that the syllable structure of a lexical entry is not stored in the lexicon (W. Levelt 1992, W. Levelt, A. Roelofs and A. Meyer 1999; A. Roelofs 1997). To test the "late syllabification" view taken in Levelt's model, Dutch speech production is investigated using the masked priming paradigm. Dutch is similar in phonological structure to English. Based on the results by L. Ferrand et al. (1997) one may expect to find a syllable priming effect in Dutch. However, based on the predictions of W. Levelt's speech production model, syllabic effects are not expected in early stages of phonological encoding.

2. The Experiments

All experiments used the masked priming paradigm (for details of the procedure, design, and materials see N. Schiller 1997, N. Schiller 1998). First a row of hash marks (forward mask) was presented on a computer screen for 500 ms, followed by the prime which was presented for 50 ms, followed by another row of hash marks (backward mask) for 17 ms. Then the target was presented for maximally 2000 ms. Participants' task was to name the target as fast and as accurately as possible. 18 participants were tested both in Experi-
ments 1 and 2, 24 participants took part in Experiment 3.

2.1. Experiment 1

In Experiment 1 there were 54 bisyllabic, monomorphemic Dutch nouns, all of which could be assigned unambiguously to one target type only (CV, CVC, or CV[C]). In each block all target words appeared in three different priming conditions (CV, CVC, and neutral). Blocks were repeated three times and randomized individually for each participant and repetition.

Neither the main effect of repetition and target type nor any of the interactions involving these variables were significant. The main effect of priming condition, however, was significant ($p < .001$ for both $F$ values). Target words were named fastest when preceded by a CVC prime (450 ms), slower when preceded by a CV prime (459 ms), and slowest when preceded by a neutral prime (488 ms). Dunnett's tests ($p < .05$) showed that both the CV and the CVC priming condition differed significantly from the neutral control condition. Planned comparisons revealed that the 9 ms difference between the CV and the CVC priming condition was also significant ($p < .01$ for both $t$ values).

The results did not show any sign of a syllable priming effect. Instead, the obtained facilitation effects may be due to the segmental overlap between prime and target, and the size of the priming effect may be dependent on the amount of overlap, but independent of the correspondence of the syllabic structure of prime and target.

2.2. Experiment 2

The word naming task can be carried out by applying nonlexical grapheme-to-phoneme conversion rules, especially in languages that have a "shallow" orthography such as Dutch. In contrast, picture naming presumably involves lexical access because the retrieval of a picture's name must be preceded by the activation of the concept and the lemma in order to access semantic information (see W. Glaser 1992 for a review). Furthermore, it may be argued that the priming effects obtained in word naming are partially due to the visual overlap between prime and target although an effort was made to avoid this by presenting prime and target in different case. Picture naming does not involve this problem.

Experiment 2 tested whether the effects found in Experiment 1 can be replicated with a different task, i.e., picture naming. Materials and task were the same as in Experiment 1 except that the targets were line drawings. The results are similar to those obtained in Experiment 1. The main effect of priming condition was again significant ($p < .001$ for both $F$ values), but not the interaction between target type and priming condition indicating the lack of a syllabic effect. Target pictures preceded by a CVC prime were named fastest (648 ms), followed by the CV priming condition (667 ms), and by the neutral priming condition (700 ms). Dunnett's tests ($p < .05$) showed that both the CVC and the CV priming condition differed significantly from the neutral control condition, and planned
comparisons revealed that the difference between the CV and the CVC priming condition was also significant ($p < .05$ for $t_1$, $p < .01$ for $t_2$).

The pattern of results is similar to the outcome of Experiment 1. Again, there was no sign of a syllable priming effect, but the data are in line with a segmental overlap account. To test the segmental overlap hypothesis, Experiment 3 was carried out in which all target words were six letters in length and the length of the primes varied between one and six letters.

2.3. Experiment 3

Materials included Dutch verb forms either in present tense (*hui.len*) or in past tense (*hui.de*). These target words have the advantage that they are equal in length, overlap in the first four letters, but have different initial syllables (CV vs. CVC). Six different primes were used which overlapped with the target in the first one, three, four, five, six (identity condition), or no letters (neutral condition).

The results support the segmental overlap hypothesis but not the syllable priming hypothesis as indicated by a lack of interaction between target type and priming condition. Instead, the main effect of priming condition was significant ($p < .001$ for both $F$ values) reflecting the fact that targets were named fastest in the identity priming condition (442 ms), followed by priming conditions that overlapped with the target in five letters (445 ms), four letters (448 ms), three letters (456 ms), one letter (470 ms), and naming was slowest in the neutral control condition (483 ms). Except for the 3 ms differences, all differences between the priming conditions were significant ($p < .05$ for both $t$ values) as revealed by Newman-Keuls post-hoc comparisons.

3. Conclusion

As predicted by the segmental overlap hypothesis, the priming effects increased with an increased segmental overlap between prime and target. This result is in line with the results obtained in the previous two experiments, indicating that the segmental overlap effect is not artificial. The effect is consistent across different tasks (word and picture naming), syntactic word classes (nouns and verbs), and different materials (Experiment 1 and 3). It may be concluded that only segments but not syllables play a functional role in Dutch speech production, at least at early stages of phonological encoding.
4. References


