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# The Role of Intra-word Constituents in Word Naming in Adult Speakers of English as Second Language

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**Abstract:** The influence of intra-word constituents on word naming latency in English as second language in an Indian context is not well known. The study investigated the effects of orthographic, phonological, and unrelated word primes on monosyllabic ($C_1V_1C_2$) word naming in comparison with a control condition, at 50 and 100 ms prime durations in a masked-priming paradigm. The orthographic primes were facilitative in accordance with the segmental overlap hypothesis only at 100 ms, while the phonological and unrelated primes exhibited interference effects contradicting the findings of studies with English as the first language.

**Keywords:** masked-priming, word naming

## 1. Introduction

The process of naming a word represented as a sequence of letters requires the recognition of both the intra-word and whole-word information, as the case may be. The former largely utilizes the orthographic to phonological conversion route of word naming while the latter draws support from the orthographic input lexicon and produces the target through the corresponding phonological output lexicon (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). The two routes however are not exclusive and principles such as cohort and spreading of activation testify this, where intra-word entities guide the selection and operation of whole-word processes.

The effects of the orthographic and phonological codes that may be implicitly operational during word naming are examined using reaction times measured on priming based experiments. The masked priming paradigm (e.g.: Evett & Humphreys, 1981) which involves the presentation of a forward and backward mask on either sides of the prime has been used extensively in automatic processing experiments to ensure that prime visibility is reduced which in turn effects the action of implicit mechanisms alone. The nature of the prime governs the interpretation of the influence of the processes involved in word naming. As early as 1994, Ferrand, Grainger and Segui found that the extent of orthographic overlap between a prime and target was decisive in faster word naming responses for targets preceded by overlapping primes. The facilitative effect of repetition priming (where the prime is the same as the target) has been documented unequivocally (e.g.: Forster & Davis, 1991; Schiller, 2000) while partially overlapping primes have exhibited language specific differences.

The findings of Chen, Chen and Dell (2002) in Mandarin Chinese revealed the absence of facilitation through initial phonemes, where as syllabic primes were facilitative. The functional unit of word naming in French was also found to be a complete syllable (e.g.: CV, CVC etc.) by Ferrand, Segui and Grainger in 1996. On the contrary, Schiller (1998) and Roelofs (2006) documented increased facilitation by CVC compared to CV, and facilitation even by the first phoneme in Dutch. Schiller (2000) found the same to be true even in English and came up with a segmental overlap hypothesis that the extent of priming corresponds with the extent of segmental overlap between the prime and target items. Verdonschot et al. (2011)

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investigated the functional unit of word naming in Japanese Kana using masked priming. They found that only when the whole mora was overlapping with the target did facilitation occur.

With reference to the effect of phonological overlap (homophonic and rhyming words) between orthographic primes and target words, research has strongly supported the presence of phonological priming effects in word naming across languages with deep (Chinese - Tan & Perfetti, 1998) and shallow (Serbo Croatian - Carello, Turvey & Lukatela, 1992) orthographies. Zeigler, Ferrand, Jacobs, Rey and Grainger in 2000 also found that word naming was significantly facilitated by phonological primes in English.

The presence of language specific differences direct one towards speculations regarding the possibilities of variations in priming effects in second language speakers. It may be possible that the effects would be influenced by the first language, particularly when the second language is learned rather than acquired. Also, the relative impact of explicit processes used in second language learning in place of the implicit processes used in first language acquisition (Kescskes & Albertazzi, 2007) may differentially influence orthographic segmentation and phonological activation leading to specific patterns of priming effects.

The present study was thus conceptualized to investigate the role of orthographic and phonological information in facilitating word naming in English as a second language in an Indian context. Only monosyllabic (CVC) words were considered as targets to rule out the effects of word length on naming. Six different types of primes were chosen and each was presented in two different prime durations (50 and 100 ms). The duration of the prime for 50 ms was considered as in Verdonschot et al. (2011) and the 100 ms primes were added to study the effects of introducing a relatively more visible prime. Three of the prime types comprised orthographic overlaps in a step-wise manner. The fourth, fifth and sixth prime types were rhyme-words, unrelated words and a control condition respectively. We hypothesized that the orthographically overlapping primes would follow the segmental overlap hypothesis to demonstrate step-wise speeding of reaction times with increased overlap. We also hypothesized that the rhyme-word primes would be facilitative as in native English speakers and that the unrelated word primes would exhibit interference.

## 2. Method

### 2.1. Participants

30 typical individuals (23 females, 7 males) aged between 23 and 25 years were considered for the study. All the individuals had English as their second language which was formally introduced in school beyond three years of age. Minimal exposure to English prior to schooling was also present. They were native speakers of Indian languages (Kannada - 16, Malayalam - 10, Telugu - 2 and Hindi – 2). All the participants were multilinguals with knowledge of atleast one Indian language apart from their native tongue. All the participants had normal or corrected to normal vision.

### 2.2. Stimuli

The stimuli were specifically designed for the priming experiment. A list of monosyllabic three letter words was made through a serial search of the words beginning with letter ‘b’ to those beginning with letter ‘t’ from the Webster’s New World College Dictionary (Agnes, 2000). Only those words were chosen that followed the $C_1V_1C_2$ structure both in terms of phonology and orthography. Also, words that were proper nouns, historical or mythological names and scientific unit labels were excluded. Thus, a total of 256 words were listed. These words were then read by three second language speakers of English in the same age range as the participants. All the words that were pronounced with difficulty or erroneously by any of the three speakers were deleted following which the list was left with 242 words. Two more words were deleted using the lottery method to arrive at a final set of 240 words which formed the ‘target’ words for the experiment.

These words were divided in six lists of 40 words each using $n^{th}$ item sampling to ensure that words beginning with each of the consonants considered were almost equally distributed in each list. The six lists were delineated to assign specific types of primes to each of them using the lottery method. The words of the first three lists were paired with $C_1$%%, $C_1V_1$% and $C_1V_1C_2$ primes respectively, corresponding with the target $C_1V_1C_2$ word. The fourth list comprised words that were paired with rhyming words (words with initial consonant substitution - $C_3V_1C_2$) for priming. The words in the fifth list were paired with words having no

letter overlap with the target word ($C_3V_2C_4$). The final list of words was used as the control condition with no letter-based prime (%%%) preceding the target word. The '%' symbol was used in the letter primes to ensure that the absolute length of the prime did not vary with that of the target. Then, the stimuli were programmed using the DMDX software. A fixation point (*) was used at the beginning of each item. The prime-target pairs were embedded in the masked priming paradigm with forward (###) and backward (###) masks of 500 and 15 milliseconds respectively. Each of the six lists was programmed in two conditions, one with a prime duration of 50 milliseconds and another with a prime duration of 100 milliseconds. Thus, a total of 12 conditions constituted the experiment. A set of stimuli for practice was also designed, which did not comprise any item considered for the main experiment.

### 2.3. Procedure

Each participant was seated comfortably in a well lit and quiet room facing a 17 inches laptop screen aligned for participant directed visibility. The participants were then asked to read aloud the target words once so as to get familiar with the list. A microphone (Mipro MM-107) connected to the laptop for recording the responses in Check Vocal software was given to the participants and were made to hold the same within a range of about five to seven inches from the lips. The participants were instructed to look at the screen from the time the fixation point appears, look through the pieces of information flickering at a fast rate and name/read the word that remains relatively still (2000 ms), as soon as possible. Details regarding the nature of the entities preceding the target word were not disclosed. Practice trials were given prior to the actual task till the participants performed as per requirement. The experiment was carried out in four sets of three lists each with a time gap of around two minutes between sets. The sets with a prime duration of 50 milliseconds were presented first.

### 2.4. Analyses

The naming responses of each of the participants were analysed for onset reaction times by marking the cursor manually using the visual spectrographic and waveform representations and auditory perceptual matching facility in Check Vocal software. The average reaction time of the correctly produced responses of each participant in each list was considered to compute the group mean and standard deviation (SD) values; and for further statistical analyses across the 12 conditions using SPSS version 17 software.

## 3. Results and Discussion

The mean and SD values across the 12 prime-target conditions are shown in Table 1.

Table 1: Mean and SD of the 12 prime-target conditions.

| Condition | Mean | SD | Condition | Mean | SD | Condition | Mean | SD |
|---|---|---|---|---|---|---|---|---|
| $C_1$%% at 50 | 536.93 | 81.07 | $C_3V_2C_4$ at 50 | 586.80 | 78.93 | $C_1V_1C_2$ at 100 | 446.06 | 72.96 |
| $C_1V_1$% at 50 | 520.80 | 80.68 | %%% at 50 | 568.43 | 78.44 | $C_3V_1C_2$ at 100 | 592.76 | 76.90 |
| $C_1V_1C_2$ at 50 | 508.40 | 80.64 | $C_1$%% at 100 | 499.53 | 73.88 | $C_3V_2C_4$ at 100 | 590.10 | 69.01 |
| $C_3V_1C_2$ at 50 | 583.50 | 81.84 | $C_1V_1$% at 100 | 478.13 | 67.83 | %%% at 100 | 560.70 | 72.87 |

The 12 conditions were then compared using Repeated Measure ANOVA [$F(11, 319) = 66.494$] and a statistically significant difference ($p < 0.001$) was obtained. The Bonferroni's test was used for further analyses. The results of the adjusted multiple comparisons are shown in Table 2.

Table 2: Table of pair-wise differences on Bonferroni's adjusted multiple comparisons at $p < 0.05$.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | S | S | S | S | NS | | | | | | |
| 2 | | | NS | S | S | S | | | | | | |
| 3 | | | | S | S | S | | | | | | |
| 4 | | | | | NS | S | | | | | | |
| 5 | | | | | | S | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | NS | NS | NS | S | S | S | | S | S | S | S | S |
| 8 | S | S | NS | S | S | S | | | S | S | S | S |
| 9 | S | S | S | S | S | S | | | | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | S | S | S | NS | NS | S | | | | | NS | S |
| 11 | S | S | S | NS | NS | NS | | | | | | S |
| 12 | NS | NS | S | NS | NS | NS | | | | | | |

Note: 1-$C_1$%%, 2-$C_1V_1$%, 3-$C_1V_1C_2$, 4-$C_3V_1C_2$, 5-$C_3V_2C_4$, 6-%%% (1-6: at 50 ms), 7-$C_1$%%, 8-$C_1V_1$%, 9-$C_1V_1C_2$, 10-$C_3V_1C_2$, 11-$C_3V_2C_4$, 12-%%% (7-12: at 100 ms), NS - not significant and S - significant

In the 50 milliseconds prime conditions, the results reveal significant differences between the control condition and all the other conditions barring $C_1$%%. There are no significant differences between $C_1V_1$% and $C_1V_1C_2$ and between $C_3V_1C_2$ and $C_3V_2C_4$ conditions. On observation of the mean scores, it is evident that the $C_1V_1$% and $C_1V_1C_2$ conditions are facilitative while the $C_3V_1C_2$ and $C_3V_2C_4$ are interfering. In the 100 millisecond prime conditions, the results reveal significant differences between the control condition and all the other conditions. There is no significant difference between $C_3V_1C_2$ and $C_3V_2C_4$ conditions. Observation of the mean scores reveals that all the three orthographic prime conditions are facilitative and $C_3V_1C_2$ and $C_3V_2C_4$ are interfering. The findings suggest that a stepwise facilitation by the three overlapping conditions is true such that the greater the extent of overlap, the faster the naming response for a prime duration of 100 ms and is in consonance with the segmental overlap hypothesis (Schiller, 1998; 2000). It may also be considered as a support for cohort based activation (Marslen-Wilson, 1987) with lesser competition for lexical access as the sequence of letters unfolds. However, the scenario is slightly different for 50 ms primes, with no facilitation of word naming with the initial letter alone and almost equal facilitation observed for a two or three letter overlap in the prime. Thus, the segmental overlap hypothesis is found to be dependent on the temporal aspects in the considered population.

The findings regarding the rhyme-word prime are in stark contrast to that observed in native speakers of the language (Evett and Humphreys, 1981) for both prime durations. Instead of being facilitative, they cause interference to word naming latency. More interestingly, the extent of interference caused by the rhyme-word primes is equivalent to that caused by the unrelated word primes. This may possibly imply that second language speakers of English who learn the language through explicit means may be weaker at automatically processing the phonological overlap between words. The interference being equivalent to the unrelated word prime condition implies that in both these conditions, alternate phonological units are activated which contradict the target activation and thereby requiring a longer time to suppress the unwanted entity and activate the required item for further production.

The findings of the comparisons between the 50 and 100 ms conditions reveal that the two control conditions and the four interfering conditions are not significantly different. However, the absence of a difference between the control condition for the 50 ms primes and $C_3V_2C_4$ at 100 ms may be indicative of a lesser degree of interference caused by the unrelated prime compared to the rhyme-word prime. There are no significant differences between the control condition of the 100 ms primes and two interfering conditions at 50 ms ($C_3V_1C_2$ and $C_3V_2C_4$), $C_1$%% and $C_1V_1$%. The findings point towards a general weaker effect of primes presented for a very short duration of 50 ms. Only the repetition prime is strong enough even at 50 ms although its strength is lesser in comparison with the corresponding prime at 100 ms. Also, the effect of the initial letter overlap prime of 100 ms is found be equivalent to the effect caused by all the facilitating primes of 50 ms. The $C_1V_1$% and $C_1V_1C_2$ primes of 100 ms are found to be more facilitating than their corresponding primes of 50 ms. The effect of $C_1V_1$% at 100 ms is found be equivalent to the effect of $C_1V_1C_2$ at 50 ms. These again imply that a prime duration of 100 ms is more facilitating when segmental overlap is present than a prime duration of 50 ms. This difference cannot be attributed to factors other than automatic processing as the participants did not sufficiently recognize the relationship between the primes and targets in both the prime duration conditions.

In sum, the hypothesis that the orthographically overlapping primes would follow the segmental overlap hypothesis to demonstrate step-wise speeding of reaction times with increased overlap has been proven to be true, atleast for the prime duration of 100 ms. The absence of the same effect at 50 ms calls for further exploration as a function of prime duration. The second hypothesis that the rhyme-word primes would be facilitative and the unrelated word primes would be interfering has been rejected with reference to second

language speakers of English. Instead, an alternate hypothesis has emerged that both rhyme-word primes and unrelated word primes exhibit interference effects on word naming in second language speakers of English.

## 4. Conclusions

The findings of the present study indicate that second language processing, irrespective of receiving education in the same, does not mirror first language processing with reference to intra-word constituents' effects on word naming. On the one hand, phonological priming effects are reversed and on the other, the findings point towards the presence of similar implicit processing mechanisms in terms of orthographic priming effects in second language speakers and the reported literature on first language speakers of English. These may be attributed to the inherent differences between the acquisition of the first language and learning of the second language, with the former introduced through the auditory-phonological channel and the latter primarily through the visual-orthographic channel, during schooling. It remains to be seen however, whether these intra-word constituents exhibit these effects on words more complex than the simple $C_1V_1C_2$ in second language speakers of English.

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