Bengali geminates in the mental lexicon

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This paper reports on a series of ERP and behavioural studies with native speakers of Bengali and addresses the question of how length, in particular consonant length, is represented in the mental lexicon. Since duration contrasts are invariably relative ('long' is longer than 'short' but with no absolute value), how do listeners process consonantal length when there are no other salient acoustic cues to differentiate between these consonants? For example, the closure duration (which is the primary cue) of a long consonant can vary between approximately 90 - 200 ms (Lahiri & Hankamer 1988) while for a short consonant it can be between 40 - 90 ms.

To investigate this question we used both behavioural and brain-imaging techniques examining the word medial geminate-singleton contrast in Bengali where this contrast is very productive. Bengali geminates and singletons contrast only word medially and all singleton consonants have geminates counterparts, except for /r/ which only occurs as a singleton (e.g. [pata] 'leaf' [pat:a] 'whereabouts'). The diachronic source for this synchronic set of underlying geminates is twofold: inherited geminates and those derived originally from consonant sequences such as C+/j/ ([bakjə] > [bak:o] 'speech'). However, gemination is also a synchronic morphophonological process where the combination /r/ + coronal C > coronal C-geminate ([mar-t-o] > [mat:o] 'beat-PAST-3P'). Sequences of heteromorphemic consonants also lead to surface geminates (e.g. [kʰel-l-o] > [kʰel:o] 'play-PAST-3P'). Furthermore, morphemes with underlying geminates have also developed such as the progressive /tʃʰ:/ ([kʰa-tʃʰ:-i] > [kʰatʃʰ:i] 'eat-PROG-1P'). Thus consonant length contrast is well established in the phonological grammars of native Bengali speakers. Our experiments, which were conducted in Kolkata (Standard Colloquial Bengali), only tested words with underlying geminates word medially.

The first two sets of experiments were cross-modal semantic priming experiments, (behavioural: 88 participants, EEG: 44), with auditory primes and visual targets (ISI for behavioural: 0 msec; ISI for EEG: 250 msec). Two sets of disyllabic words were chosen as auditory primes; words with medial lexical singletons with no corresponding geminate counterparts, and words with underlying medial geminates with no corresponding word that had a medial singleton. Pseudoword primes were created by shortening or lengthening this medial consonant to create the corresponding (fake) geminate or singleton, e.g., *ʃona* 'gold'~ **ʃonna*; *ʃunno* 'zero'~**ʃuno*. Both ERPs (specifically N400) and reaction times were measured. One aim was to investigate whether an incorrect geminate pronunciation would have the same effect as an incorrect singleton. Would **ʃonna* activate the word semantically related to *ʃona* in the same way as **ʃuno* would activate the semantically related word to *ʃunno*? Would more or less consonantal information help or hinder lexical activation, or would incorrect duration be ignored?

Condition	Auditory Prime	Visual Target	Hypothesised priming (control-test)	RT Priming Results	Hypothesised N400	N400 Results
test (word)	*ʃona* 'gold'	*rupo* 'silver'	yes	20ms**	low	low
control (word)	*jala* 'burn'				high	high
test (*word)	**ʃonna*		**?**	32ms**	**?**	low
control (*word)	**jalla*				high	high
test (word)	*ʃunno* 'zero'	*khali* 'nothing'	yes	15ms**	low	low
control (word)	*aḍḍa* 'gossip'				high	high
test (*word)	**ʃuno*		**?**	3ms	**?**	high
control (*word)	**aḍa*				high	high

Significant semantic priming (indicated by **) is observable for real words in both RT and N400 measures. However, we also find significant priming and lower N400 with pseudowords, but only when the real word is a singleton. That is, the pseudoword **ʃonna* (mispronunciation of *ʃona*) primes *rupo* with a lower N400 compared to its control, but **ʃuno* (mispronunciation of *ʃun:o*) does not prime *khali*. These results show that a perfect match of consonantal length information was not necessary for lexical activation. However, while more information facilitates the recognition of the semantic associate of the real word, less information does not result in facilitation but neither does it have an inhibitory effect.

To investigate whether this asymmetry is also evident in pre-attentive auditory processing, we conducted a mismatch negativity (MMN) study. Bengali word/pseudoword pairs which only differed in the duration of the medial consonant ([g^{h}en:a]/*[g^{h}ena] and [kena]/*[ken:a]) were presented in a standard oddball paradigm (15% deviants). The results show a latency difference with the singleton pseudoword *[g^{h}ena] being significantly slower than the real word geminate [g^{h}en:a] while [kena]/*[ken:a] peak at similar latencies. The asymmetry is thus already evident in pre-attentive processing despite the distance of deviance in the stimuli being identical (which is evidenced by the lack of amplitude difference between conditions). In the case of a pseudoword, where there is no available lexical representation, the MMN response is slower than when a lexical entry can be accessed. This is in line with previous evidence that the MMN also reflects higher cognitive processes and access of linguistic long-term memory traces and lends support to the theory that the singleton pseudoword (*[g^{h}ena]) is treated as a pseudoword while the geminate pseudoword *[ken:a] elicits the same pattern as the corresponding real word [kena].

Our findings for Bengali medial geminates demonstrate an asymmetry in the processing of underlying geminates and singletons. These results provide greater insight into the processing of linguistic duration and how this is mapped onto a representation of length in the mental lexicon. Two scenarios are conceivable: geminates are either represented by a weight (mora) or a length specification (two X-slots) in the lexicon while singletons have no weight or only one X-slot. A geminate mispronunciation subsumes the singleton real-word representation because all other (featural) information is identical. However, when a geminate is mispronounced as a singleton, either the weight specification, i.e. a mora, is lacking, or an X-slot is missing, which does not match a geminate representation and activation fails. Thus, full lexical access is achieved through a mispronunciation only if there is sufficient duration in the acoustic signal to map onto the weight/length specification of the corresponding real word.

All in all, these results indicate a difference in the specificity of the representations which results in the asymmetry because the information in the acoustic signal of a geminate consonant does not mismatch with the representation of a singleton while the acoustic information of a singleton creates a mismatch with the lexical entry of a geminate. We have argued earlier that the one possible strategy to identify contrasts despite variation could be to keep contrast sensitivity asymmetric (Lahiri & Reetz 2010). This strategy makes sense when the overall detection rate across all possible contrasts is higher as compared with a situation in which the contrast sensitivity is kept symmetric for all relevant contrasts. This is borne out by the asymmetric activation of mispronunciations of duration contrasts as well as featural contrasts.

References

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Lahiri, Aditi, and Henning Reetz. 2010. “Distinctive Features: Phonological Underspecification in Representation and Processing.” *Journal of Phonetics* 38: 44–59.