

Memory for allophonic variants in event-related potentials

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A phoneme is the smallest sound unit that can distinguish word meaning [1]. An allophone, by contrast, does not change meaning but is a surface realization that can vary by phonetic environment and accent. For example, /t/ is a phoneme that is often produced as a tap [ɾ] in intervocalic position in American English (e.g., *city* ['sɪɾi]) and as a plosive [t] in the same environment in Southern British English (e.g., *city* ['sɪti]) [2].

A previous study demonstrated phonemic categorization using event-related fields [3]. In the varying-standard oddball paradigm, participants categorized varying standards as the phoneme /d/, and a neural discriminative response (i.e., mismatch field; MMF) was elicited when /t/ was presented as a deviant. This supported the idea that phonemes are stored in memory. Using the varying-standard oddball paradigm, the present study examined whether allophonic variants of /t/ (i.e., the tap [ɾ] and the plosive [t]) are stored in the memory of American and Southern British English speakers.

In this event-related potential (ERP) experiment, the words *fleeing* and *fleeting* were used as stimuli. The word *fleeting* was recorded by a Southern British English speaker, and the duration of /t/ was manipulated. The 0 ms /t/ stimulus was identified as *fleeing* with no /t/ and judged as participants' own accent by both American and Southern British English speakers in a behavioral pre-test. When /t/ was present, shorter /t/ durations (i.e., 30–50 ms) were perceived as *fleeting* with an American English accent (i.e., a tap [ɾ]), whereas longer durations (i.e., 70–90 ms) were perceived as *fleeting* with a Southern British English accent (i.e., a plosive [t]; see Fig. 1). After confirming these allophonic distinctions between accents in the pre-test, participants' ERP responses were recorded.

Table 1 shows the three experimental conditions, each including two deviants against either varying or single standard/s. In Condition A, multiple tap [ɾ] tokens of *fleeting* (30–50 ms /t/) were presented as varying standards. Against the deviant *fleeing* with no /t/ (0 ms), a neural discriminative response (e.g., mismatch negativity (MMN) or late discriminative negativity (LDN)) was predicted to be elicited. As for the other deviant, a plosive [t] in *fleeting* (80 ms), if American English speakers stored the allophonic variant (tap [ɾ]) in memory and grouped the varying standard stimuli as the allophone, MMN or LDN would be elicited [4].

In Condition B, multiple plosive [t] tokens of *fleeting* with the duration of 70–90 ms were presented as varying standards. Here, we predicted MMN or LDN in response to the deviant *fleeing* with no /t/. As for the other deviant with a tap [ɾ] (40 ms), if Southern British English speakers stored the allophonic variant (i.e., plosive [t]) in memory and grouped varying standard stimuli as the allophone, MMN or LDN would be elicited.

Condition E also employed an oddball paradigm but this time with only the word *fleeing* with no /t/ (0 ms) as a single standard stimulus. Both allophonic variants of *fleeting* with a tap [ɾ] (40 ms) and a plosive [t] (80 ms) were the deviant stimuli. The ERP amplitudes of the word *fleeing* in Conditions A and B were compared to that of the same stimulus in Condition E.

Fig. 2 displays the ERP amplitudes of difference waves for acoustically identical stimuli either presented as a standard or a deviant across conditions, collected from American English speakers. Neural discriminative responses were observed for the stimuli of *fleeing* without /t/, suggesting that the brain stores the phonological category of /t/. The results from both American and Southern British English speakers will be presented at the conference to discuss whether the brain stores allophonic variants.

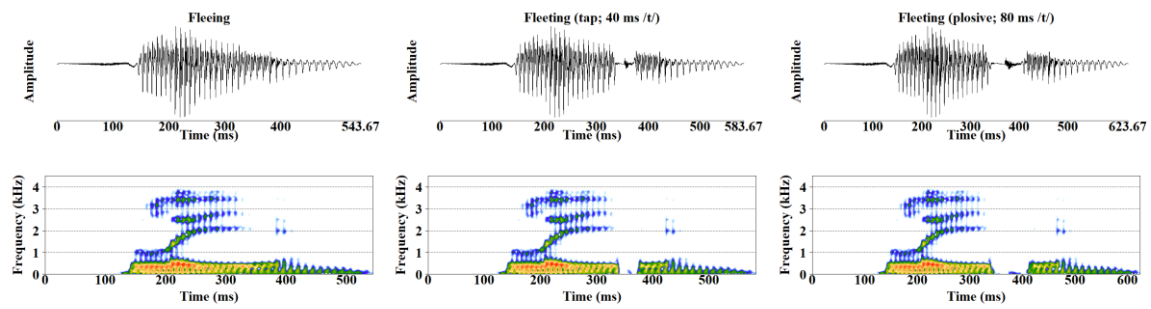


Fig. 1. Stimuli of *fleeing* with no /t/ (left; S11), *fleeing* with the 40 ms /t/ (middle; S41, S42, and S45), and *fleeing* with the 80 ms /t/ (right; S91, S92, and S95).

Table 1. Conditions and stimuli used in the ERP experiment.

Stimulus/Condition	A	B	E
0 ms /t/	S11 (dev) 150 trials	S12 (dev) 150 trials	S15 (stn) 1200 trials
30 ms /t/	S21 (stn) 240 trials		
35 ms /t/	S31 (stn) 240 trials		
40 ms /t/	S41 (stn) 240 trials	S42 (dev) 150 trials	S45 (dev) 150 trials
45 ms /t/	S51 (stn) 240 trials		
50 ms /t/	S61 (stn) 240 trials		
70 ms /t/		S72 (stn) 240 trials	
75 ms /t/		S82 (stn) 240 trials	
80 ms /t/	S91 (dev) 150 trials	S92 (stn) 240 trials	S95 (dev) 150 trials
85 ms /t/		S102 (stn) 240 trials	
90 ms /t/		S112 (stn) 240 trials	

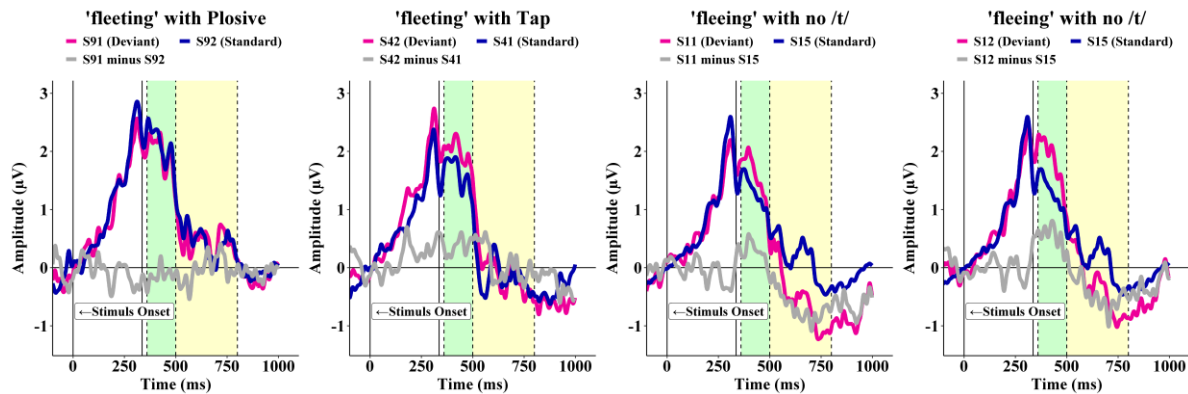


Fig. 2. ERP amplitudes of difference waves for *fleeing* with a plosive [t] (S91 – S92), *fleeing* with a tap [ɾ] (S42 – S41), and *fleeing* with no /t/ (S11 – S15 and S12 – S15), collected from American English speakers (Electrodes: Fz, Cz, FC1, and FC2).

References

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