Lexical tones, which are pitch information used to distinguish lexical meanings, are an important phonological property in tonal languages. However, it remains hotly debated how lexical tones are planned in the phonological encoding stage of word production. Whereas some researchers proposed that lexical tones are independently retrieved and encoded in ways similar to segments in production [1, 2], other researchers proposed that lexical tones are encoded like metrical stress in non-tone languages [3, 4, 5]. Moreover, the relative encoding timing of lexical tones is also unclear. Some researchers suggested that lexical tones are encoded at the early stage together with syllabic information [5, 6], whereas other researchers indicated that lexical tones may be encoded at a later stage [7, 8]. To address these issues, we employed a phonologically-primed picture naming task and utilized the high temporal resolution of electroencephalography (EEG) to investigate the encoding process of lexical tones in overt Mandarin Chinese word production.

Forty native Mandarin speakers (21 males) from North China were asked to produce the disyllabic names of 104 target pictures and 52 filler pictures while their oral responses and EEG signals were recorded. Each picture was preceded by a monosyllabic visual prime, presented together with its auditory form. We manipulated the tonal relatedness and syllabic relatedness of the primes in relation to the initial morpheme of the target picture names (e.g., 鹦鹉, ying1-wu3, ‘parrot’), resulting in four prime conditions: (1) homophone prime (e.g., 英, ying1, sharing the syllable and tone); (2) syllable-overlap prime (e.g., 营, ying2, only sharing the syllable); (3) tone-overlap prime (e.g., 綢, gang1, only sharing the tone); (4) unrelated prime (e.g., 悖, bei4, phonologically unrelated). The behavioral results (Fig.1A) revealed that there was a significant interaction between tonal and syllabic relatedness. The syllable-related primes (homophone and syllable-overlap prime) yielded significantly shorter naming latencies than the other syllable-unrelated primes. Moreover, the homophone prime yielded significantly shorter onset latencies than the syllable-overlap prime conditions, but the tone-overlap prime exhibited significantly longer onset latencies than the unrelated prime. This suggested that additional tonal overlap facilitated the production only when the syllabic information could be prepared but hampered the production when the syllabic information was not readily prepared. Regarding the EEG data, the analysis of the stimulus-locked ERP (i.e., ERP time-locked to the picture onset; Fig.1B) only revealed there was an early tonal relatedness main effect in the 250–350 ms time window (with more negativity in left frontocentral regions for tonal related primes than tonally unrelated primes), and a later syllabic relatedness main effect in the 350–500 ms time window (with larger negativity in left frontocentral regions but more positivity in right frontal region and bilateral posterior regions for syllable-related primes than syllable-unrelated primes). In contrast, analysis of the response-locked ERP (i.e., ERP time-locked to the speech acoustic onset; Fig.1C) revealed that an early syllable-relatedness effect in the -450~-250 ms time window (with more negativity in frontocentral regions but more positivity in posterior regions for syllable-related primes than syllable-unrelated primes), but a significant interaction between tonal and syllabic relatedness in the -250--100 ms time window. Further analysis showed that the homophone prime elicited larger negativity in left frontocentral regions than the syllable-overlap prime, but no difference was observed between the tone-overlap prime and the unrelated prime. These results indicate that lexical tones can be independently retrieved in an earlier time window than the syllable at the phonological encoding stage, but need to be planned and integrated with the syllable at the later phonetic encoding stage.
Fig. 1 (A) Mean RTs (in ms) for different prime types; (B) Stimulus-locked average ERPs in representative electrodes (FC5 and POZ) and (C) Response-locked average ERPs in representative electrodes (FC5 and POZ).

References: