The processing in the brain of the temporal concord of aspect markers in Mandarin has attracted the attention of researchers, but the picture is not complete yet. This study focuses on GUO, the phonological realization of the two morphemes guo₁ and guo₂. They occur with time adverbs of different natures: guo₁ with indefinite time adverbs ('in the past'), guo₂ with definite time adverbs. The ERP results show that guo₁ temporally violated elicits a biphasic N400-P600, and guo₂ a P600, suggesting common cognitive processes ('localization') between the two, and specific cognitive process ('existential') for guo₁, in line with their linguistic analyses.

1 Introduction

1.1 The multidimension of the perception of an event in time

The time at which an event occurs can be perceived in different ways by the human cognition (Baggio et al., 2012). For instance, an event can be seen as located in time according to the time of speech ('temporal localization'). Conversely, it can be placed in time by taking another event as its reference, such that the event in question is located in a sequence of two events ('temporal sequencing'). Another facet of the cognitive perception of time concerns the existential status of the event: events placed in the past and in the present are more likely to be taken as real, and events in the future as unreal (Lyons, 1977). Such cognitive ways to perceive time have correlates in language. 'Tense' in its traditional definition expresses the temporal localization of an event (Comrie, 1985), but it can also be used to refer to events in a sequence (Klein, 1994). Similar claims can be made for 'aspect'. When it comes to the occurrence of an event in time, perfective aspect can exhibit a temporal sequencing meaning. Some aspect markers may also be used to express temporal localization as well (Iljic, 2010).

1.2 Expressing temporal reference in Mandarin with aspect markers and their neuronal processing in temporal concord violation paradigms

Mandarin is considered as a tenseless language, i.e., it does not have morphemes encoding tense distinctions, but several aspect markers can be used to express temporal relations. Among them, the postverbal morphemes -le and -guo are analyzed as expressing different cognitive facets of time: temporal sequencing for -le (Woo, 2018), temporal localization for -guo (Iljic, 2010). Interestingly, -le and -guo are grammatical when occurring with a deictic past time adverb, but not with a deictic future time adverbs. See (1).

(1) Zhangsan zuotian/*mingtian jiao-le / jiao-guo yangtai de hua.  
Zhangsan yesterday/*tomorrow pour-LE / jiao-GUO balcony DE flower  
'Zhangsan (already) poured the flowers on the balcony yesterday/*tomorrow.'

The verb you ‘to have’ has grammaticalized into a verbal auxiliary in some Mandarin-speaking regions, expressing the temporal existence of the event (Collart & Su, 2022). Similar with -le and -guo, ‘you + VP’ exhibits the same temporal concord violation. See (2).

(2) Zhangsan zuotian/*mingtian you jiao yangtai de hua.  
Zhangsan yesterday/*tomorrow have pour balcony DE flower  
'Zhangsan poured the flowers on the balcony yesterday/*tomorrow.'
of ‘you + VP’ was reflected by a N400 component on the verb, taken as indicating the violation of the existence of the event in time (Collart, 2018). Overall, it appears that the aspect markers in Mandarin placed in temporal concord configurations can be used to express the different cognitive perceptions of the occurrence of the event in time, and this idea finds supportive evidence from electrophysiological data.

1.3 Distinguishing between guo, and guo2: The present study

However, the picture is not complete. The linguistic literature points out that -guo is the phonological realization of two distinct morphemes: guo1 (‘experiential guo’), expressing the existence and the localization of the event in time, and guo2 (‘phasal guo’), only indicating the localization of the event in time (Iljic, 2010; Collart, 2022). Syntactic tests support this distinction: (a) guo1 can appear with the negation mei, but not guo2, (b) guo2 can occur with -le, but not guo1, (c) guo1 appears after indefinite deictic time adverbs (e.g., yiqian ‘in the past’), guo2 after definite deictic time adverbs (e.g., zuotian ‘yesterday’). Crucially, the temporal concord violation pattern is also found for guo1 as well (see (3), to compare with (1)).

(3) Zhangsan yiqian/*yihou jiao-guo (*-le) nüwang de hua.  
Zhangsan in.the.past/*in.the.future jiao-GUO1 (*-LE) queen DE flower  
‘Zhangsan poured the queen’s flowers in the past/*in the future.’

The present study proposes to investigate the neuronal processing of the temporal concord violation of guo1 and to compare with the one of guo2 in order to determine whether the different linguistic analyses are reflected in their neurophysiological processing. To do so, the processing of sentences as in (1), involving guo2 (for which the brain process has already been explored) is compared with sentences as in (2), involving guo1. Different predictions can be made based on their linguistic analyses and previous ERP results: (a) if guo1 is used to express both temporal existence and temporal localization, then its temporal concord violation is expected to elicit a biphasic N400 + P600 response, while only a P600 is expected for guo2; (b) if the brain does not distinguish between guo1 and guo2 concerning the processing of their temporal concord violation, the same ERP component is expected: A P600 effect.

2 Methodology

2.1 Participants

The participants were 24 native speakers of Mandarin (14F, mean age: 26.2 y.o., range: 20–40 y.o.), right-handed and without brain disorder. They signed a consent form approved by the Center for Research Ethics of National Taiwan Normal University.

2.2 Materials

The material was the same as in Collart & Chan (2021), except for the deictic time adverbs: the definite time adverbs were zuotian ‘yesterday’ and mingtian ‘tomorrow’, the indefinite time adverbs were guoqu ‘in the past’ and weilai ‘in the future’, and not yiqian/yihou to avoid ‘past in the past/future’ interpretation. The 272 sentences, dispatched into four lists with a Latin square design (34 per condition + 136 fillers to counterbalance the grammaticality of the sentences) were tested for naturalness in an online pilot study (74 participants who did not take part in the ERP experiment, 7-point Likert scale).

2.3 Procedure and data acquisition

The procedure and data acquisition parameters replicated the ones in Collart & Chan (2021).

2.4 Preprocessing pipeline and statistical analyses

The preprocessing pipeline and statistical plan in Collart & Chan (2021) was adopted, except for the length of the ERP epochs. The epochs were computed starting from the onset of the deictic time adverbs and lasted until the end of the sentence (3200ms long). The ERP data
were analyzed with repeated-measure ANOVAs (DV = voltage, IV = Type (Definite vs. Indefinite, Grammaticality (Grammatical Vs. Ingrammatical), Anteriority (Frontal vs. Central vs. Posterior), Hemisphere (Left vs. Midline vs. Right) at two time windows.

3 ERP Results
The temporal concord violation involving definite adverbs only elicited a P600 (see Fig. 1), but a biphasic N400-P600 was found for the indefinite adverbs (see Fig. 2).

![Fig. 1. Panel A: ERP waves of the definite temporal concord conditions (black = grammatical, red = ungrammatical, negative voltage plotted upward). Panel B: topographic maps and boxplots of the difference wave at guo2 (ungrammatical minus grammatical; mean amplitude from -1.5 μv (blue) to +1.5 μv (red)) at the 300–500 and 500–700 ms time windows](image)

![Figure 2. Panel A: ERP waves of the indefinite temporal concord conditions (black = grammatical, red = ungrammatical, negative voltage plotted upward). Panel B: topographic maps and boxplots of the difference wave at guo1 (ungrammatical minus grammatical; mean amplitude from -1.5 μv (blue) to +1.5 μv (red)) at the 300–500 and 500–700 ms time windows](image)
These observations were statistically verified: only the Type x Grammaticality interaction was significant at the 300–500ms time window \((F(1,23) = 9.62, p < .01)\); only the main effect of Grammaticality was significant at the 500–700ms time window \((F(1,23) = 13.89, p < .01)\).

4 Discussion

The ERP results indicate distinct and also overlapping processing patterns for guo₁ and guo₂. Guo₁ elicited a N400 effect followed by a P600. The N400 can be seen as indicating the difficulty to integrate an event which is asserted as existing (meaning of guo₁) in a non-existing context (meaning of future time adverb). The P600 reflects the difficulty to locate an event perceived as be past (meaning of guo₁) in a future time context. Conversely, only a P600 was found for guo₂, which can be analyzed the same way as for the P600 elicited by guo₁. These results, coherent with the linguistic analyses of guo₁ and guo₂, are modelized in Fig. 3.

Finally, these results may even suggest a cognitive continuum between the meaning of the aspect markers in Mandarin and their ERP signatures: ‘you + VP’ (N400, existential) – guo₁ (N400+P600, existential+localization) – guo₂ (P600, localization) – -le (LAN, sequencing).

5 Conclusion

This study bridges linguistic analyses of the aspect markers guo₁ and guo₂ in Mandarin with their ERP responses as well as a tentative model with other markers. More insight could be given by comparing with the processing of tense markers in Indo-European languages.

Selected references


