The prediction of tone in written Chinese: a study on chéngyǔ

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Current models of prediction are underspecified regarding suprasegmental features (e.g., stress, tone). It remains unclear whether the brain anticipatorily represents these global properties or how they weight lexical pre-activation [1, 3]. This represents a significant gap, given their essential role in word recognition. This work investigates the role of tonal information in the visual recognition of highly predictable Chinese idioms, *chéngyǔ* (成语). In Chinese spoken language, tones are essential for distinguishing meanings between otherwise identical syllables. In written Chinese, tone is completely opaque: a phonetic radical can be related to the word's segmental phonology; however, no character feature is tone-related. The role of tone in predictive processing has only been studied in spoken language, using the Visual Word Paradigm [2, 5]. Recent Chinese evidence [5] suggests tone is not predicted independently, but only integrated with segmental information. This challenges traditional models of suprasegmental representation in the mental lexicon. We developed a new paradigm to investigate the role of tone in prediction. Phonological prediction is enhanced in high cloze contexts [4], so we used frequent and familiar Chinese idioms to induce strong predictions of the last character of the string. We designed a pilot, online task with a Rapid Sequential Visual Presentation. Our independent variable, tone, was manipulated across two conditions: (a) different tone (diffT), same segmental structure; (b) same tone (sameT), same segmental structure. Each item consisted of a whole *chéngyǔ*, with the critical condition being on the last character, which was substituted with a word that fit the conditions above. For the fourth character, subjects (N=28) performed a speeded *chéngyǔ* recognition task. Under the assumption that the tone of an expected word can be predicted in Chinese, we expect slower reaction times in rejecting fully homophones (sameT) wrong endings with respect to ones which share only segmental phonology (diffT). Accuracy and Reaction Times (RT) were analyzed using linear mixed models. Results show a very high accuracy all conditions ($M = 97.75\%, range = 92 - 100\%$). In addition, participants were more accurate in the segmental overlap (diffT) condition compared to the reference condition (correct) ($b = 1.99, SE = 0.76, z = 2.60, p < .05$). In contrast, there was no significant difference in accuracy for the homophonous condition (sameT) relative to the control condition ($b = -0.26, SE = 0.37, z = -0.71, p = .480$). Our manipulation does not yield a significant effect on RTs ($z = 1.70, p = .089$), despite this the model estimates a non significant numerical difference ($b = 30.46, SE = 17.92$) in line with our hypothesis with slower response times in the tonal overlap (sameT) condition. Despite results are not conclusive, since we expected effects on RT and not only on accuracy, we think the new proposed methodology, with appropriate adjustments of instructions, presentation modality and control of confound variables, can represent a promising tool to investigate non-segmental phonological predictions during reading. In particular, we planned some improvements for the upcoming replication of the experiment that will be presented at the conference: (i) increasing the participant sample to strengthen the statistical power; (ii) limiting across-subject variability in approach to the task by implementing a RT limit with an explicit feedback when the response time is slower than 2000 ms; (iii) adding a third condition with no phonological overlap, to adjust the interference effect of phonological activation.

References

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Figures and Tables

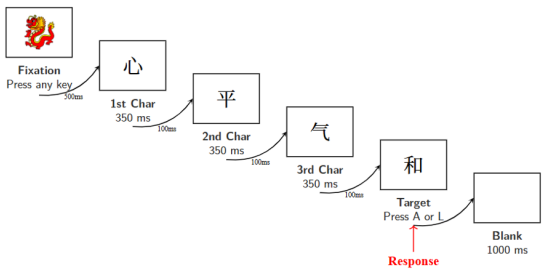

Figure 1: Experimental trial structure with timing parameters

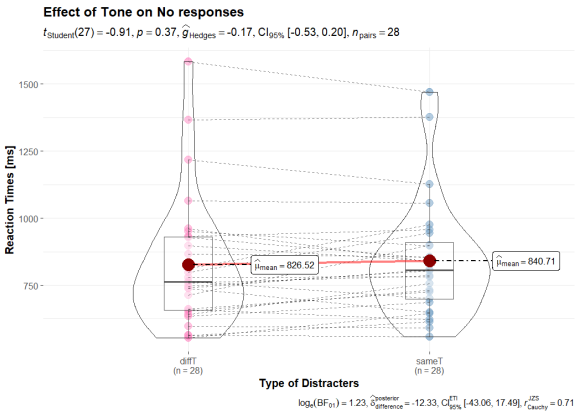

Figure 2: Mean Reaction Times for *no* responses across experimental conditions (aggregated by subject)

Conditions	Chinese character	Pinyin	English translation
Target	地	di4	Ground
Homophone (sameT)	弟	di4	Brother
Different tone (diffT)	邸	di3	Residence

Table 1: Examples of the target and the competitors for the *chéngyǔ tán tiān shuō dì* 谈天说地, lit. "say sky say earth", fig. "discuss of everything".

Optional Supplemental Information: Chinese idioms

Chéngyǔ (成语) are Chinese idiomatic sentences which have the highest value in terms of sociolinguistic reputation, since most of them have a literary origin. The figurative meaning is strictly linked to their cultural source, for this reason, their meaning cannot be inferred by the literal counterparts of the idiom. For example, the following chéngyǔ comes from an anedocte from the classical Taoist text *Liezi* (列子).

	愚	公	移	山
(1)	*yú*	*gōng*	*yí*	*shān*
	foolish	man	move	mountain

Literal meaning: A foolish man moves mountains

Figurative meaning: Perseverance in difficult times

They have unique characteristics, which make them particularly suitable for investigating predictive mechanisms. The high cultural value of *chéngyǔ* is reflected in their regularity: the quadrisyllabic form, in particular, comes from the classical literature. More than 90 % of Chinese idiomatic expressions have a fixed, four-character structure, which is their most prominent feature. The order of characters is unmodifiable, and they typically do not permit syntactic operations, such as adverb insertion or negation. *Chéngyǔ* can behave as both lexical units and complex structures (phrases). More than one-third of *chéngyǔ* is symmetrical in structure and semantics. It means that there is a bipartition between the first and the second part of the idiom, which exhibit the same syntactic structure. Moreover, they are also semantically symmetrical, since the two elements have either similar or opposite meanings.

	谈	天	说	地
(2)	*tán*	*tiān*	*shuō*	*dì*
	say	sky	say	ground

Figurative meaning: To discuss of everything

We decided to adopt *chéngyǔ* as our experimental stimuli, since they are (i) highly predictable; (ii) frequently used in everyday communication; (iii) structurally frozen and consistently formed of four monomorphemic words.