Automatic Activation and Processing of Color-Emotion Metaphors in Chinese-English Bilinguals: Evidence from ERPs

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INTRODUCTION

The representation and processing of ABSTRACT concepts is claimed to be based on embodied or metaphorical connections with perceptual, motor, and linguistic experiences (e.g. Barsalou, Boroditsky, Casasanto, Gibbs, Glenberg, Lakoff, Prinz). We previously demonstrated that the color-emotion association of **Red-Anger** is similar in both English and Chinese speakers, and likely due to **common** embodied experiences in both cultures; while other associations (**Blue-Sadness** in English speakers, **Red-Happiness** in Chinese speakers) differed because of **culturally-specific** experiences (Chen et al., in revision.).

A rating study on the associative strength of numerous color-emotion pairs suggested that Chinese-English bilinguals can activate metaphorical representations of emotions from **BOTH** languages, with language context acting as a cue to differentially activate the corresponding metaphorical representations of that culture. Furthermore, another study of Chinese-English bilinguals using more automatic tasks found that metaphorical associations shared across both languages (**Red-Anger**) or learned from L1 (**Red-Happiness**) were automatically activated in either language contexts, but the **Blue-Sadness** association was surprisingly not detected in either the L1 or L2 context.

Existing research on conceptual metaphors in bilingual participants is mainly limited to behavioral studies (e.g., Boroditsky, 2001; Chen & Kacinik, in prep; Chen et al., under revision), such that the neural processes that underlie how bilinguals represent and process conceptual metaphors remains unknown.

The current study thus used the Event Related Potentials (ERP) technique to more precisely examine the underlying neural activity and time-course with which bilingual speakers activate and switch between metaphorical representations of each language. The N400 component was used to examine the mismatch effect resulting from when emotional words appeared in colors that were congruent or incongruent with the corresponding conceptual metaphor (e.g., HAPPY displayed in **red** or **blue**). Chinese-English bilinguals were hypothesized to show evidence of the metaphorical association learned from their L1 (**Red-Happiness**) in both language contexts, but that the magnitude of incongruency effects would vary based on the specific language.

METHOD

PARTICIPANTS:

- 22 **Chinese-English bilinguals** living in New York .

MATERIALS:

- Five words in either English or Chinese for each of the two emotions: **Happiness** and **Sadness**, presented in **red** or **blue**. For e.g., GLAD (Happiness), DEPRESSED (Sadness).

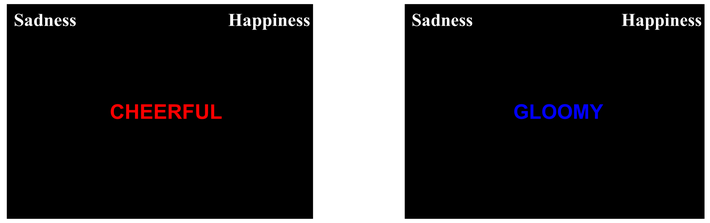
- Participants did the tasks in BOTH English or Simplified Chinese, in separate sessions.

EEG RECORDING:

- The EEG was recorded by using a 64-channel Biosemi ActiveTwo system.

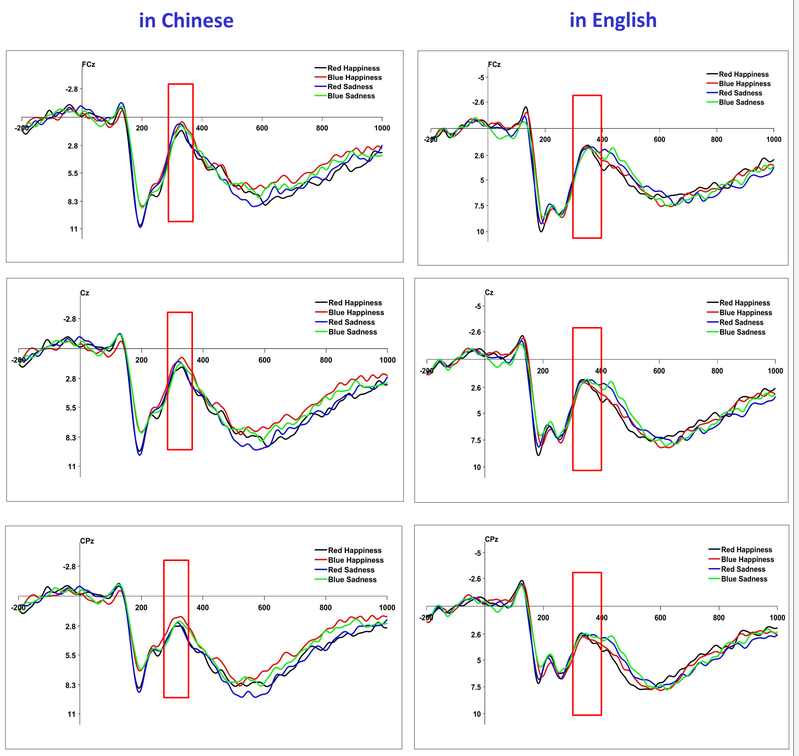
PROCEDURE:

- Participants judged if target words indicated Happiness or Sadness. The order of language sessions and response keys were counter-balanced.



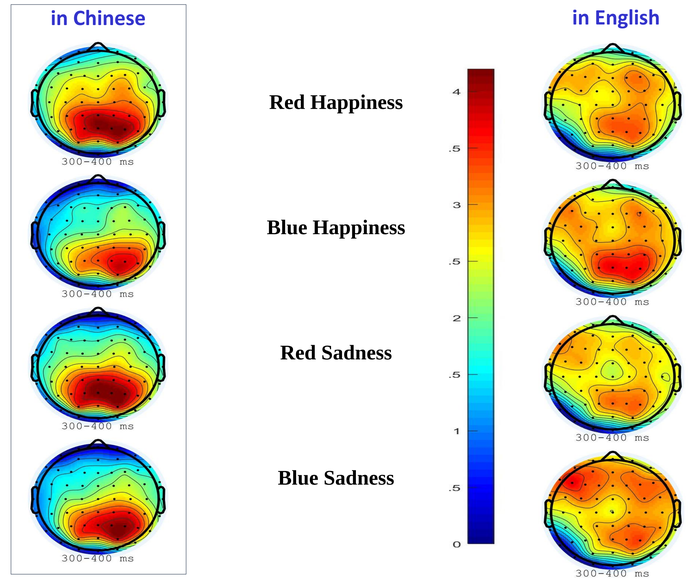
Example English Trials from the Study

RESULTS



N400: Mean amplitudes in the 300ms to 400ms time window were averaged across the FC1, FC2, FCz, C1, C2, Cz, CP1, CP2, and CPz electrodes.

The metaphorical incongruency N400 effect was only significant for the **Red-Happiness** association in the Chinese condition, $p = 0.016$, $t(21) = 2.623$, Cohen's $d = 0.559$. The incongruency effects for Red-Happiness in English, and for the Blue-Sadness association in either Chinese or English were all non-significant, $p > 0.1$.



Scalp distributions indicate that the N400 effect tended to be **generally stronger in the Chinese condition** than the English condition. This is not surprising and in accordance with the nature of our bilingual participants since Chinese was their first and native language, while English is their second and less proficient language.

The scalp distributions also suggest that the N400 metaphorical incongruency effects were evoked more strongly in the left hemisphere (LH) than in right hemisphere (RH). A paired-samples t-test was conducted on the N400 incongruency effect between Happiness conditions (Happiness in Red font – Happiness in Blue) on the N400 amplitudes averaged across the electrodes in the left versus right FC, C, CP, and P groups. The result showed that the **Red-Happiness** N400 incongruency effect was marginally significantly stronger in the LH than in the RH, $p = 0.081$, $t(21) = 1.830$, Cohen's $d = 0.390$, and seen by the greater extent of green-blue coloring in the LH vs. RH for the incongruent **Blue-Sadness condition.**

DISCUSSION

Our preliminary results indicate that bilinguals can activate emotion metaphors learned from L1 automatically in an L1 context. However, the **Red-Happiness** metaphorical effect was NOT significant in the L2 condition. This contradicts the findings of our previous behavioral study. It may be that the L2 effect is too weak to be detected in our small sample, that it is affected by additional processes, or that these participants are potentially less proficient in English than those from our earlier work. Our sample size is unfortunately still too limited for any definitive conclusions because we had to prematurely stop running participants due to the pandemic. Data collection will eventually resume to achieve the originally planned sample size based on power analysis.

Future studies should extend this research to non-verbal stimuli like facial expressions that would be less influenced by participants' linguistic proficiency than word stimuli, and to test other types of bilinguals with more diverse language backgrounds.