

Development of Decomposed Parallel Processing in Dual Language Immersion 2nd Graders



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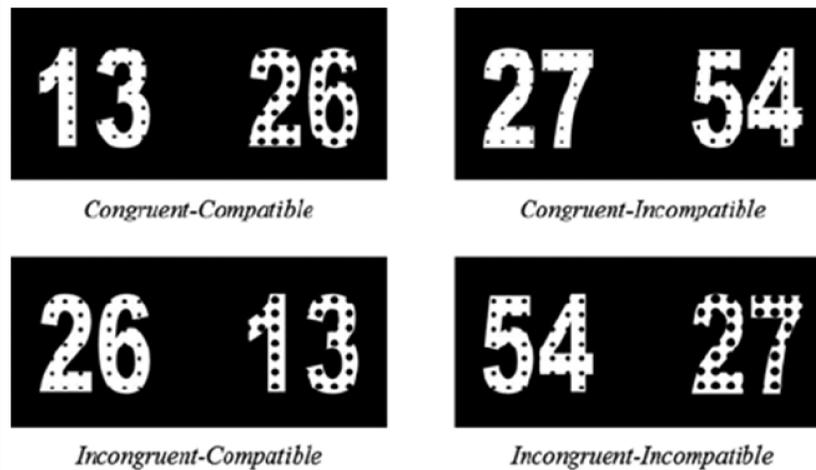
LITERATURE REVIEW

Chinese students outperform American students in math, even before starting formal education. (Miura, Okamoto, Kim, & Chang, 1993; Siegler & Mu, 2008; Wang & Lin, 2009)

Native Mandarin-speaking children automatically process place value in two-digit Arabic numbers two years before their English-speaking peers, at age six instead of age eight. (Chan, Au, & Tang, 2011; Chan, 2014; Schwarz & Ischebeck, 2003).

It's easier to learn to count in Mandarin than in English. (Miller, Smith, Zhu, & Zhang, 1995; Miura, Okamoto, Kim, Steere, & Fayol, 1994)

Trial types in the dot-number Stroop task



In congruent trials, the physically larger dots are in the numerically larger number. In compatible trials, the magnitude comparison between unit and decade digits lead to the same decision (e.g., for the pair 13_26, $1 < 2$ and $3 < 6$).

(Chan et al., 2011).

Decomposed sequential processing

- Young children rely on the decade digit to determine which is larger and process both digits sequentially from left to right
- Faster reaction times on unit-decade incompatible pairs
- Slower reaction time on incongruent trials

Decomposed parallel processing

- Decade and unit digits are processed simultaneously in parallel
- Slower reaction times on compatible pairs

(Nuerk et al. 2004)

HYPOTHESIS

In comparison to English monolingual children, native English-speaking children who learn Mandarin Chinese at school through a DLI program will have significantly higher inverse efficiency scores on the compatible-incongruent condition of the dot-number Stroop task, indicating increased evidence of decomposed parallel processing.

METHODS

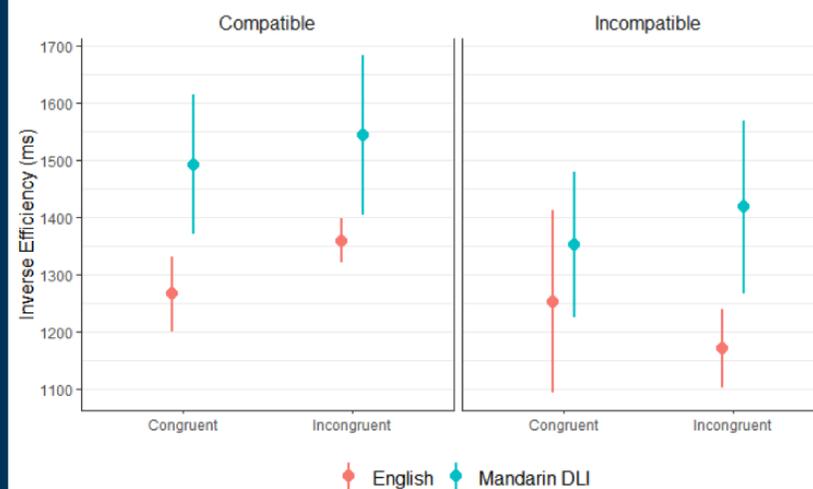
Parental consent & youth assent
Demographic questionnaire
Dot-Number Stroop task (Chan et al., 2011)

Demographic data

Age (M = 8.3, SD = 0.5)

Language of math instruction	Female	Male
Mandarin	7	6
English	3	1
Totals (N = 17)	10	7

Inverse Efficiency as a Function of Congruity and Unit-Decade Compatibility



IE was calculated for each participant by dividing the average reaction time of correct trials by the proportion of correct trials.

ANALYSIS & RESULTS

The results of the performed 4 x 2 mixed design ANOVA (conducted on inverse efficiency with condition as within-subject factors and language group as a between-participant factor) were insignificant and small, $F(31.52) = 0.42, p = 0.67, \eta^2 = .003$.

In an independent samples *t* test on language group and the inverse efficiency of the compatible-incongruent condition, the Mandarin DLI group (M = 1494.0ms, SD = 518.0) shows a higher IE than the English group (M = 1359.2ms, SD = 77.5); $t(15) = -0.51, p = 0.62, d = -.29$.

DISCUSSION

Results are currently inconclusive. Children in the English monolingual sample seem to have slower inverse efficiency scores in the Compatible Incongruent condition. This indicates a possibility that they are still using decomposed sequential processing.

Mandarin DLI students appear to be using, or are potentially beginning to use, decomposed parallel processing as indicated by their relatively low inverse efficiency scores in the Compatible Incongruent condition.

WHAT'S NEXT?

- Increased sample size
- Analysis of data collected on other measures
- Measures delivered in "target language"
- EEG validation of dot-number Stroop
- Exploratory research using dot-number Stroop with language groups that vary in base system

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