The effects of culture, response language, and computational skill on estimation strategies

Ineke Imbo[1] & Jo-Anne LeFevre[2]

[1] Department of Experimental Psychology, Ghent University (Belgium)
[2] Centre for Applied Cognitive Research, Carleton University (Canada)

E-mail: Ineke.Imbo@UGent.be

Introduction

- **Computational skill**
  - Does the Asian advantage in exact arithmetic (*Campbell & Xue, 2001; LeFevre & Liu, 1997*) extend to approximate arithmetic?
- **Response language**
  - Is number processing language-dependent? Abstract Code model (*McCloskey*) and Triple Code model (*Dehaene*) vs. Encoding Complex model (*Campbell*)
- **Culture**
  - Are Asians less adaptive than non-Asians? (*Imbo & LeFevre, 2009*)

Method

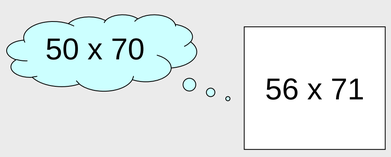
Participants

- 40 **Belgian**-educated adults answering in **L1** (Dutch)
- 40 **Chinese**-educated adults answering in **L1** (Chinese)
- 40 **Chinese**-educated adults answering in **L2** (English)

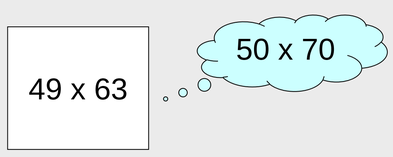
Materials

Computational estimation task (*Lemaire & Lecacheur, 2002*)

Rounding-down problems: rounding down strategy produces best estimate of exact answer



Rounding-up problems: rounding up strategy produces best estimate of exact answer



Procedure

Choice/no-choice method (*Siegler & Lemaire, 1997*)
- **Choice**: choose the *best* strategy for every problem
- **No-choice/Down**: use rounding down on *all* problems
- **No-choice/Up**: use rounding up on *all* problems

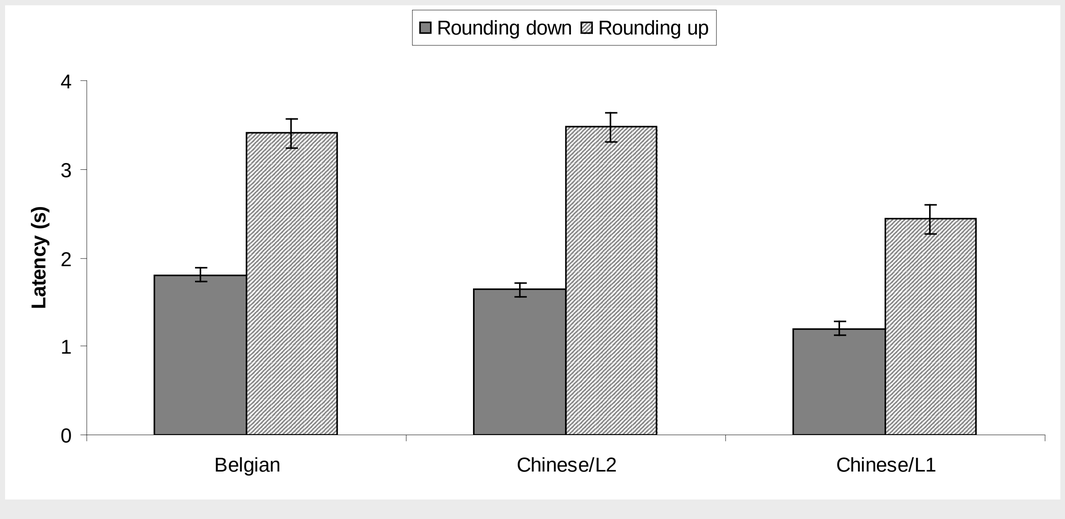
Each condition was further divided in two blocks
- Block without WM load
- Block with **executive WM load** (CRT task, *Szmalec et al., 2005*)

Strategy Efficiency

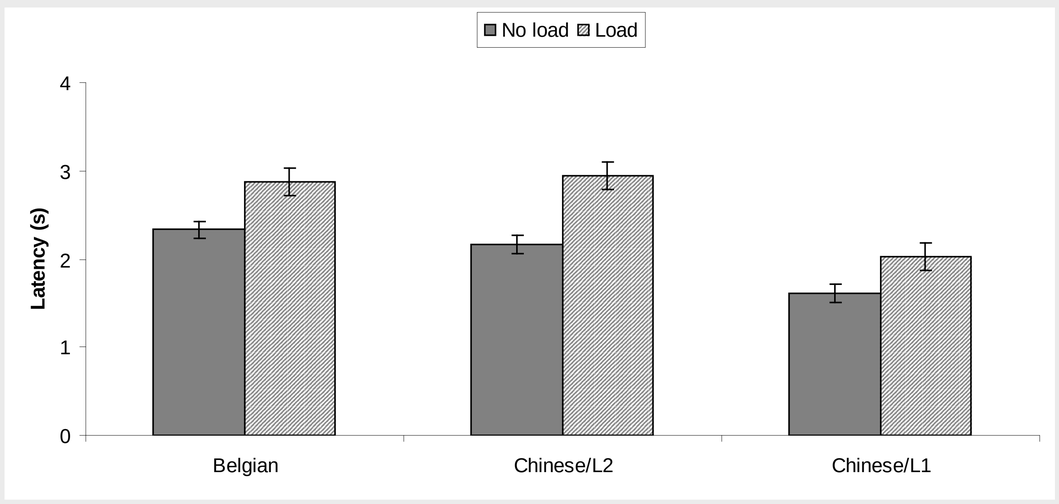
3 (Group) x 2 (Strategy) x 2 (Load) ANOVA on latencies

- **Group**
  - Chinese/L1 (1.8 s) < Belgian (2.6 s)
  - Chinese/L1 (1.8 s) < Chinese/L2 (2.6s)

- **Group x Strategy**
  - Strategy effects in Chinese/L2 > Chinese/L1
  - Strategy effects in Belgian > Chinese/L1



- **Group x Load**
  - Load effects in Chinese/L2 > Chinese/L1

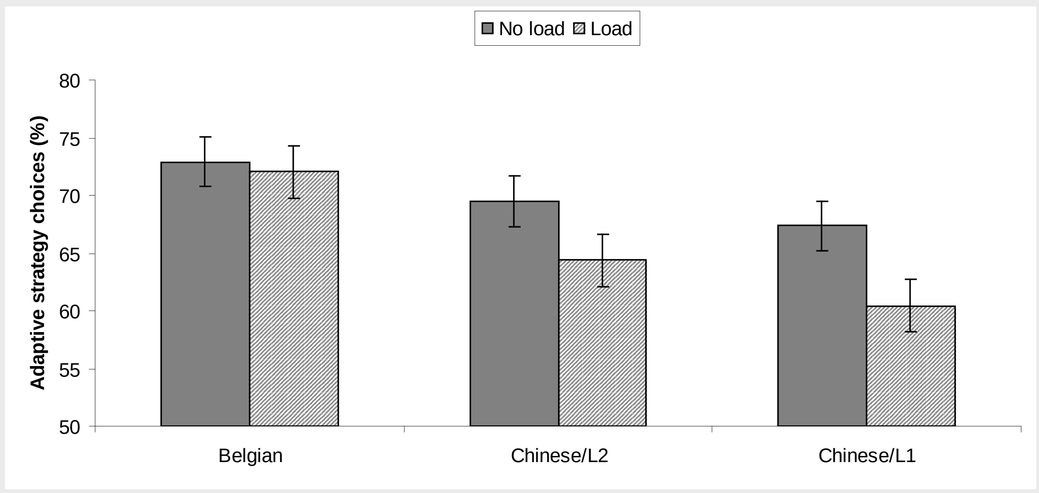


Strategy Adaptivity

3 (Group) x 2 (Load) ANOVA on adaptive strategy choices

- **Group**
  - Belgians (72.5%) > Chinese/L1 (63.8%)
  - Belgians (72.5%) > Chinese/L2 (66.9%)

- **Group x Load**
  - Belgians: No-load = Load
  - Chinese/L1 and Chinese/L2: No-load > Load



Conclusions

- **Computational skill**
  - The Asian advantage extends to *approximate* arithmetic
  - WM equally involved in Asians & non-Asians
    = *Imbo & LeFevre (2010)* but ≠ *Imbo & LeFevre (2009)*

- **Response language**
  - Bilinguals are more efficient when answering in L1
  - Responding in L2 loads on executive WM resources
  - Rounding up is more difficult in L2 than in L1
    → Calculation/estimation and language processing are integrated
    → Evidence for the Encoding Complex model (*Campbell*)

- **Culture**
  - *Chinese* (but not Belgians) are *less adaptive* under WM load
  - Educational approaches in *Asia* focus on *practice and training of arithmetic facts*
    → Asian students are experts in applying learned algorithms, but may have lower levels of *number sense*.
  - Educational reform movements in *Europe* emphasize flexibility, adaptive expertise, and the use of meta-strategies
    → Belgian students are familiar with using a *variety of strategies*