

# THE CONSISTENCY EFFECT ON COMPARE PROBLEMS: AN EYE MOVEMENT STUDY IN PRIMARY SCHOOLS

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## Introduction

- Students have difficulty in solving arithmetic problems containing a relational term that is inconsistent with the required arithmetic operation, leading to more reversal errors.
- Hegarty, Mayer, and Green (1992) studied eye movements of undergraduates, and found that high-accuracy undergraduates appear to be using the mental model approach because they spend more time reading inconsistent than consistent, but low accuracy undergraduates appear to be using direct translation approach because they spend same amount of time on consistent and inconsistent.
- The present study aimed to examine elementary students' performance and eye movements on two-step compare problems.

## Method

### Participant

- Twenty-nine 6<sup>th</sup> graders were recruited from two primary schools in Taipei.
- All participants had normal or corrected-to-normal vision, and their reading comprehension scores were in the normal range.

### Apparatus

- Eye movements were recorded by the EyeLink 1000 with a sampling rate of 1000 Hz.
- Items were displayed on the 19-inch LCD monitor.
- The screen resolution was set to 1280\*1024 pixels.
- The viewing distance was approximately 60 cm.

### Materials

- Four consistent items and 4 inconsistent items were used in this study. All items were two-step compare-word problems adapted from 6<sup>th</sup> grade mathematics textbook.
- Each item consisted of four sentences in Chinese.
  - The first sentence was an assignment statement expressing the background information.
  - The second sentence contained a relational statement expressing the value of two variables and their relationship.
  - The third sentence provided the quantity of one the variables.
  - In the fourth sentence, the problem solver is asked to find the value of the unknown variable.

Table 1. An example of consistent/inconsistent problems

Consistent problem	Inconsistent problem
轉角的麵包店， (There is a bakery at the corner.)	轉角的麵包店，
每條土司以成本加60%作為定價， (The price of each loaf of bread is 60% more additional to the cost.)	每條土司以成本加60%作為定價，
1條土司的成本為40元， (The cost of a loaf of bread is 40 dollars.)	1條土司的定價為40元， (The price of a loaf of bread is 40 dollars.)
問這條土司的定價是多少元？ (What is the price of a loaf of bread"?)	問這條土司的定價是多少元？

### Procedure

- In the first session, participants were tested by the *Reading Comprehension Screening Test* in classroom. Those who passed the PR25 cut-off point and had parent consent form were recruited to the second session.
- During the second session, each participant was tested individually approximately 30 minutes. The participant was asked to report their solving process but not finished any calculation. After introduction of this experiment, a 9-point calibration procedure and a practice session of two problems preceded the formal experiment.

## Results

- Instead of the correct answer, accuracy was evaluated by the participants' oral solution plan.
- Participants were categorized to 3 types based on the solution performance and their read comprehension test were equal.
  - Good solvers ( $n = 8$ ) committed 2 or less errors on the 8 items.
  - Reversal solvers ( $n = 8$ ) committed 3 or more errors, most of which were reversal errors.
  - Poor solvers ( $n = 8$ ) committed 3 or more errors, most of which were not reversal errors.
- As Figure 1 shows that good and reversal solvers solved consistent items more successfully than did the poor solvers,  $F(2, 21) = 4.90, p = .018$ .
- Additionally, good solvers solved inconsistent problems more successfully than did the reversal and poor solvers,  $F(2, 21) = 15.76, p = .000$ .

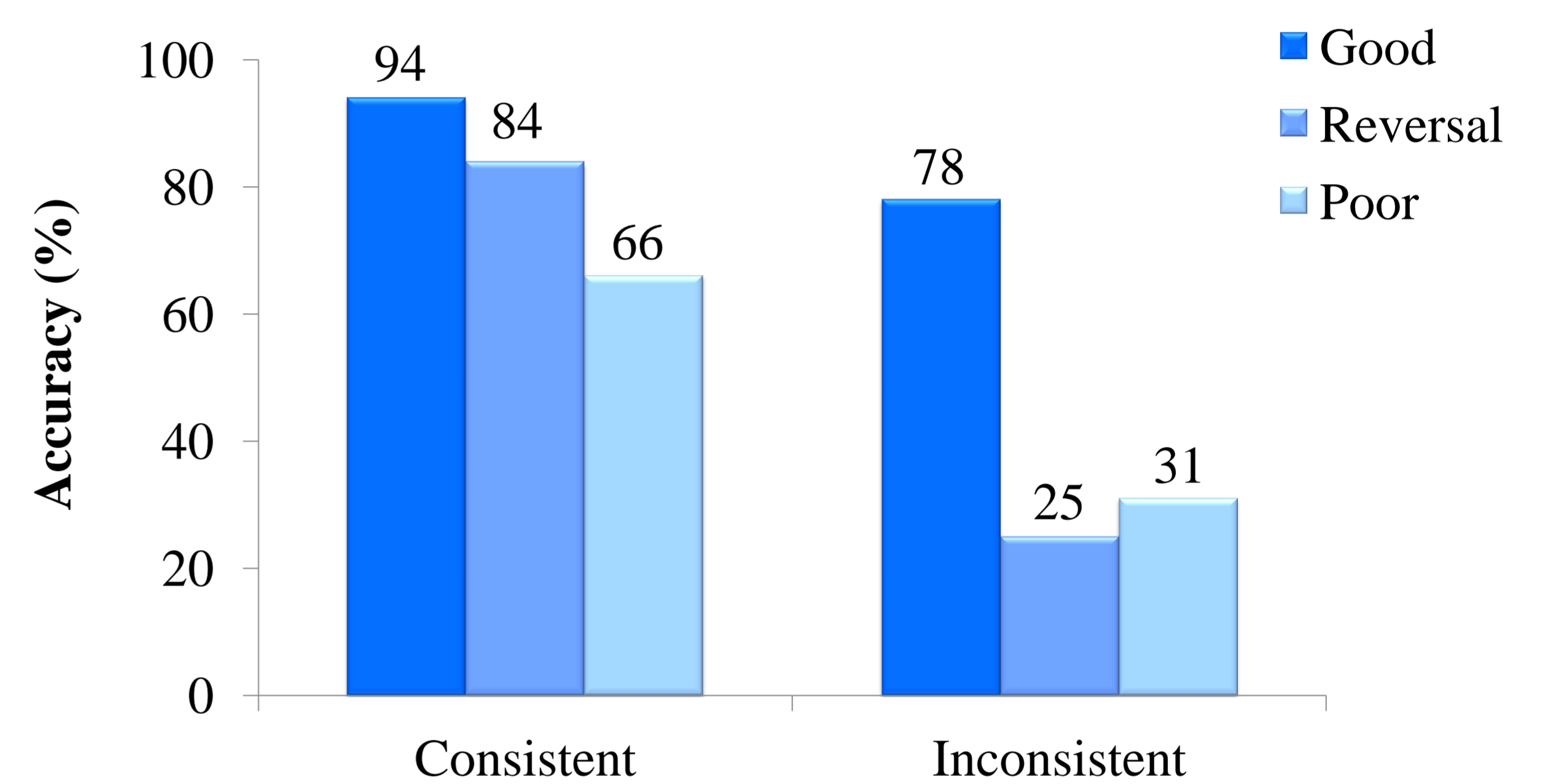


Figure 1. accuracy per item for 3 types of solvers

- As figure 2 shows, the total fixation duration(TFD) of consistent items was marginally shorter for the good solvers, than that for the inconsistent items,  $t(7) = -2.18, p = .066$ , while it was the same for both types of items for the reversal and poor solvers.

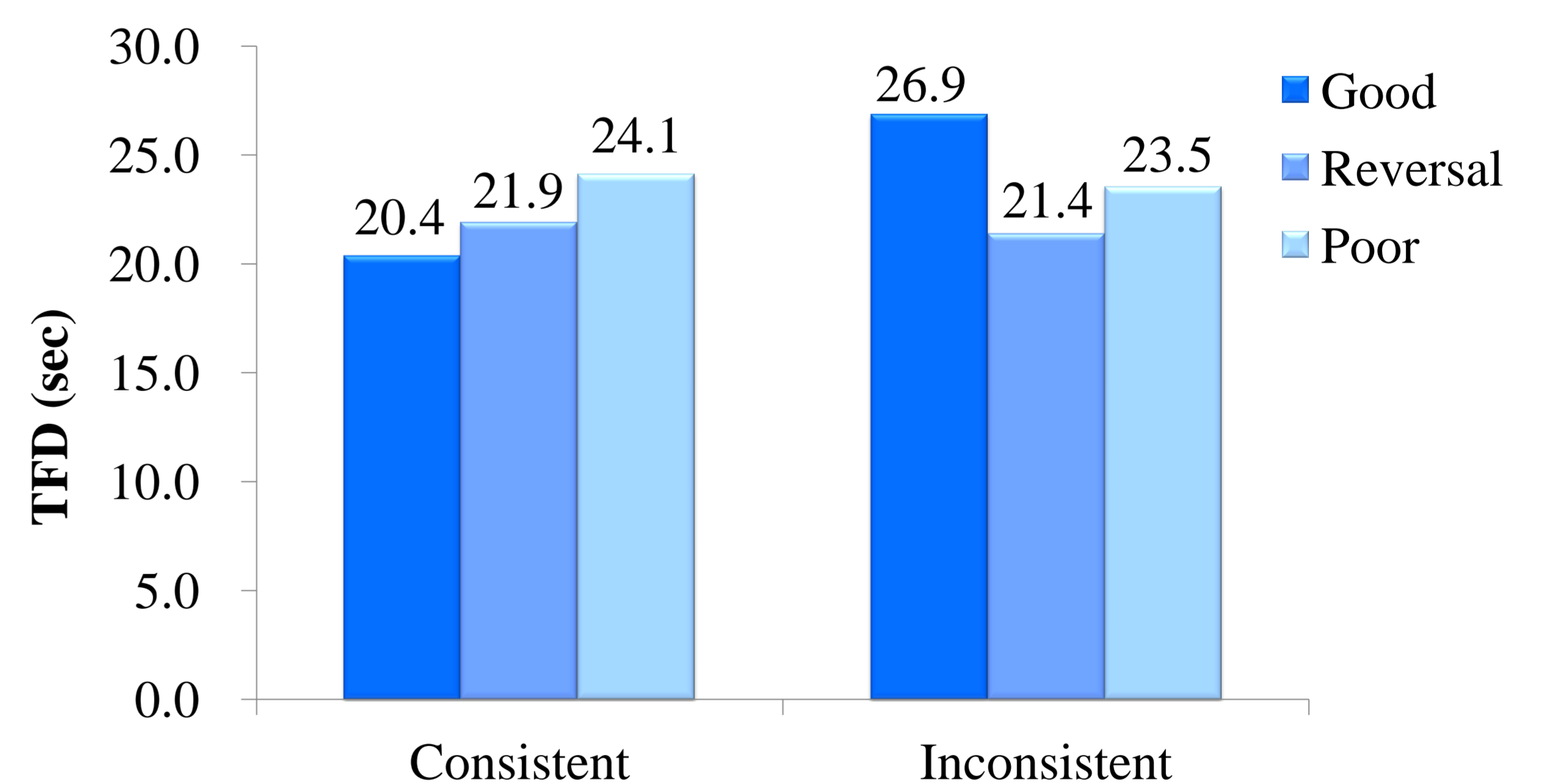


Figure 2. Total fixation duration per item for 3 types of solvers

## Discussion

- The results indicated that good solvers possessed schema for compare problems, took more time to process inconsistent problems, and solved the problems more successfully.
- Reversal error solvers possessed basic mathematics skills, but perceived inconsistent problems as consistent problems.
- Poor solvers exhibited worse mathematics skills than their peers, committed more errors on both types of problems, and took the same time to solve them.

## Acknowledgments

This study is supported by the grant 102-2511-S-224 -002 -MY2 from the National Science Council in Taiwan.

## References

- Hegarty, M., Mayer, R. E., & Green, C. E. (1992). Comprehension of arithmetic word problems: Evidence from students' eye fixations. *Journal of Educational Psychology, 84*(1), 76-84.