Eye Movement Differences between Retrieval and Procedures in Simple Subtraction

Evan T. Curtis, Corrie Bouskill, & Jo-Anne LeFevre

Carleton University

Do eye movements provide insight into processes used on arithmetic problems?

- Curtis and LeFevre (2011, CSBBCS) did not find that eye tracking data on multiplication (e.g., 4 x 8) provided information beyond that of latencies and errors
- Here, revisions to the eye tracking methodology were made; specifically, initial fixation locations were varied randomly across trials
- This change was designed to decrease the confounding of initial gaze and location
- The problem size effect refers to the fact that problems with larger operands slower and more error prone than small problems (see Zbrodoff & Logan, 2005)
- In subtraction, large problems are solved slowly because participants use time-consuming procedural strategies to solve problems (LeFevre et al., 2006)
- **Is the use of procedures reflected in eye movements?**

Methods and Materials

- Participants (*N* = 30) solved simple subtraction problems by producing the solution verbally
- Problems were produced by inverting all addition problems using combinations of operands 2 to 9
- Problems with a double-digit left operand were considered large, all others were considered small
- Regions of interest were defined around each operand and the subtraction sign (see Figure 1)

11	-	5

***Figure 1*. Example trial displaying regions of interest**

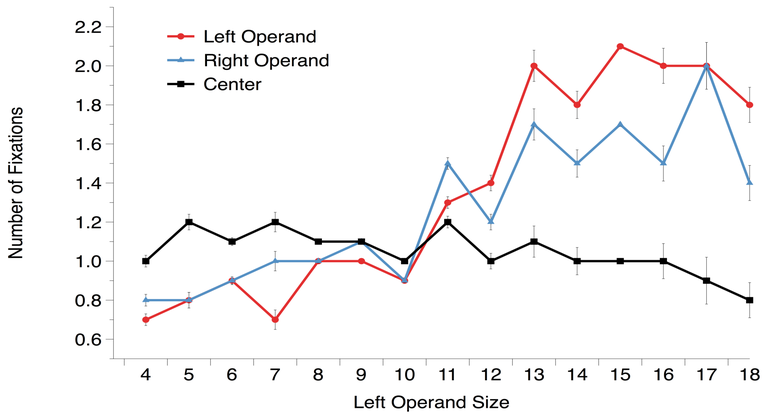

***Figure 2*. Total fixations as a function of left-operand size**

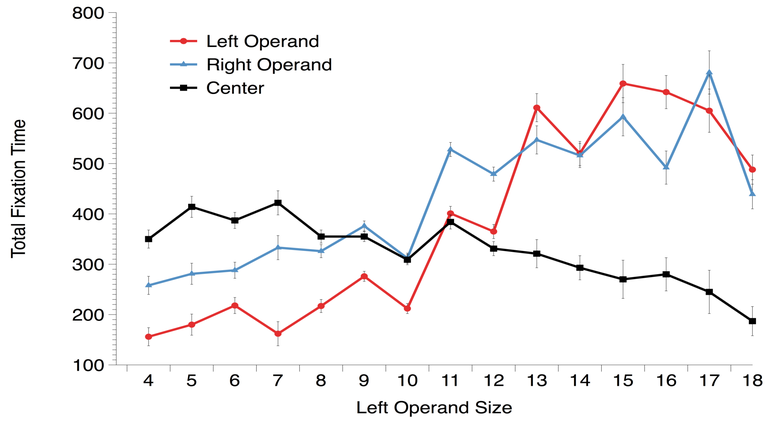

***Figure 3*. Total fixation time as a function of left-operand size**

Results

Behavioural data:

- Participants were faster on small than on large problems (1080 vs. 1481 ms)
- Participants made fewer errors on small than on large problems (6 vs. 17%)

Fixation patterns on **small** problems:

- Participants made similar numbers of fixations on the subtraction sign and the two operands (Fig 2)
- Participants looked at the subtraction sign for longer than the operands (Fig 3)

Fixation patterns on **large** problems:

- Number of fixations and fixation time on the subtraction sign was the same across size
- Participants looked more often and for longer at each operand; number of fixations was greater for the left operand, whereas fixations times were similar

Conclusions

- Recall that small subtraction problems are often solved via retrieval whereas large problems are more frequently solved using procedures, not retrieval
- Although fixations on the center of the screen remained consistent across problem size, fixations on the operands increased as a function of problem size
- Fixation patterns plausibly reflect procedural usage in mental arithmetic tasks

Eye movements and fixation patterns are reflective of procedural strategies in mental arithmetic and not of memory-driven retrieval processes

Carleton University
CACR
NSERC CRSNG
Canada