Comparison of Negative and Positive Integers

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Introduction

The integers constitute an important number class. However, they have been relatively neglected by cognitive scientists. Although there are many studies of natural number processing and rational number processing, there are few if any studies of integer processing. As a result, the cognitive processes and representations that support integer processing are unknown.

Research Questions

This study addresses three fundamental questions about integer processing, specifically of integer comparison.

(1) Are negative integers compared more slowly than positive integers?

(2a) Is there a distance effect for negative integers that parallels the distance effect for positive integers (i.e., natural numbers) (Moyer & Landauer, 1967)?

(2b) If so, are the distance effects for negative and positive integers comparable?

(3a) Is there a Spatial-Numerical Association of Response Codes (SNARC) effect for negative integers that parallels the SNARC effect for positive integers, i.e., that smaller numbers are responded to faster with the left hand and larger numbers with the right hand (Dehaene, Dupoux, & Mehler, 1990)?

(3b) If so, are the SNARC effects for negative and positive integers comparable?

Method

We are currently conducting an experiment that addresses these questions. The paradigm derives from the fMRI experiment by Pinel, Piazza, Le Bihan, and Dehaene (2004). Participants are presented with pairs of integers and must indicate which one is larger by pressing a button. There are two within-subject variables, the valence of the numbers being compared (positive or negative) and the distance between them (near or far). Example stimuli are shown in Table 1. The dependent measures are latency and accuracy.

Table 1: Sample Stimuli

Valence	Near	Far
Positive	1,3	2,8
Negative	-9,-7	-8, -2

Preliminary Results

Three participants have been run; we are currently in the process of running 13 more. The trends are promising. For example, with respect to question (1), negative numbers are compared more slowly than positive integers (mean difference: 48 msec). With respect to question (2a), there is a distance effect for negative integers, with near distances compared more slowly than far distances (mean difference: 76 msec), and with respect to question (2b) this is comparable to the distance effect observed for positive integers (mean difference: 60 msec). We will perform the appropriate statistical analyses when we finish collecting the data.

Conclusion

The current study is the first that we know of that examines the processing (i.e., comparison) of negative integers relative to that of positive integers. It promises to illuminate the underlying cognitive processes and representations and, because of its design, lay the groundwork for future neuroimaging studies.

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References

Dehaene, S., Dupoux, E., & Mehler, J. (1990). Is numerical comparison digital? Analogical and symbolic effects in two-digit number comparison. *Journal of Experimental Psychology: Human Perception and Performance*, *16*, 626-641.

Moyer, R. S., & Landauer, T. K. (1967). The time required for judgments of numerical inequality. *Nature*, *215*, 1519-1520.

Pinel, P., Piazza, M., Le Bihan, D., & Dehaene, S. (2004). Distributed and overlapping cerebral representations of number, size, and luminance during comparative judgments. *Neuron*, *41*, 983-993.