Comparison of Numbers

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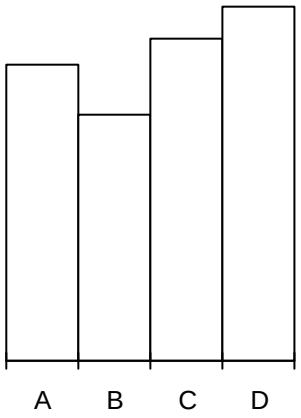
Abstract It is well-known fact ([1], [2]) that in human brain two different mechanisms in perception of numbers operate: The first three natural numbers are perceived in about equal times of 500 msec. and for higher numbers the perception-times become gradually longer. We showed in a previous work ([3]) that this perception-times depend on the form of presentation of numbers (such as sets of bars, dots or geometric figures) with some very interesting consequences.
In this work we investigate the problem of comparison and determination of the largest or smallest numbers in a given set with the same method of time-measurement. Using an experimental set-up with computer, we presented to groups of pupil in primary school and students various sets of numbers in different forms of presentation: in decimal form or in form of bars with their length representing the number.
The results show that geometric comparison is definitely much more speedy than tabular comparison and there are also interesting clues in comparison towards the largest and smallest numbers.

In this work we conducted a series of experiments to determine the times a subject needs to perceive the largest or smallest in a set of numbers. The experimental set-up and the electronic device to measure the time intervals was the same as in [3]. In accordance with our general hypothesis that perception-times depend on the form of presentation of numbers ([3]), we used in the current experiment the following two distinct forms of presentation for the same set of numbers, e.g. :

A	B	C	D
7,4	6,2	8,1	8,9



The heights of the bars in the graphic presentation are proportional to the corresponding decimal numbers in the table form.
The numbers we used were decimal ones of the form a,b ranging from 0,0 to 9,9 and the set of numbers consisted of 2, 3, 4 or 5 elements. The reason we stopped by 5 is that we used two groups of subjects, the first being a group of 40 pupil in the 5. class of primary school and the second a group of students with ages 20-30. One of our goals was to compare the performances of the pupil with that of the students. Our two other natural goals were to compare the performances in tabular form and graphic form on the one side, and to compare the performances in discerning the largest and smallest on the other side. In this sense, we can talk about three parameters: child-adult, table-graphics and largest-smallest (on the fourth

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parameter, the number of the set, in conjunction with the others, we shall report in a separate paper).
Holding any two of these parameters fixed, one can observe the effect of the states of the third on the performance.
Every subject was tested by ten presentation of any possible form: 2, 3, 4 or 5 numbers, in table or graphic form, asked for the largest or smallest. This made a total 12800 time-measurements for the two groups.

Results and Discussions

We present the results of the above measurement in the following two tables, the first being for the pupil and the second for the students.

Number of The Decimal Set	Perception-Time of The Largest Numbers (msec.)		Perception-Time of The Smallest Numbers (msec.)	
	Table	Graphics	Table	Graphics
2	1442,56	833,65	1562,51	977,34
3	1911,51	916,34	2052,32	1026,27
4	2351,91	1048,86	2391,59	1109,07
5	2830,12	1262,32	2807,48	1269,21

Table 1: Perception-Times of Pupil

Number of The Decimal Set	Perception-Time of The Largest Numbers (msec.)		Perception-Time of The Smallest Numbers (msec.)	
	Table	Graphics	Table	Graphics
2	918,09	550,93	886,64	579,76
3	1226,19	598,92	1157,98	652,2
4	1512,95	663,91	1446,39	700,72
5	1764,95	749,73	1724,15	800,04

Table 2: Perception-Times of Students

We give in the following two tables the results of the t-tests for 5% significance level and one-sided comparison ($t > 1,645$).

Number of The Decimal Set	Pupil		Students	
	t-Values for The Largest Number	t-Values for The Smallest Number	t-Values for The Largest Number	t-Values for The Smallest Number
2	13,37	13,03	15,80	14,04
3	18,75	17,63	22,87	13,22
4	23,40	21,93	23,94	15,23
5	18,94	18,45	21,79	18,11

Table 3

Number of The Decimal Set	Presentation in Table-Form		Presentation in Graphics	
	t-Values for The Largest Number	t-Values for The Smallest Number	t-Values for The Largest Number	t-Values for The Smallest Number
2	8,54	9,94	6,26	8,23
3	9,51	10,14	7,27	6,81
4	10,12	9,47	6,53	7,29
5	9,91	9,53	7,84	6,63

Table 4

Number of The Decimal Set	Pupil		Presentation in Graphics	
	t-Values for The Largest Number and Smallest Number Comparison (Table form)	t-Values for The Largest Number and Smallest Number Comparison (Graphics)	t-Values for The Largest Number and Smallest Number Comparison (Table form)	t-Values for The Largest Number and Smallest Number Comparison (Graphics)
2	1,575	2,671	0,875	1,154
3	1,459	2,173	1,682	1,595
4	0,416	0,975	1,196	1,143
5	0,204	0,088	0,740	1,153

Table 5

As the tables 3 and 4 show beyond question, students are more speedy than pupil in every fixed task and everybody is more speedy with graphics than with tables. These results are in full accordance with our expectations. Everyday experience in education shows that graphics are a better aid than tables and our measurements can be seen as an additional manifestation of this fact. There is a little surprise regarding the perception times of the largest and smallest numbers as reflected in the last table. Together with Table 1 and Table 2 we can conclude cautiously that in graphic presentation both pupil and students tend to perceive the largest number more speedy than the smallest (significant in two cases). But in tabular presentation there are contrary tendencies. The pupil tend to perceive the largest number more speedy but the students tend to perceive the smallest numbers more speedy. It could be argued, that in graphic form the largest number represents the biggest figure and it is biologically (in an evolutionary sense) more important than a smaller figure. In case of tables, the adults might be trained during their education to order the numbers from smaller to bigger and this inclination might cause them to search for the smallest first.

References

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