IMPROVEMENT OF JUDGMENTS FOR SMALL HORIZONTAL TANGENT DISTANCES

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A meter stick which an observer sees at different locations in a laboratory or classroom looks to be a meter's length at these various distances. This is according to the psychological law of size constancy. The application of a "mental meter-stick" to various areas in the environment requires guessing, estimation or judgment, rather than recognition, and this type of behavior is subject to psychological laws which frequently lead to constant errors.

Adults are given to the estimation of dimensions. A fine large fish is carried along the street by its captor. Some observers will estimate its weight others its length. Usually circumstances do not permit verification of the estimates made. The confidence level for these estimates varies widely but some of the "judges" might be willing to place bets since they believe in their ability to match numbers with perceptions.

The problem in the present experiment was to examine the accuracy with which horizontal tangent length on the ungraduated side of a steel tape could be judged.[1] The method of average error was employed.

After the observers had made a judgment and written it down the actual centimeter length of the stimulus was announced and its value written in a parallel column. Reinforcement was thus immediate. Each observer was aware of his degree of success before making the next judgment. The tape-measure lengths presented for estimation showed chance variation within vague limits and were given in groups of 5 successive trials. There was a short rest pause after each group. There were 10 such groups and the 50 judgments constituted one experiment. Two experiments of this type, separated by a period of three weeks, were conducted in a psychology class of some 30 students. These experiments were designed

(1) This idea is not original with the author. He is indebted to Mr. Massood Torfeh, Civil Eng., Teheran, Iran, for the information that he and associates had sometimes made a game of guessing quickly exposed tape-measure lengths. Perhaps others have practiced it. No published data on this game have been found.

to serve the joint purposes of training and research. Each was planned for and accomplished within a period of 50 min. It was anticipated that the errors of estimate would be quite variable and the amount of learning not very conspicuous.

Conditions and Procedure

In both experiments the means for producing and exposing the horizontal lengths of steel tape to be estimated were the same. The essential unit was an ordinary commercial tape-measure in its brown round plastic container, 5.5 cm. in diameter and 2 cm. in thickness. A small wooden knob was attached to the free and of this steel tape and projected 2 cm. from the concave side on which the centimeter scale was etched. The back side which the observers were to see when it was presented, was convex, bright, and clean without any scale marks or other identifiable spots. This general convenience tape-measure could be drawn out to a length of 2 meters, and was of course graduated in both cm. and mm. Most of the stimulus lengths used were less than 1 m.

The method of presenting the stimuli was a natural and simple one and did not require the use of any other apparatus. The experimenter, who was also the class instructor, stood behind a small lecture table 80 cm. high at the front of the room and on the same floor level with the observers. He held the plastic container of the tape-measure between thumb and two fingers of his right hand and grasped the end-knob with his left thumb and fore finger. The two hands were held near together, at arm's length, and at shoulder level. E gave a signal for attention and then quickly, moving the hands apart, stretched out a horizontal length of tape.[1] The exposed portion was not in any way obscured by E's hands. The movement of his hands was started and stopped with about equal suddenness. He did not try to adjust the length exposed to any premeditated value. Where his hands happened to stop he held them still for 5 seconds, while the Os made their estimates. Then still holding the tape in the same drawn-out position he read off the exposed length to the nearest cm. It will be noted that the tape was in proper position for E to read the scale from left to right, the numbers were right side up, and the dark edge of the slit opening in the plastic box formed a good index to see against the scale. E endeavored to double check his scale readings. He

(1) The quick pull-out of this steel tape from its container was accompanied by a rubbing high pitched noise. There were no clicks audible in this sound complex. Such clicks might serve as an accessory cue for estimation. Some tape measures of this general form do have rather prominent click noise.

called them out to his assistant[1] who announced them in Turkish numerals and also wrote them in a column on the black-board.

Seating arrangements were planned so as to group the Os in as narrow a sector in front of E, and the stimuli, as could conveniently be worked out. The objective was to make the presented stimuli nearly tangent for varying lines of sight. Two rows of regular class-room tables were placed at the rear of the room.[2] There were 4 tables in each row and 3 Os could be seated on each side of each table. The tables in the two rows were end to end so that the 8 lines of Os were in positions corresponding approximately to radii from the stimulus position as center. The Os nearest the back wall formed a reception sector-angle of 40°, those in the shortest radius line covered 60°. The mean for the sectors which included the positions of the rows of Os was about 50°. For those who sat at the back and directly in front of the stimulus a tape length of 1 m. would subtend an angle at the eye of 7.5° but for those in the most oblique positions the angle was 6.5°. Those who were in the front line and at the center had for a 1 m. stimulus on angle of 11.5° and the most oblique views at this general distance gave 9.0°. This latter value may be taken as about the mean for the entire subject group in both experiments. The inspection of stimuli of this order of magnitude, in terms of subtense angle at the O's eye, may be made by single fixations or by eye-movements and fixations and need not require head movements to make estimations of length. However, the subjects were left free in respect to this feature of their behavior and no instructions were given in reference to it.

The routine conduct for both experiments consisted of the following steps: (a) E called for attention and then quickly pulled out a strip of steel tape, (b) this strip, whatever its length might be, was held constant and steady for 5 seconds, (c) the Os estimated (silently) the length of the stimulus and recorded their judgments in cms., (d) E read off the length of the exposed section of tape, (e) the assistant announced this length in Turkish and then wrote the numerals in a column on the blackboard, and (f) each O copied this value on his record sheet opposite his estimate. This cycle of related steps quickly became organized behavior and the members of the class were able to advance together quite evenly. The record sheets were uniform and had been carefully prepared by the subjects according to

(1) The author wishes to acknowledge the able assistance of his associate and translator, Dr. Beğlân Birand, in the conduct of these experiments.

(2) These table were 80 cm. wide 140 cm. long and 80 cm. high. The classroom was 8.71 m. long and 7.62 m. wide. There were three large windows along the side of the room which was to the left of the subjects, and there were large ceiling lights.

instruction, and under supervision, on large cross ruled sheets. A second assistant served as proctor and trouble adjuster during the tests.[1] There was little time or opportunity for the subjects to pay attention to other than their own record sheets. The Os were on their honor in reference to the opportunity of substituting the announced stimulus length for their estimate. Cooperation on the part of the Os was excellent and there was no reason to assume that any advantage was consciously taken of this opportunity.[2] A low percentage of correct guesses was to be expected according to the law of probability. As will be shown in this paper the percentage turned out to be the same in both experiments.

Instructions and Observers

The instructions were as follows: "This is to be an experiment in estimating short lengths in terms of centimeters. A length of tape will be pulled out quickly, and held before you. You will look at it carefully, judge its length as accurately as you can and write down the number of cm. in the correct space in your blank record-table. Be independent, do not copy others, make up your own mind, decide quickly and record. Do not rub out and make changes. When the assistant announces the length of tape that was exposed for your judgment write this number in the proper space just to the right of your recorded estimate. Note the comparison. Were you too high, too low, or just about right? Set yourself to do fully as well or better on the next trial. Try from these repeated experiences to gain increasing accuracy in your estimates. The stimulus lengths will differ, some longer some shorter, from trial to trial, but the variation will have some regularity about it. Let us consider this experiment as a sport or game. We probably can learn to play it quite well. There is a good prize that we all can win which is Psychological Satisfaction."

In giving these instructions and in illustrating how the stimuli would be presented no attempt was made to revive or set up perceptual standards of length. For example, the tape was not drawn out to 100 cm. and announced as 100 cm. The tape was drawn out to different lengths but the actual extents were not read off.

Preliminary to Experiment I no mention was made about the tendency to estimate in terms of units of 5 or 10 cm., such as 25, 30, ... 65, 70,

(1) The service of Miss Iffet Dinç, Assistant in Psychology, in this connection is gratefully acknowledged.

(2) The dead stillness in the classroom that lasted for 2 to 4 sec. after the tape was pulled out while estimations were being formulated was an impressive social phenomenon of these tests.

75, ... 100, 110, etc. Before Experiment II was performed a rather full discussion of the results for the previous one was presented to the class. At that time the tendency to estimate in terms of round numbers was given some consideration.

The subjects were psychology students and most of them were women. All had taken part in previous class experiments which were introduced quite frequently. These experiments, requiring the full class hour, were longer than those usually undertaken. The subjects had proven cooperative and well motivated and were ready to undertake such tests.[1] For Experiment I there were 31 Os who took part, however, two records had to be discarded because of erasures and irregularities in recording. There were 33 Os in Experiment II and one record was unusable.

Order of Stimuli

The stimuli in Expt. I were given in groups of five and after each group there was a brief interval of rest. From the first to the fifth stimulus in a group the increases in length represented somewhat irregular steps due to the chance element involved in pulling out the tape. The increase in length from the first to the second stimulus (A to B) was about 18 per cent, from the second to the third it was 15 per cent, from the third to the fourth it was 14 per cent, and about 12 per cent from the fourth to the fifth stimulus member. This is the way the experiment turned out. The procedure of presenting the stimuli did not admit of a plan in terms of precise numbers. The five ranges of stimuli, A, B, C, D and E, and the 10 groups which made up the 50 judgment problems are shown in Table 1. The ranges overlap somewhat and this was to be expected. The means and standard deviations are given at the bottom of the table. The brief pause after each group of five stimuli was in order for the Os "to take breath", review performance and adjust mental set. There was a longer break between the 5th and 6th groups. The reaction of the Os upon turning in their records seemed to indicate moderate satisfaction with attained results. However, no one seemed highly elated or to consider himself a perfect psycho-estimeter.

The plan for Experiment II was also that of using 10 groups, each of 5 successive trials, each trial with a different tape-stimulus extention. But in this experiment only a single range of stimuli was employed. This was from 66 to 105 cm., somewhat wider than any single range used in the

(1) These two experiments took place in the early part of the second semester of the psychology course on scientific methods. They were conducted on March7 and 29 respectively in 1956.

Table 1. Tape measurements in cm. for the stimuli used in Experiment I.

Group	A	B	C	D	E
1	22	36	64	90	126
2	25	54	62	94	110
3	19	43	83	107	142
4	39	60	81	98	117
5	21	52	89	110	135
6	39*	39*	83	114	128
7	37	58	77	110	133
8	20	53	80	102	152
9	35	65	91	117	140
10	31	70	99	127	139
Means	28.8	53.0	80.9	106.9	132.2
S.D.	7.8	10.5	10.8	12.1	11.8

Table 2. Tape measurements in cm. for the stimuli used in Experiment II.

Group	M	N	L	O	P
1	77	89	105	78	67
2	66	79	82	82	94
3	77	95	83	102	87
4	68	95	89	84	101
5	76	85	87	93	82
6	80	89	99	91	78
7	70	82	81	92	86
8	81	99	89	102	81
9	76	87	97	78	93
10	69	78	83	81	88
Means	74.0	87.8	89.5	88.3	85.7
S.D.	5.0	6.8	7.8	8.6	9.0

previous tests but not quite as wide as ranges C and D taken together. The individual values for the second series of 50 stimuli are presented in Table 2. For each group the stimuli were displayed to the Os in successive order from L to P. On the average it was found that the first stimulus in each group tended to be a little shorter than the others of that group. This was not a planned difference. It seems to have resulted from a habit formed by E's former experience in presenting the stimuli of the earlier experiment.

Between groups of five trials in Expt. II a break interval of 60 sec. by stop-watch was introduced. The Os were requested to use this break for close study of their degree of success on this past set of five judgments, and to fix their mental sights for the trials that were to follow. The subjects appeared to cooperate well with this suggestion and spent very little time merely glancing about the room. Following the 5th group of five trials the record blanks were turned face down and the class listened to a 15-min. lecture on a quite different subject. The second half of Experiment II was carried out with the same routine as the first half except at a little faster tempo. The record blanks were similar for both experiments. For the second a blank line was left below each group of five trials for later use in working up the data. This also proved useful to the subjects in clarifying the progress of the series of tests for them.[1]

Results for Experiment I

Under estimation was the dominant tendency in these judgments of small horizontal tangent distances. There were 29 Os and each recorded 50 estimates thus providing a sample of 1450 judgments. A total of 847 or 58.4 per cent of the judgments were in the minus direction. There were 509 or 35.1 per cent of plus judgments and 94 or 6.5 per cent of correct estimates.[2] The algebraic average of the 29 individual scores gave an observer-group mean for each of the 50 stimuli employed. These 50 means, which are in per cent of stimuli, are presented in Table 3 which is arranged in the same order as used for the stimulus lengths in Table 1. From left to right in Table 3 the vertical columns represent the results for the five stimulus ranges, A to E, which averaged respectively: 28.8, 53.0, 80.9, 106.9,

(1) The Os were not asked to use the backs of their record sheets for comments. Their remarks might have developed some useful information. Unfortunately there was not time for this additional task.

(2) These latter were mostly cases of estimations in round numbers on stimuli that chanced to measure in round numbers (5s or Os). There were 13 such stimuli (See Table 1) out of the 50 used and these collected 57 or 61 per cent of the correct judgments.

Table 3. Group results for estimations on five ranges of tape-measure lengths used in Experiment I. The subjects were 29 university students in psychology.

Trial Group	GROUP ERRORS AS PER CENT OF STIMULUS					Group Means
	A	B	C	D	E	
1	+9.54 <.01	+1.53 —	−2.48 —	+ 1.88 —	−3.80 <.05	+1.33
2	−6.88 <.05	−11.42 <.001	−3.16 <.05	−4.15 <.01	+5.50 <.01	−4.02
3	−7.08 <.05	−6.82 <.001	−5.78 <.01	+3.22 <.05	+4.08 —	−2.48
4	−7.33 <.01	−9.80 <.001	−1.83 —	+0.71 —	+1.06 —	−3.44
5	−11.47 <.001	−12.15 <.001	−4.12 —	+0.50 —	+4.09 <.02	−4.63
6	−3.72 —	−3.72 —	−10.07 <.001	−5.17 <.01	+3.75 <.05	−3.79
7	−0.57 —	−5.18 <.01	−0.95 —	−0.84 —	+1.04 —	−1.30
8	+0.02 —	−8.34 <.01	−4.18 <.02	+2.80 —	+2.20 —	−1.50
9	−2.65 —	−7.15 <.001	−6.64 <.001	−2.83 <.02	+0.39 —	−3.78
10	+2.22 —	−8.44 <.001	−3.00 —	−1.84 —	+3.13 <.05	−1.59
Means 2–10	−4.17	−8.11	−4.41	−0.84	+2.80	−2.95
Means 2–5	−8.19	−10.05	−3.72	+0.07	+3.65	−3.64
Means 6–10	−0.94	−6.57	−4.97	−1.58	+2.13	−2.39

and 132.2 cm. The prevalence of minus signs is immediately obvious. There are 32 means that show a group preponderance of under estimation. They range from —0.57 to —12.15 and average —5.43 per cent. The means that have plus signs range from +0.02 to +9.54, they average +2.65 per cent of stimulus and tend to occur with stimuli 1 m. or longer in length.

Slightly more than half, 27 of 50 group means, reported in Table 3 are based on data which show good statistical stability. Considering these means as judgment differences from their respective standards (the stimuli lengths) these 27 means meet the criterion of P = .05 level of confidence or better. Some of the means that demonstrate this level of statistical significance represent the over estimation tendency but most of them are associated with the stronger tendency for under estimation in judging the stimuli that were presented and under the conditions employed.[1] The under estimation trend seems clear for stimulus lengths from about 20 to 80 cm., ranges A, B, and C. In range E, 110 to 152 cm., 9 of the 10 means represent over estimation. D appears to be a transition range. Here 5 means were plus and 5 were minus but those with minus signs tended to be the larger (average —2.98 compared to +1.82) so that the total mean for trial groups 2-10, Table 3, Col. D., was —0.84.

The predominance of under estimation in ranges A, B, and C, and of over estimation in range E has been mentioned. These tendencies did not appear, however, in the first group of five trials, see Table 3. Apparently one trial in each range was necessary as preliminary orientation for the subjects. Therefore the averages at the bottom of Table 3 do not include group 1. The means for groups 2 to 10 inclusive for ranges A to E were found to be: —4.17, —8.11, —4.41, —0.84 and +2.80 per cent, and the grand average for these five ranges was —2.95 per cent. Stimulus range B, 36 to 70 cm., gave decidedly the strongest indication of the under estimation tendency of judgment found in this experiment.

The design of Expt. I was not supposed to be highly favorable for learning achievement. Reinforcement through immediate knowledge of results could not be maximized for learning as the succeeding stimulus was usually quite different from the proceeding one.[2] The Os had to fumble about to find ways for taking hold of the task. These difficulties not withstanding there soon was some improvement in relative accuracy of group judgments that took place within the single experimental session. This reduction in the constant error tendencies is revealed in the comparative sets of means presented at the bottom of Table 3. Means are given for trial groups 2-5 inclusive and for trial groups 6 to 10 inclusive, in other words the last half of the judgments is contrasted with the first half minus the first 5 trials. For ranges A and B there was a considerable decrease in the under estimation tendency. A dropped from —8.19 to —0.94 per cent, and B from

(1) Especially the means that gave P = .01 or .001 are found to be of minus sign.

(2) Within the series of 50 stimuli there was one instance where two stimuli of the same length, 39 cm., occured in succession, see Table 1. For both of these stimuli the mean group score was —3.72 per cent, even though the individual pairs of scores showed some differences as would be expected.

—10.05 to —6.57 per cent. Range C revealed no decrease, —3.72 compared with —4.97. Range D shifted to —1.58 and range E showed a decrease in over estimation tendency from +3.65 to +2.10 per cent. The over all change in the last 25 trials compared with the previous 20 was a reduction in judgment error amounting to 1/3, that is, —3.64 to —2.39 per cent.

Estimating in Round Numbers

Approximation judgments tend to precede those that are more precise. Precision may develop with experience. The use of round numbers signifies a course scale for psychological approach to the problem of estimation. The 29 Os in Expt. I recorded judgments ending in the digits 5 or 0 in 56.2 per cent of their total sample. On a chance basis the occurrence of each of the ten digits as terminal numbers in estimates might be expected to amount to 10 per cent of the trials. The general result 56.2/20 equals 2.81 in place of 1.00. This tendency did not decrease much in the second half of the experiment. In the first half the number of judgments ending in 5 or 0 amounted to 416/725 = 57.4 per cent, in the second half the fraction was 400/725 = 55.2 per cent, a difference of 2.2.

On a centimeter scale the digits 5 and 0 occur with equal frequency. There is however more frequent use for zero or 10s than of 5s by the 29 subjects. The combined frequency was 816/1450, but the proportion was 457/359. This amounted to 27 per cent more frequent use of the less precise of the two psychological scales for approximating extents in the range 20 to 150 cm. The mean for the use of 5s by the group was 359/29 = 12.4, and for the use of zeros was 457/29 = 15.8. The difference, 3.4, does not quite qualify at the. 05 level of confidence due chiefly to high variance in one case but is an interesting psychological trend.

The 29 Os may be divided into two groups on the basis of frequency of use of the 5s and 10s. The prediction would be that the sub-group making more use of these terminal digits would show the larger average error of estimate. There were 15 Os who used these digits in half or more of their recorded judgments. See Table 4. Their average use was 37.3/50 = 74.6 per cent. There were 14 Os who used these course psychological tools in less than half of their reported estimates and their average was 18.3/50 = 36.6 per cent, see Table 5. One group used the round numbers about twice as much as the other sub-group. In Table 4 there are 150 data entries, 2 show zero scores, 40 are plus scores, 26.6 per cent, and 108 are minus scores, 72.4 per cent. Nine of the 10 averages are minus, 12 of 15 means for groups 2 to 5 are minus, 13 of 15 means for groups 6 to 10 are minus. In Table 5 there are 140 entries, 2 show zero scores, 46 are plus, 32.8 per cent, 92

Table 4. Results for 15 subjects who used round numbers in more than half of their judgments in Experiment I.

O's. No.	STIMULUS SETS OF FIVE TRIALS EACH										Means	Means
	1	2	3	4	5	6	7	8	9	10	2-5	6-10
2	-2.8	-13.2	+4.8	-9.0	-12.1	-2.6	-10.4	-4.2	-5.2	-4.8	-7.37	-5.44
3	+1.8	-3.2	-6.6	-3.2	-3.8	-6.4	+2.4	-5.4	-3.8	+0.4	-4.20	-2.56
6*	0.0	-8.2	-12.8	-8.4	-18.8	-14.4	-11.8	-1.0	-12.6	-3.2	-12.05	-8.60
9	+11.6	-3.0	+1.8	+2.0	-15.4	-3.4	+4.0	-5.2	-2.4	+3.4	-3.65	-0.72
11	+3.2	-18.8	-14.0	-8.0	-7.2	-6.4	-5.2	-7.6	-5.0	-2.8	-13.25	-5.40
12	-2.0	-7.8	-4.4	-4.6	-0.4	-1.0	-5.2	+2.6	-5.0	-5.4	-4.30	-2.80
13	+6.8	-2.6	+10.0	-4.8	+1.4	-7.6	-7.0	+6.2	-6.4	-7.8	+1.00	-4.52
18*	+5.8	-9.6	-14.2	-10.0	-11.6	-16.4	-4.2	-6.4	+0.4	+1.0	-11.86	-5.12
19*	+2.6	+5.4	-4.4	-3.8	-8.2	-5.4	+1.8	+8.2	-7.2	-2.6	-2.75	-1.04
20*	+8.0	0.0	-2.0	-6.0	-5.6	-1.4	-4.0	-4.8	-1.0	-6.2	-3.40	-3.48
22	+3.8	+13.6	-1.8	-4.2	+6.8	-3.6	-2.0	+3.0	+6.8	+6.4	+3.60	+2.72
24	-5.0	-9.2	-10.8	-7.0	-5.6	-7.6	-1.0	-8.6	+0.4	-0.4	-8.15	-3.44
25	+4.2	-7.6	+0.6	-1.8	-2.2	-6.6	+0.4	-9.2	-1.6	+4.6	-2.75	-2.48
26	-5.4	-0.2	-4.8	+7.6	-0.4	+4.8	+3.2	+3.0	-1.4	-2.6	+0.55	+1.40
27	-2.0	-3.0	-1.8	-9.4	-5.0	-2.8	-3.4	+6.0	-2.0	+1.4	-4.80	-0.16
Mean Per cent	+1.64	-4.56	-4.02	-4.70	-5.88	-5.38	-2.82	-1.56	-3.06	-1.24	-4.79	-2.87

Os with * after the number did not take part in Expt. II.

are minus, 65.6 per cent. Eight of 10 general averages show minus, 10 of 14 means for groups 2 to 10 are minus. The two tables are quite comparable as general pictures of the trend of judgments in the experiment. However, the final average results shown at the lower right of each table, when compared, reveal the fact that the subjects who used the round numbers in more than half their estimates did less well than their fellow students. For trial groups 2 to 5 the comparable averages are —4.79 and —2.45, and for trial groups 6 to 10 we find —2.81 as against —1.95 per cent.

Estimation in Reference to Observer's Position

As explained earlier the seating of the Os was arranged at two rows of class room tables. There were 13 seated at the tables in row A and their

Table 5. Results for 14 subjects who used round numbers in less than half of their judgments in Experiment I.

O's.	STIMULUS SETS OF FIVE TRIALS EACH										Means	Means
No.	1	2	3	4	5	6	7	8	9	10	2 - 5	6-10
1 *	-4.8	-5.4	-5.6	-3.0	-1.8	+0.8	-1.4	+5.4	-3.4	+2.4	-3.95	+0.76
4	+4.4	-9.8	+1.4	-0.2	-6.0	-0.4	-2.6	-1.2	-7.6	-0.2	-3.65	-1.20
5	-0.8	-8.4	+5.2	+2.2	+4.6	-2.6	-1.4	-2.6	-15.0	-6.6	+0.90	-5.64
7	-1.4	-3.2	-0.4	-6.0	-6.0	+0.2	-5.2	+3.6	+4.4	-2.6	-3.90	+0.08
8	+2.6	-5.6	-2.6	-1.2	+1.8	+1.6	+1.6	+7.2	-1.4	-0.4	-1.90	+1.72
10	-10.8	+0.2	+6.4	+1.6	+2.6	-6.0	+8.2	+1.2	-4.8	-3.2	+2.70	-0.92
14	-3.8	-11.4	-7.4	-1.8	-6.2	-9.8	+3.6	-4.8	-4.4	+2.0	-6.70	-2.68
15 *	+8.2	-5.4	-9.8	-2.0	-9.4	-2.8	+6.4	-1.4	+0.4	-5.2	-6.65	-0.52
16 *	+10.2	+6.0	+10.4	+5.8	+3.2	+2.2	+2.0	+8.4	-10.8	+4.0	+6.35	+1.16
17 *	+6.0	+0.8	-5.8	-4.6	0.0	+2.8	+9.8	-6.2	0.0	+2.0	-2.40	+1.68
21	+13.6	+14.4	-3.2	-0.4	-9.4	-12.0	-8.2	-18.2	-4.8	-6.4	+0.35	-9.92
23	+1.8	-6.4	-3.6	-1.4	-7.2	-3.2	+0.8	-3.4	-3.8	-3.0	-4.65	-2.52
28	-4.6	-11.6	-1.4	-3.2	-5.0	-0.6	-4.4	-0.8	-10.2	-72.2	-5.30	-5.64
29	-6.0	-3.4	-7.8	-7.8	-9.0	-3.0	-7.8	-7.0	-2.2	+1.4	-5.50	-3.72
Mean Per Cent	+1.00	-3.51	-1.30	-1.57	-3.41	-2.34	+0.10	-1.41	-4.11	-2.00	-2.45	-1.95

Os with * after the number did not take part in Expt. II.

distance from the stimulus tape ranged from 6.7 to 3.4 meters. The 130 average scores for this group are presented in Table 6. There were 16 subjects seated at the nearer tables, row B, and their distance from the stimulus ranged from 5.5 to 6.6 m., see Table 7. The mean values for the vertical columns of both these tables, except for column 1, are all of minus sign. The under estimation trend is larger in Table 6. The mean for the 9 groups, 2 to 10 inclusive, is here —3.87. per cent while for Table 7 the comparable mean is —2.22 per cent. The difference in favor of the Os who were nearer the stimulus is rather large, 2.22/3.87 = 57.4 per cent. Most of this difference applies to the first half of the experiment. The averages for groups 2 - 5 are —5.83, and —1.89 respectively, while for the groups 6 to 10 they are nearly equal, —2.30 and —2.48. There may have been some adjustment on the part of the more distant subjects tending to compensate for the handicap.

Table 6. Results for 13 subjects seated in Row A at 6.7 to 8.4 meters from the stimuli in Experiment I.

O's. No.	STIMULUS SETS OF FIVE TRIALS EACH										Means 2-5	Means 6-10
	1	2	3	4	5	6	7	8	9	10		
1	-4.8	-5.4	-5.6	-3.0	-1.8	+0.8	-1.4	+5.4	-3.4	+2.4	-3.95	+0.76
2	-8.8	-13.2	+4.8	-9.0	-12.1	-2.6	-10.4	-4.2	-5.2	-4.8	-7.38	-5.44
7	-1.4	-3.2	-0.4	-6.0	-6.0	+0.2	-5.2	+3.6	+4.4	-2.6	-3.90	+0.08
11	+3.2	-19.8	-14.0	-8.0	-7.2	-6.4	-5.2	-7.6	-5.0	-2.8	-12.25	-5.40
12	-2.0	-7.8	-4.4	-4.6	-0.4	-7.0	-5.2	+2.6	-5.0	-5.4	-4.30	-2.80
14	-3.8	-11.4	-7.4	-1.8	-6.2	-9.8	+3.6	-4.8	-4.4	+2.0	-6.70	-2.68
15	+8.2	-5.4	-9.8	-2.0	-9.4	-2.8	+6.4	-1.4	+0.4	-5.2	-6.66	-0.52
17	+6.0	+0.8	-5.8	-4.6	0.0	+2.8	+9.8	-6.2	0.0	+2.0	-2.40	+1.68
18	+5.8	-9.6	-14.2	-10.0	-11.6	-16.4	-4.2	-6.4	+0.4	+1.0	-11.35	-5.12
19	+2.6	+5.4	-4.4	-3.8	-8.2	-5.4	+1.8	+8.2	-7.2	-2.6	-2.75	-1.04
20	+8.0	0.0	-2.0	-6.0	-5.6	-1.4	-4.0	-4.8	-1.0	-6.2	-3.40	-3.48
24	-5.0	-9.2	-10.8	-7.0	-5.6	-7.6	-1.0	-8.6	+0.4	-0.4	-8.15	-3.44
25	+4.2	-7.6	+0.6	-1.8	-2.2	-6.6	+0.4	-9.2	-1.6	+4.6	-2.75	-2.48
Mean Per Cent	+0.94	-6.64	-5.64	-5.20	-5.86	-4.32	-1.12	-2.57	-2.09	-1.38	-5.83	-2.30

Another division of the Os into two sub-groups was made for comparison of central and peripheral seating positions. There were 15 Os who were located at the two tables that were next the wall on each side of the room. These students viewed the stimuli from positions that were 13° to 25° oblique from the plane represented by the tape. Their results have been compiled in Table 8. The four central class-room tables, the two in row A, and the two in row B, in front of them, seated 14 Os and their results in terms of average scores have been incorporated in Table 9. Again it is seen, as expected, that the averages for all vertical columns, except for No. 1 are minus values, and the large majority of the averages for horizontal columns (individual observers) are of minus sign. The total average for groups 2 to 10 for the outside Os was —3.00 and for the inside group —2.92, a minor difference. But in the fore part of the experiment there was a larger difference, —4.20 as compared with —3.08. Here the more centrally located Os seem to do about 27 per cent better than their associates. And again, in the second half of the trials those who were under handicaps due to viewing position (the oblique locations) appear to have compensated for

Table 7. Results for 16 subjects seated in Row B at 5.5 to 6.6 meters from the stimuli in Experiment I.

O's.	STIMULUS SETS OF FIVE TRIALS EACH										Means	Means
No.	1	2	3	4	5	6	7	8	9	10	2–5	6–10
3	+1.8	-3.2	-6.6	-3.2	-3.8	-6.4	+2.4	-5.4	-3.8	+0.4	-4.20	-2.56
4	+4.4	-9.8	+1.4	-0.2	-6.0	-0.4	-2.6	-1.2	-1.6	-0.2	-3.65	-1.20
5	-0.8	-8.4	+5.2	+2.2	+4.6	-2.6	-1.4	-2.6	-15.0	-6.6	+0.90	-5.64
6	0.0	-8.2	-12.8	-8.4	-18.8	-14.4	-11.8	-1.0	-12.6	-3.2	-12.05	-8.60
8	+2.4	-5.6	-2.6	-1.2	+1.8	+1.6	+1.6	+7.2	-1.4	-0.4	-1.90	+1.72
9	+11.6	-3.0	+1.8	+2.0	-15.4	-3.4	+4.0	-5.2	-2.4	+3.4	-3.65	-0.72
10	-10.8	+0.2	+6.4	+1.6	+2.6	-6.0	+8.2	+1.2	-4.8	-3.2	+2.70	-0.92
13	+6.8	-2.6	+10.0	-4.8	+1.4	-7.6	-7.0	+6.2	-6.4	-7.8	+1.00	-4.52
16	+10.2	+6.0	+10.4	+5.8	+3.2	+2.2	+2.0	+8.4	-10.8	+4.0	+6.35	+1.16
21	+13.6	+14.4	-3.2	-0.4	-9.4	-12.0	-8.2	-18.2	-4.8	-6.4	+0.35	-9.92
22	+3.8	+13.6	-1.8	-4.2	+6.8	-3.6	-2.0	+3.0	+6.8	+6.4	+3.60	+2.12
23	+1.4	-6.4	-3.6	-1.4	-7.2	-3.2	+0.8	-3.4	-3.8	-3.0	-4.65	-2.52
26	-5.4	-0.2	-4.8	+7.6	-0.4	+4.8	+3.2	+3.0	-1.4	-2.6	+0.55	+1.40
27	-2.0	-3.0	-1.8	-9.4	-5.0	-2.8	-3.4	+6.0	-2.0	+1.4	-4.80	-0.16
28	-4.6	-11.6	-1.4	-3.2	-5.0	-0.6	-4.4	-0.8	-10.2	-12.2	-5.30	-5.64
29	-6.0	-3.4	-1.8	-7.8	-9.0	-3.0	-7.8	-7.0	-2.2	+1.4	-5.50	-3.72
Mean Per Cent	+1.65	-1.95	-0.32	-1.56	-3.72	-3.58	-1.65	-0.61	-4.77	-1.79	-1.89	-2.48

this and, for groups 6 to 10, show an average of —2.03 which is rather better than the average —2.79 found in Table 9 for the more centrally located observers.

Results for Experiment II

Brief mention may be made of the distinctive conditions used in Experiment II. There were five respects in which it differed from the previous one. First, only one range of stimuli was employed and this was from 66 to 105 cm. Second, there was a 60 sec. pause after each group of five stimuli. Third, stress was placed on using the 60 sec. pauses to study previous results so as to improve later estimates. Fourth, after the 5th group of 5 stimuli, i.e. after 25 stimuli had been presented to the observers, there was a 15-min. break. During this interval the record sheets were turned

Table 8. Results for 15 subjects seated at tables near the sides of the room in Experiment I.

O's. No.	GROUP ERRORS AS PER CENT OF STIMULUS										Means	Means
	1	2	3	4	5	6	7	8	9	10	2-5	6-10
3	+1.8	-3.2	-6.6	-3.2	-3.8	-6.4	+2.4	-5.4	-3.8	+0.4	-4.20	-2.56
4	+4.4	-9.8	+1.4	-0.2	-6.0	-0.4	-2.6	-7.2	-1.6	-0.2	-3.65	-1.20
6	0.0	-8.2	-12.8	-8.4	-18.8	-14.4	-11.8	-7.0	-12.6	-3.2	-12.05	-8.60
10	-10.8	+0.2	+6.4	+1.6	+2.6	-6.0	+8.2	+1.2	-4.8	-3.2	+2.70	-0.92
11	+3.2	-19.8	-14.0	-8.0	-7.2	-6.4	-5.2	-7.6	-5.0	-2.8	-12.25	-5.40
14	-3.8	-11.4	-7.4	-1.8	-6.2	-9.8	+3.6	-4.8	-4.4	+2.0	-6.70	-2.68
15	+8.2	-5.4	-9.8	-2.0	-9.4	-2.8	+6.4	-1.4	+0.4	-5.2	-6.65	-0.52
16	+10.2	+6.0	+10.4	+5.8	+3.2	+2.2	+2.0	+8.4	-10.8	+4.0	+6.35	+1.16
17	+6.0	+0.8	-5.8	-4.6	0.0	+2.8	+9.8	-6.2	0.0	+2.0	-2.40	+1.68
18	+5.8	-9.6	-14.2	-10.0	-11.6	-16.4	-4.2	-6.4	+0.4	+1.0	-11.35	-5.12
19	+2.6	+5.4	-4.4	-3.8	-8.2	-5.4	+1.8	+8.2	-7.2	-2.6	-2.75	-1.04
20	+8.0	0.0	-2.0	-6.0	-5.6	-1.4	-4.0	-4.8	-1.0	-6.2	-3.40	-3.48
22	+3.8	+13.6	-1.8	-4.2	+6.8	-3.6	-2.0	+3.0	+6.8	+6.4	+3.60	+2.72
27	-2.0	-3.0	-1.8	-9.4	-5.0	-2.8	-3.4	+6.0	-2.0	+1.4	-4.80	-0.16
29	-6.0	-3.4	-1.8	-7.8	-9.0	-3.0	-7.8	-7.0	-2.2	+1.4	-5.50	-3.72
Mean per Cent	+2.09	-3.19	-4.28	-4.13	-5.21	-4.92	-0.45	-1.27	-3.18	-0.32	-4.20	-2.03

face down and E endeavored to give an interesting lecture on a quite different topic, and so divert the attention of the group from the experimental routine. The fifth difference between Expts. I and II was that in the latter the majority of the Os were somewhat experienced having served in the first one, they were not naive about making such estimates.

The general results for Expt. II are represented in Table 10, which resembles Table 3 in its general arrangement. There are 50 entries of group means, 31 of these represent minus values and 19 are of plus sign. For comaprison, it may be noted that in Table 3 there are 32 means with minus and 18 with plus signs. If we treat these means without regard to signs we find that for Table 3 the average error of estimate was 4.42 per cent and for Table 10 the average was 4.88 per cent. In an over-all view these tables seem quite comparable. However, each of these data displays shows its own more characteristic distribution pattern. For Table 3 columns A, B, C and D show predominance of minus values while column E is plus. In

Table 9. Results for 14 subjects seated at four tables near the central axis of the room in Experiment I.

O's.	STIMULUS SETS OF FIVE TRIALS EACH										Means	Means
No.	1	2	3	4	5	6	7	8	9	10	2-5	6-10
1	-4.8	-5.4	-5.6	-3.0	-1.8	+0.8	-1.4	+5.4	-3.4	+2.4	-3.95	+0.72
2	-8.8	-13.2	+4.8	-9.0	-12.1	-2.6	-10.4	-4.2	-5.2	-4.8	-7.48	-5.44
5	-0.8	-8.4	+5.2	+2.2	+4.6	-2.6	-1.4	-2.6	-15.0	-6.6	+0.90	-5.64
7	-1.4	-3.2	-0.4	-6.0	-6.0	+0.2	-5.2	+3.6	+4.4	-2.6	-3.90	+0.08
8	+2.4	-5.6	-2.6	-1.2	+1.8	+1.6	+1.6	+7.2	-1.4	-0.4	-1.90	+1.72
9	+11.6	-3.0	+1.8	+2.0	-15.4	-3.4	+4.0	-5.2	-2.4	+3.4	-3.65	-0.72
12	-2.0	-7.8	-4.4	-4.6	-0.4	-1.0	-5.2	+2.6	-5.0	-5.4	-4.30	-2.80
13	+6.8	-2.6	+10.0	-4.8	+1.4	-7.6	-7.0	+6.2	-6.4	-7.8	+1.00	-4.52
21	+13.6	+14.4	-3.2	-0.4	-9.4	-12.0	-8.2	-18.2	-4.8	-6.4	+0.35	-9.72
23	+1.4	-6.4	-3.6	-1.4	-7.2	-3.2	+0.8	-3.4	-3.8	-3.0	-4.65	-2.52
24	-5.0	-9.2	-10.8	-7.0	-5.6	-7.6	-1.0	-8.6	+0.4	-0.4	-8.15	-3.44
25	+4.2	-7.6	+0.6	-1.8	-2.2	-6.6	+0.4	-9.2	-1.6	+4.6	-2.75	-2.48
26	-5.4	-0.2	-4.8	+7.6	-0.4	+4.8	+3.2	+3.0	-1.4	-2.6	+0.55	+1.40
28	-4.6	-11.6	-1.4	-3.2	-5.0	-0.6	-4.4	-0.8	-10.2	-12.2	-5.30	-5.64
Mean per Cent	+0.51	-4.98	-1.03	-2.18	-4.12	-2.84	-2.44	-1.73	-3.98	-2.98	-3.08	-2.79

Table 10 (Expt. II) columns L, M, and P show the predominance of minus values while N and O tend to show plus estimation means. For Expt. II it seems unnecessary to set off the first group of 5 trials as preliminary practice. In the right hand column, headed "Group Means" in Table 10, it will be observed that of the 10 groups of stimuli 8 gave means with minus signs. The general tendency is therefore for this judgment behavior to exhibit a marked preference for under estimation.

A cyclic trend in judgments seems superimposed on this general tendency to guess to low. In the means shown at the bottom of Table 10, Column L, the first stimulus after a 60 sec. pause, gave strong minus results throughout with an average of —9.27 per cent for the ten stimulus groups. For stimulus position M the mean, although also minus, is much smaller, —1.56. The "minus tendency" seems compensated at position N where 6 of the groups means show plus and the average is +0.37 per cent. The fourth stimulus in the cycle seems to show an excess of compensation resulting in a mean of +1.11. And now on the fifth stimulus, P, the trend to

Table 10. Group results for estimations of tapemeasure lengths ranging from 66 to 105 cm. as used in Experiment II. The subjects were 32 university students in psychology.

Trial Group	GROUP ERRORS AS PER CENT OF STIMULUS					Group Means
	L	M	N	O	P	
1	−10.20 <.001	− 4.10 <.01	− 0.42 —	− 12.53 <.001	− 8.21 <.001	− 7.09
2	− 8.48 <.001	− 1.43 —	+ 3.32 <.02	+ 3.20 >.05	+ 5.43 <.031	+ 0.41
3	− 7.44 <.001	+ 0.59 —	− 6.60 <.01	+ 4.43 <.001	− 3.85 <.02	− 2.57
4	− 11.75 <.001	+ 5.17 <.01	+ 1.79	+ 14.42 <.001	− 0.03	+ 1.92
5	− 15.23 <.001	− 5.00 <.001	− 0.54 —	− 3.29 <.01	− 6.75 <.001	− 6.16
6	− 3.92 .02	− 1.06 —	+ 2.93 >.02	+ 2.14	− 9.86 <.001	− 1.96
7	− 10.62 <.001	− 3.47 <.02	− 0.65 —	+ 5.20 <.001	+ 5.02 <.001	− 0.90
8	− 9.14 <.001	+ 0.10 —	+ 0.84 —	+ 1.35	− 6.41 <.001	− 2.65
9	− 8.56 <.001	− 2.40 <.01	+ 2.20 <.05	− 5.38 <.001	− 2.49 <.05	− 3.33
10	− 7.34 <.001	− 4.05 <.01	+ 0.87 —	+ 1.55	+ 2.77 <.02	− 1.24
Means 1-10	− 9.27	− 1.56	+ 0.37	+ 1.11	− 2.44	− 2.36
Means 1-5	− 10.62	− 0.95	− 0.49	+ 1.25	− 2.68	− 2.70
Means 6-10	− 7.92	− 2.18	+ 1.24	+ 0.97	− 2.19	− 2.02

"pull up" the judgments seems to have relaxed and the minus tendency again taken over, —2.44, but not as strongly as will appear at the start of the next cycle. There is indeed quite large variation among the 10 trial

groups shown in Table 10, but the cyclic pattern of starting with a strong minus for stimulus sequence L, decreasing the minus trend in sequences M and N, achieving a plus status for O and reverting to minus on the fifth stimulus member seemed a persistent one. It is apparent in the series of means for groups 1 to 5, and also in the means for groups 6 to 10 with only slight modification, and may be considered one of the major findings of this study. It is noteworthy that after the sixty seconds break the majority estimate tendency again comes in strongly even though most of the Os must have seen that their previous judgment was in the minus direction. Noteworthy also is the fact that the 15-minute break did not change the general behavior pattern from the trend found in the first half of the trials.

The data from this class experiment seem to qualify as a reasonably good sample since 36 of the 50 means, considered as deviations from their respective standards, show statistical reliability at the .05 level of confidence or better, usually better. In fact, 21 of the 36 mean differences show P = 001.

In terms of the grand averages, the Os in Experiment II did a little better than in Experiment I, since the means are in terms of per cent of the stimuli comparison of the two sets is justifiable and shows the following:

Expt. I Groups 2 to 10, —2.95; Groups 2 to 5, —3.64; Groups 6 to 10, —2.39.

Expt. II Groups 1 to 10, —2.36; Groups 1 to 5, —2.70; Groups 6 to 10, —2.02.

The amount of improvement shown between the first and second halves is not as prominent in Expt. II as in No. I, 2.02/2.70 = 74.8 per cent, 2.39/3.64 = 65.7 per cent.

In Expt. II the Os did not make as much use of round numbers as previously although no instruction to this effect had been given. Still the incidence was 497/1600 = 31 per cent and in terms of the two halves, 1st half, 295/800 = 38.2 per cent and 2nd half, 202/800 = 25.3 per cent. Again a test may be made of the hypothesis that those who more frequently used zeros and fives as terminal digits in their judgments will tend to make the larger errors. This test has been made for Expt. II in Tables 11 and 12. The 16 Os reported in Table 11 used the round numbers in more than 30 per cent of their judgments and in 9 of the vertical columns representing the 10 sets of trials minus means are found. The grand average for groups 1 to 5 inclusive was found to be —3.30 and for groups 6 to 10, —2.64 per cent. The 16 Os whose results are reported in Table 12, used round numbers in 30 per cent or less of their judgments. In this table 2 of the 10 vertical columns for the sets of trials show plus means and it was found that the mean for groups 1 to 5 was —2.15, and for groups 6 to 10, was —1.43 per cent. Comparing these means we have 2.15/3.30 = 65.2 per cent for

Table 11. Results for 16 subjects who used round numbers in more than 30 per cent of their judgments in Experiment II.

O's No.	STIMULUS SETS OF FIVE TRIALS EACH										Means	Means
	1	2	3	4	5	6	7	8	9	10	1-5	6-10
1_2	-6.1	+1.0	-14.3	+6.6	-5.2	-1.6	-2.0	-6.6	-7.1	+4.0	-3.60	-2.66
5_8	-9.5	-10.4	-3.2	-4.0	-7.3	-0.7	+2.6	-4.9	-2.8	-1.9	-6.88	-1.54
7	-13.0	-9.7	-9.1	+0.7	-6.7	-8.9	-3.0	-5.9	-1.3	-1.0	-7.56	-4.02
10_9	-7.3	-0.8	-1.8	+1.2	-5.2	+1.1	-2.3	-0.2	-2.9	-0.3	-2.78	-0.92
13	-4.7	-3.8	-2.3	+6.0	-4.9	+2.6	-3.4	-7.5	-10.7	-7.1	-1.94	-5.22
15_{11}	+0.6	-1.5	-4.8	+1.4	-10.1	-3.3	+10.2	-2.0	-2.7	+5.6	-2.88	+1.56
16	-2.2	+5.8	+6.3	+3.4	-5.9	+0.2	-1.7	+3.3	-3.1	+1.3	+1.48	0.00
17	-1.8	+1.3	+0.3	+1.1	-3.7	+1.7	-3.7	+0.8	-7.2	-7.1	-0.58	-1.90
18_{12}	-6.4	-0.8	-2.6	+0.3	-7.0	+0.6	-6.8	-2.2	-5.2	+3.5	-3.30	-2.02
19_{13}	-10.3	-7.2	-7.5	+1.1	-8.7	-8.1	-0.8	-3.6	-3.0	-5.7	-6.58	-4.24
23_{22}	+4.3	+5.3	-2.8	+0.9	-11.0	-0.9	-6.0	-4.7	-1.4	-3.0	-0.66	-3.20
24_{23}	-4.6	+3.4	+1.9	-2.0	-1.7	-5.6	-2.7	-7.7	0.0	-1.2	-0.60	-3.44
25	-12.9	-1.6	-3.3	-0.2	-7.4	-0.4	+0.3	+7.0	-5.1	-3.3	-5.08	-0.36
26_{24}	-12.3	+3.9	+0.8	+4.4	-5.2	0.0	+1.9	-1.4	-1.9	+1.1	-1.68	-0.06
27	-18.3	+1.3	-5.0	+3.2	-6.1	-4.7	-1.9	-8.6	-15.8	-11.4	-4.98	-8.48
28	-10.1	+0.8	-0.8	-6.3	-10.4	-13.1	-5.1	-7.7	-3.5	+0.5	-5.36	-5.78
Mean Per Cent	-7.16	-0.81	-3.01	+1.11	-6.66	-2.57	-1.52	-3.24	-4.60	-1.25	-3.30	-2.64

The digits in small type following an O's number provide the number for the same O as reported for Exp. I in Tables 4 and 5. Numbers not followed by small digits represent Os who served only in Exp. II.

groups 1 to 5, and 1.43/2.64 = 54.2 per cent for groups 6 to 10. This evidence indicates that those making less use of the round numbers made errors that were 1/3 to 2/5 smaller than for the other group of estimators.

One or more correct estimates were made by 31 out of 32 of the Os in Expt. II, and the range was from 0 to 7. The 16 stronger users of round numbers in their estimates made a total of 48 correct judgments with an average of 3.0. On the other hand the 16 Os who used round numbers in 30 per cent or less frequency had a total of 57 correct judgments and an average of 3.56, representing a better performance by about 19 per cent.

As a summary of the presentation of results from these experiments an

Table 12. Results for 16 subjects who used round numbers in 30 per cent or less of their judgments in Experiment II

O's. No.	STIMULUS SETS OF FIVE TRIALS EACH										Means	Means
	1	2	3	4	5	6	7	8	9	10	1-5	6-10
2_{28}	-16.8	+0.8	+0.3	+5.5	-7.8	-2.7	0.0	-1.2	-2.6	-2.0	-3.60	-1.70
3_{3}	-2.6	-1.5	-0.1	+0.8	-4.0	-4.1	+1.0	+0.5	-4.0	-3.5	-1.48	-2.02
4_{4}	-6.6	-1.6	+2.2	-1.0	-8.7	-4.1	-0.4	+1.0	-4.1	+7.9	-3.14	+0.06
6_{7}	-0.5	+6.9	+5.4	+7.0	-0.5	-0.3	+0.3	+5.1	-1.5	+4.4	+3.66	+1.60
8	-12.6	+0.2	-8.9	+1.0	+0.5	-1.2	+0.3	-1.7	-1.7	0.0	-3.96	-0.86
9_{8}	+0.8	+4.4	+2.4	0.0	-4.4	+1.2	-2.0	-4.3	-6.1	-6.5	+0.64	-3.54
11	-7.5	+1.1	-8.1	-1.1	-4.6	-1.5	+6.2	-6.6	-1.8	-2.4	-4.04	-1.22
14_{10}	+2.2	+5.7	-5.1	+6.8	-4.4	-1.0	-1.7	-0.3	-2.5	+1.3	+1.04	-0.84
20_{14}	-7.2	+3.4	-1.6	-1.5	-6.1	-1.0	+0.5	-4.3	-3.8	-2.8	-2.60	-2.28
21	-11.9	+3.5	-2.9	+6.8	-9.6	-6.9	-0.2	-6.4	-1.5	+0.2	-2.82	-2.96
22_{21}	-11.3	-0.4	+4.4	-2.8	-9.2	+2.7	-2.3	-6.6	-2.5	-7.6	-3.86	-3.26
28_{25}	+0.5	+5.1	-0.8	+1.1	-8.3	-7.3	-3.4	-8.8	-4.3	-14.7	-0.48	-7.70
30_{27}	-3.2	+0.7	-5.9	+4.0	-2.9	-4.3	-4.1	-5.5	0.0	+5.1	-1.46	-1.76
31_{29}	+1.4	+1.9	+3.3	+9.1	-2.3	+5.2	-0.4	-2.1	+1.1	-0.6	+2.68	+0.64
32	-13.4	-4.4	-12.6	+3.2	-5.5	+3.8	+3.8	+0.8	+1.6	+0.5	-6.54	+2.10
33	-21.8	-5.3	-10.4	+3.0	-7.0	-1.3	-0.1	+4.6	+0.7	+0.9	-8.30	+0.96
Mean Per Cent	-6.90	+1.25	-2.40	+2.62	-5.30	-1.43	-0.16	-2.34	-2.06	-1.24	-2.15	-1.43

The digits in small type following an O's number provide the number for the same O as reported for Exp. I in Tables 4 and 5. Numbers not followed by small digits represent Os who served only in Exp. II.

analysis of the make-up of our sample populations of judgments may be reviewed. Summary of judgment samples in reference to sign value:

Expt. I, correct 94=6.5 %; plus 509=35.1 %; minus 847=58.4 %; total 1450.

Expt. II, correct 105=6.6 %; plus 611=38.2 %; minus 884=55.2 %; total 1600.

Correct judgments occured with nearly equal frequency in both sample populations. The distribution of such judgments with reference to the two halves of each experiment shows them slightly more frequent in the second half:

Expt. I, total correct 94; 1st half 46=49 %; 2 nd half 48=51 %.

Expt. II, total correct 105; 1st half 50=47.6 %; 2nd half 55=52.4 %.

Over estimation in these samples of space judgments was found in slightly more than one third of the trials. The comparative distribution for this element in the results shows about equal occurrence between first and second sections. This is seen in the following:

Expt. I total plus 509; 1st half 260=51.1 %; 2nd half 249=48.9 %.

Expt. II total plus 611; 1st half 299=49.0 %; 2nd half 312=51.0 %.

Judgments which showed under estimation tendency were substantially more frequent in each sample population than the plus and correct judgments combined. And again it was found that the minus estimates distribute themselves almost equally between the trials 1 to 25 and 26 to 50, respectively for each experiment:

Expt. I total minus 847; 1st half 419=49.5 %; 2nd half 428=50.5 %.

Expt. II total minus 884; 1st half 451=51.0 %; 2nd half 433=49.0 %.

These displays seem to indicate that the general pattern of estimation trends which developed in the first 25 trials persisted in the next 25 judgments, and that these trends were proportionally similar in both experiments even though the two differed as to stimulus range.

There were 41 different subject observers who served in one or both of the experiments here reported. No one of these Os throughout the 50 trials was consistently high or low in their estimation results. It was to be expected that some estimates would be plus and some minus and that the general tendency would be for the signs and their values to cancel each other. The experiments have revealed a dominating tendency toward under estimation. Inspection of Tables 4 and 5 for Expt. I and Tables 11 and 12 for Expt. II reveals only one instance where all 10 means for one subject are of minus sign (Table 5, No, 28). There are several instances where 8 or 9 of one subjects means are of minus sign. On the other hand there is one instance (Table 5, No. 16) of a subject who showed 9 plus means out of 10. But otherwise there were only 6 Os, counting both experiments, who showed as many as 6 plus means out of 10. Such comparisons indicate that our samples are not stratified with some observer having one tendency and others having the other tendency. Each 0 in his 50 judgments showed both plus and minus errors. But the latter predominate in both frequency and extent of displacement, and the total result is a picture of constant error of some statistical reliability.

CONCLUSION

This paper reports investigation of a problem that seems relatively new at least from the standpoint of methodology in the study of the psychology of judgment. Stimuli were presented to observers for their estimation with respect to length in centimeters. The experimenter who presented these stimuli did not know in advance what the lengths of the stimuli would be, but he did have an idea about and could exercise an influence on their range. He did not know in which direction or by what amounts successive stimuli would vary but he had some idea of the probable variation. This method of developing and presenting the stimuli did not permit the observer to define his task as that of "hitting a fixed target" through the exercise of careful judgment. The target was always changing. The error noted in one trial could not have maximal reinforcement value for learning since the stimulus for the next trial was always a new and probably a different one. The O might judge the new stimulus in reference to his memory of and experience with the preceeding one. He might judge the new stimulus rather independently of the preceeding one. For example, perhaps he could, in imagination, operationally apply a meter scale to the perceived bright strip of steel tape, "measure it", write down the result, and then note "the confirmation", when the actual stimulus length was announced. Another possibility is for the O to perceive the stimulus as an element in a patterned visual field. He might see it in relation to the dimensions of the human figure that extended the stimulus, held it for view, and thus served as background and frame of reference. This would be a paired comparison type of situation but not nearly as prescribed or well defined as having a chalk line on a blackboard above E which could serve as a standard length.

As a design for the study of judgment this model seems to fit many everyday human situations including some games. Perhaps it may be described as the method of average error used with single, successive stimuli of limited-accidental origin. In terms of amount of error tendency the experiment that made use of one rather wide range of stimuli (No. II) appeared to give more nearly correct group judgments than the one using five related ranges of stimuli. In both experiments as conducted the dominant group tendency was in the direction of under estimation. This constant error amounted to not more than 4 per cent. The observers made some improvement between the first and second half of each set of 50 trials, but this was of haulting and irregular character. Many in their guesses at first used subjective scales composed of units of 5 or 10 cms. This group trend slowly gave way to more precise responses. Individual observer results have not been featured in this report. The limited scope of the present study as regards experimental conditions leaves many questions unanswered.