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ABSTRACT

This paper reports the results of an experiment on the accuracy of information processing during attention focused arousal under two conditions: single estimation and double estimation. The attention of 187 college students was focused by a task requiring high level competition for a monetary prize ($10) under severely limited time conditions. The task was to give an accurate estimate of how many numbers there were in a set of numbers and to estimate their total accurately. Under the first condition, only one estimate was required, but under the second condition, upper and lower estimates are required. Of the 50 subjects who were able to complete the tasks under the time constraints, a high number reported extremely unbalanced estimates, revealing a lack of consistency between single and mid-double (mean of the double estimates) estimates that was indicative of overarousal for the levels of complexity of the tasks. The mid-double estimate appeared more accurate than the traditional single estimate, but additional research should be done where the press is reduced to match task complexity or the task complexity is reduced to match the level of the press. (SLD)

Accuracy of Information Processing Under Focused Attention

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ACCURACY OF INFORMATION PROCESSING UNDER FOCUSED ATTENTION

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Introduction

This experiment compares accuracy of information processing during a focused attention task under two conditions (a) the single judgement condition and (b) the double judgement condition. Subjects' attention was focused by a task requiring high level competition for monitory prizes under severely limited time conditions. The task was to give an accurate estimate how many numbers there were in a set of numbers and to accurately estimate their total. Under the first condition only one estimate was required. Under the second condition both an upper and lower estimate were required. The true values were only known to the experimenter.

The experiment

The experimental design was that 187 subjects taking an introductory university psychology class competed in degree of accurate judgement for a prize of $10 under the severely limited time conditions of 72 accuracy judgements in 7 minutes. The time conditions were so stringent that only 50 subjects completed (26.7%, consisting of 15 males and 35 females, aged 19-38 years). The stimulus materials were the same randomised numbers presented in two separate presentations. The first presentation required an accurate estimate of (a) how many numbers there were in the set, and (b) the total of the numbers. The second independent presentation required accurate upper and lower estimates of (a) and (b). Twelve sets of numbers were used in a 3x4 factor design consisting of 3 levels of 'how many numbers' by 4 levels of 'range of the numbers'.

Analysis

The analyses included assessments of 'press' and comparisons of accuracy under the two conditions using paired sample t-tests of condition (a) represented by differences between the single estimates and the true values, and condition (b) represented by the differences between the mean of the double estimates and the true values. The main effects and interactions were also analysed.

Significance of the research

One wide and significant application of this research is in the collection of highly valued questionnaire judgement responses. Under conditions where the mean of a double judgement is more accurate than a single judgement, and the response is highly valued, then it would be more effective to ask for an upper and lower bound as in condition (b) of this experiment.

Background

The inverted U relationship between attention focused arousal and task performance has been known since the early animal experiments of Yerkes and Dodson in 1908. Later, researchers showed that higher arousal can reduce the optimal performance of complex tasks and enhance the performance of simpler tasks (Hebb, 1955). More recently, information processing theory has be used to try and explain the complex interaction between attention focused arousal and accuracy on judgement tasks of varying complexity (Lee, 1995).

Methodology

Method

This paper reports the results of an experiment on the accuracy of information processing during attention focused arousal under two conditions (a) single estimation and (b) double estimation. Accuracy of estimation under each condition was compared. The significance of this research was that if the double estimate condition was to prove more accurate then data gathering techniques might utilise this result. For example, questionnaires might request an upper and lower rating rather than the traditional single rating and the mean of the double estimate (mid-double estimate) could be expected to be more accurate given the appropiate stress and difficulty level of the task. The stimulus materials in this experiment

consisted of 12 sets of numbers presented twice - once under condition (a) and once under condition (b). Subjects were required to estimate how many numbers there were in each set and to estimate the total of the numbers in each set. This was a 3x4 two factor complete randomised block design repeated over 50 subjects. The numbers in the 12 sets varied in two dimensions of complexity. There were three levels of 'how many numbers' and the numbers came in four logarithmically increasing ranges. The numbers within each of these 12 sets were randomly generated and their totals calculated. The 3x4 conditions, with the totals, are shown in table 1.

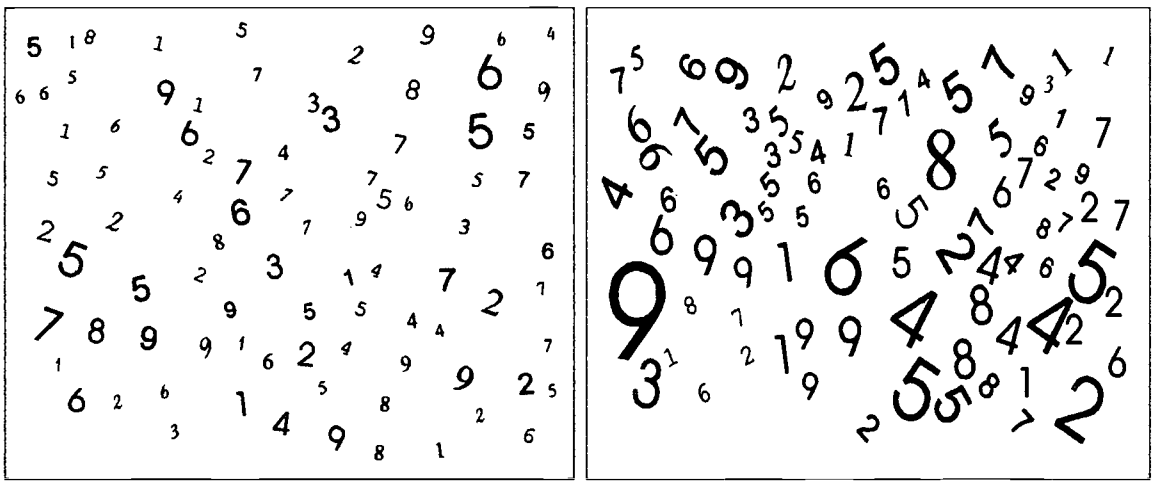
Factor levels of the 12 sets of numbers

Table 1: 3x4 factor design - 3 levels of 'how many numbers' and 4 levels of 'range'

Random number groups for Single Estimates												
Group	1	2	3	4	5	6	7	8	9	10	11	12
Range	9	99	999	9999	9	99	999	9999	9	99	999	9999
no.	27	27	27	27	87	87	87	87	146	146	146	146
Totals	172	1243	14325	137215	545	4538	50653	425128	884	7642	72126	792535
Random number groups for Double Estimates												
Group	1	2	3	4	5	6	7	8	9	10	11	12
Range	9	99	999	9999	9	99	999	9999	9	99	999	9999
no.	27	27	27	27	87	87	87	87	146	146	146	146
Totals	135	1115	13296	127185	444	4346	49560	415034	720	7387	70970	782378

In the single estimate condition subjects were required to give a single estimate of 'how many numbers' and the 'total' of each set. The 12 sets of numbers were randomised on one side of an A3 sheet of paper (11.75" x 14.5"). In the double estimate condition the 12 sets of random numbers were regenerated according to the same conditions, which gave different totals. They were then presented in randomised formats. In this second condition subjects were required to give an upper and lower estimate for both 'how many numbers' there were and their 'total'. To prevent subjects being able to easily match the sets in condition (a) with those in condition (b) the numbers in each set were randomised in font, in size, in position and each set was placed in a randomised position on the other side of the A3 sheet. Figure 1 shows, for format comparison, set 5 from condition (a) and (b)

Single and double estimate stimulus materials



			1st estimate	2nd estimate
How many numbers	1A1.	**How many numbers**	9B1.	9B2.
What is their total	1A2.	**What is their total**	9B3.	9B4.

Figure 1: Comparison of the randomised formatting of set 5 for condition (a) and (b)

Setting the arousal level for focused attention

The stimulus materials were administered to 187 volunteer university students on an introductory psychology course at the University of the South Pacific. The subjects' attention was focused by reducing the time for the 72 judgements to 7 minutes - 3 minutes for side (a) and 4 minutes for side (b) - and by offering 10 prizes of $10 to the subjects who completed the task most accurately. This limited time was also intended to dissuade subjects from trying to match sets on sides (a) and (b) The conditions were so stringent that only 50 subjects (26.7%) completed the task.

Subjects' single and double estimates for both 'how many numbers' and their 'totals' were entered into the SPSS for all 12 sets. The means of their double estimates were correlated with their corresponding single estimates. These correlations were to be used as a judgement of 'press'. An MANOVA was calculated to judge the effects and interaction of the factors. The percentage errors of subjects' single estimates were compared with the percentage errors of their double estimates using paired t-tests. These comparisons were to be used to judge which was more accurate at the different levels of task complexity.

Four sets of results indicated that all levels, except the lowest level of the number task, were too complex for this level of arousal

Results

Of the 50 subjects who completed, 36 subjects responded with 358 extremely high or extremely low single or mid-double estimates. Of these, 33 subjects responded with 188 unbalanced estimates, either extremely high or extremely low. This high number of subjects reporting extreme unbalanced estimates points to a lack of consistency between single and mid-double estimates that is indicative of over arousal for the levels of complexity of the tasks.

The paired consistency between single and mid-double estimates was measured by their correlations as shown in table 2. Six correlations of single estimates with means of double estimates for 'totals' are low. Two are negative and six reach significance ($p<=0.002$) because of the extreme estimates. This lack of constancy indicates considerable press implying that the tasks of totalling the numbers were too difficult at all levels for the amount of arousal generated in the experiment.

Table 2: Correlations of single estimates with mid-double estimates of 'how many numbers and 'totals'

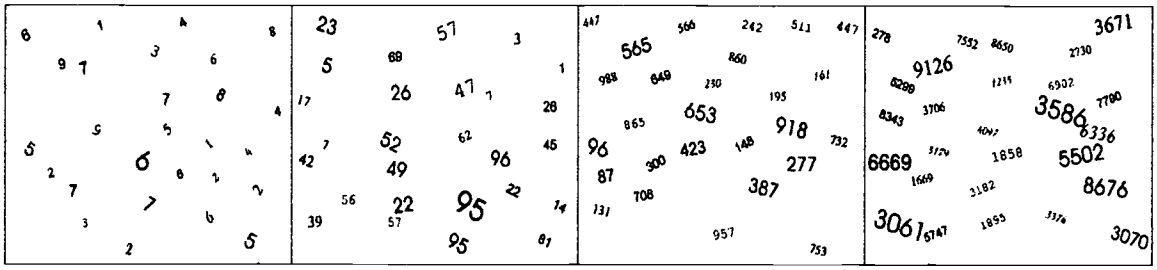
Correlations of single and mid-double estimates of "how many" numbers												
Set No.	1	2	3	4	5	6	7	8	9	10	11	12
Corr	0.1853	0.1438	0.0962	-0.014	0.1077	0.0093	-0.112	0.0538	-0.061	0.0546	0.4081	-0.029
n	50	49	50	50	49	49	50	50	50	50	50	49
sig	P= .198	P= .324	P= .506	P= .926	P= .461	P= .949	P= .440	P= .711	P= .674	P= .706	P= .003	P= .842
Correlations of single and mid-double estimates of "total" of numbers												
Set No.	1	2	3	4	5	6	7	8	9	10	11	12
Corr	0.4383	0.015	0.9382	0.9686	0.0051	0.0844	0.7414	0.4419	-0.023	0.9981	-0.018	-0.024
n	49	49	50	50	49	49	49	49	50	50	50	48
sig	P= .002	P= .918	P= .000	P= .000	P= .972	P= .564	P= .000	P= .001	P= .876	P= .000	P= .904	P= .873

Table 2 also shows that 11 of the correlations of single estimates with means of double estimates for 'how many numbers' are low. Two are negative and one reaches significance ($p=0.003$) because of an extreme estimate. This again indicates considerable 'press' implying that the tasks of totalling the numbers were too difficult at the higher levels for the amount of arousal generated in the experiment. The MANOVA results indicated significant within subject effects for estimates of 'how many numbers' ($p=0.000$) for the 'totals' ($p=0.000$) and for the interaction ($p=0.000$). However, the main factor effects and their interaction was not significant, although the 'how many numbers' factor came close to significance ($F=2.95$, $p=0.063$). This again supports the above conclusion that the levels of both factors presented too complex a task at the given level of focused attention, the 'totals' more so than the 'how many numbers'. Like the correlations, the paired t-tests showed no discernable

pattern which also supported the above conclusion. The results indicated that the lowest/ easiest level of the 'how many numbers' task was the limit of complexity under these conditions. The stimulus materials and the results for this simplest level are shown in figure 2.

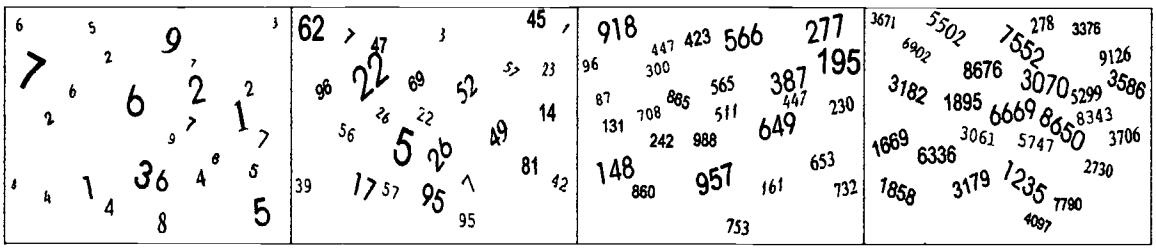
Single estimates 'how many numbers' = 27

Set 1 range 0-9 Set 2 range 0-99 Set 3 range 0-999 Set 4 range 0-9999



Double estimates 'how many numbers' = 27

Set 1 range 0-9 Set 2 range 0-99 Set 3 range 0-999 Set 4 range 0-9999



% error in single v mid-double estimate of 'how many numbers'				
Set no.	1	2	3	4
Single	13.93	13.11	20.37	37.11
Mid-double	13.96	18.48	17.78	18.93

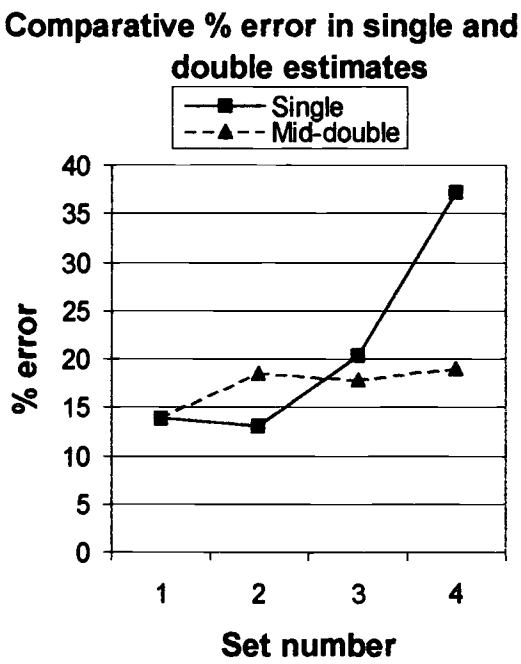


Figure 2. Greater percentage accuracy of the mid-double estimate compared with the traditional single estimate

The graph in figure 2 shows the increasing error of the traditional single estimate compared with the accuracy of the mid-double estimate

Conclusion

The numbers of unbalanced extreme responses, correlations, MANOVA and paired t-tests indicate that all levels of the 'totals' task were too complex for these subjects at this level of aroused focused attention. Similarly, all but the lowest level of the 'how many numbers' task were too difficult for these subjects. The fluctuations in the comparisons of the percentage errors for the single estimates and the double estimates on the lowest level of the 'how many numbers' task indicates (a) that this task is at the limit of complexity for these subjects under this high level of arousal and (b) that for estimates whose complexity is appropriate to the level of focused attention, the mean of the double estimate is more accurate than the traditional single estimate.

This conclusion suggests that in order to replicate, over a range of complex estimates and levels of arousal, the important result that the mid-double estimate is more accurate than the traditional single estimate, similar research should be done where either (a) the press is reduced to match the task complexity and/or (b) the task complexity is reduced to match the level of press.

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