

# Random key-press generation: Supplementary data and analysis

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In a series of 4 experiments, Towse (1998) described the performance of adult participants in their attempts at producing random sequences under various conditions. When the task was to produce random numbers orally (Experiment 1), there was a consistent effect of response speed and set size on different indices of performance. When the task was to produce key-presses (Experiment 2), task effects were weaker, and indeed there was no significant effect of speed or set size for R and RNG measures. The implied difference between response modality was confirmed in Experiment 3, where number and key-press responses were compared directly at two set size configurations. Nonetheless, there is an issue of replicability (especially for a null effect), and to an extent of generalisability (do all key-press tasks behave in this way?). The following experiment examines this issue; participants were asked to produce random key-press sequences using a single row of responses, where this row comprised 10 or 15 keys.

## Method

### Subjects and Design

Subjects were 12 adult volunteers drawn from the same population pool as Experiment 1 of Towse (1998). The study used a 2 (set size; 10 or 15 keys) by 2 (production speed; medium or fast) within-subjects design. Production conditions corresponded to the values reported for Experiments 1 & 2 in Towse (1998).

### Procedure

The randomisers sat directly in front of the computer keyboard and monitor, with all events controlled by an Archimedes 310 microcomputer. The keyboard was fitted with a specially designed overlay so that there were 15 keys in an upper row, and 10 keys in a lower row. Keys were identical in size and had no distinguishing features.

Written instructions asked adults to generate a random sequence of key-presses in time with a computer generated beat, using one of the rows on the keyboard. A key-press response was required in the 1 second interval following a tone, with the computer recording the first key-press only. A distinguishing tone was presented if a subject failed to press a key in the allotted time. This latter feature provided feedback and encouraged responses at the appropriate pace. Subjects were asked to produce a “jumbled up” -unpredictable- sequence of keys (using the same instructions as Experiment 2 of Towse, 1998), and it was pointed out that long runs of adjacent keys, or mere repetition of the same key, would not occur with a

high frequency in random sequences. Again, to maintain consistency, responses were made by pressing keys using one finger throughout.

Subjects started each condition with their first key-press. After 100 responses had been collected, the computer signalled the subject to stop. The task was repeated using the same row of keys, but with the alternate production speed. They then completed randomisation sequences by repeating the two conditions with the remaining row. The order of set size and production speed was rotated across individuals.

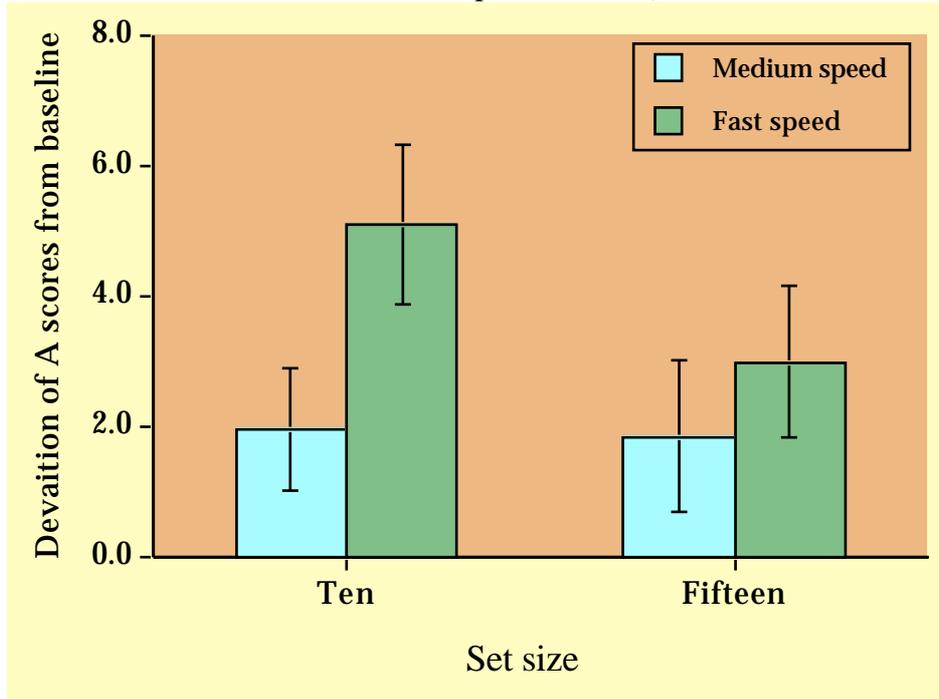
## Results and Discussion

Table 1. Standardised scores representing departures from randomness.

<i>Measure of randomness</i>	<i>Set size=10</i>		<i>Set size=15</i>	
	<i>Medium</i>	<i>Fast</i>	<i>Medium</i>	<i>Fast</i>
RNG	0.237	0.210	0.159	0.256
R	0.105	0.796	0.443	0.293
A	1.945	5.087	1.836	2.993

For the purpose of analysis, keys were given numerical values with values increasing from left to right. As with the data from Towse (1998), different measures of random performance were taken; here, the results focus on RNG, R and A scores. All values were standardised to measure departure from an appropriate random sequence (see Table 1 for means). Analysis of variance on the RNG scores, with generation speed and set size as factors, showed no significant main effects nor a significant interaction (all  $F_s < 1$ ). Analysis of variance using R scores also showed no significant main effects ( $F_s < 1$ ) and no significant interaction  $F(1,11)=1.58$ . The A index showed a reliable effect of speed,  $F(1,11)=17.24$ ,  $p < .01$ , no significant effect of set size,  $F(1,11)=1.07$ , and a significant interaction,  $F(1,11)=6.03$ ,  $p < .05$ . This interaction reflected an increase in adjacent key-presses with a faster speed which occurred mainly when using the smaller set size, as shown in Figure 1 below. It is not clear what theoretical interpretation should be made of this interaction, but it is noteworthy for running counter to other data sets, where the larger set size tends to be randomised less successfully (for example, Towse & Valentine, 1997).

Figure 1. Deviation of A scores from baseline performance (bars show standard errors)



Taken as a whole, these findings reinforce the view that random key-pressing need not be the same as random number generation, insofar as random key-pressing does not appear to show a strong sensitivity to speed or set size manipulations. Such an interpretation, of course, is similar to the view taken in Towse (1998) on the basis of Experiment 2 where the effect of task manipulations was found only for A scores and Experiment 3 where key-pressing and number generation produced divergent effects. Although there are likely to be differences between key-pressing configurations (for example, the physical distance between keys is, on average, higher in a single row of keys), the overall conclusion appears to be similar.

One important caveat that needs to be added to the above conclusion is that the number of experimental subjects in these key-pressing studies are small. This objection however, does not explain why number and key-press tasks behave significantly differently when compared directly (Towse, 1998; Experiment 3). In addition, the lack of *strong* effects itself is important in that random generation is often used in a dual task methodology, and as such one might argue that random key-pressing may not be sufficiently demanding to show appropriate interference costs (at the very least, it suggests that random key-pressing as a dual task is only worthwhile in studies with a fairly large sample size). Nonetheless, it is of course possible that effects are there, but are just weaker in the key-pressing task than in the number generation task. So as to evaluate the importance of the experimental effects, data from the above study, and from Experiment 2 of Towse (1998), were combined and re-analysed, both in terms of the statistical significance of experimental manipulations and their associated effect sizes.

## Combining experimental effect across studies

Thus, scores were combined in order to increase the sample size from which manipulations could be evaluated. These results should be treated cautiously, as for example subjects were paid in Experiment 2 of Towse (1998), but not the above study. Notwithstanding these

issues, the arrangement of keys (a row or block) was entered as a between-subjects factor, and set size and response speed as within-subjects factors, and measures of effect size (partial  $\eta^2$  were derived). RNG analysis still failed to show an effect of production speed,  $F(1,22)=2.33$ , partial  $\eta^2=.096$ , or set size,  $F<1$ , partial  $\eta^2=.041$ , or a significant interaction,  $F<1$ , partial  $\eta^2=.002$  (the effect of keyboard arrangement was non-significant,  $F(1,22)=1.75$ , partial  $\eta^2=.074$ ). R scores also failed to show main effects of speed,  $F<1$ , partial  $\eta^2=.026$ , or set size,  $F<1$ , partial  $\eta^2=.000$ , but the interaction between them was marginally significant,  $F(1,22)=4.01$ ,  $p<.06$ , partial  $\eta^2=.154$  (taking the general form described for Towse, 1998, Experiment 2). The effect of arrangement was marginally significant,  $F(1,22)=3.42$ ,  $p<.08$ , partial  $\eta^2=.135$ , performance tending to be more random with a block of keys. The A index showed no effect of set size,  $F<1$ , partial  $\eta^2=.028$ , a significant effect of speed,  $F(1,22)=27.2$ ,  $p<.001$ , partial  $\eta^2=.553$ , and an effect of arrangement,  $F(1,22)=8.32$ ,  $p<.01$ , partial  $\eta^2=.275$ , with the block configuration producing more random sequences than the row configuration. There was also a marginal interaction between speed and set size,  $F(1,22)=3.53$ ,  $p<.08$ , partial  $\eta^2=.138$ , and a three way interaction,  $F(1,22)=5.26$ ,  $p<.05$ , partial  $\eta^2=.193$ . The latter effect can best be understood with reference to the interaction between speed and set size reported in Towse (1998, Experiment 2), and the absence of a corresponding effect in the data described for the above experiment.

The degree to which the key-press data diverge from oral random number generation is emphasised by calculation of effect sizes for number generation, using data from Experiment 1 of Towse (1998). For the RNG measure, the measures of effect size are strong for both manipulations of speed (partial  $\eta^2=.587$ ) and set size (partial  $\eta^2=.758$ ). For R scores, effect size is strong for set size (partial  $\eta^2=.651$ ), though not as strong for speed (partial  $\eta^2=.128$ ). For A scores, the effect is strong for speed (partial  $\eta^2=.793$ ), while not as strong for set size (partial  $\eta^2=.185$ ).

## Conclusions

This brief report shows that random key-pressing using a single finger does not show a strong sensitivity to either the number of items being randomised, or the speed of responses, for two commonly used indices of performance (a measure of response distribution and a measure of paired frequencies), despite the report that oral number generation is strongly affected by such configurations. This comparison between number and key-pressing remains apparent even when data are collected from twice as many participants in the key-pressing condition, and is highlighted by a comparison of effect sizes. The implication is not so much that no effect on key-pressing can be found (indeed, A scores do vary with response speed) with any sample size, but rather than there is a considerable difference in the strength of effects. These might have several causes. For instance, number generation is difficult because of the natural sequences that appear - there are strong associations between neighbouring numbers, while the associations between key configurations may be less severe. Furthermore, with key-press responses, the choices are presented to the generator, whilst for numbers, the responses must be maintained as an internal set, making it difficult to respond appropriately with large sets.

## References

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