

# A developmental study of random generation in children

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Random generation is a complex task, and is affected by several aspects of response configuration. For example, among adult subjects, the number of response alternatives affects response sequences; a larger set size leads to response alternatives being sampled with uneven probabilities. This effect has been attributed to the requirement to maintain an internal representation of all response choices simultaneously, based on the finding that the visual provision of response alternatives removes the set size effect in random number generation (Towse, 1998). It is of interest, then, to establish whether children are also affected by changes in the number of response alternatives.

## Method

### Participants and Design

Data were available for 49 children from two school classes. There were 26 younger children, mean age 8 years 6 months (ranging 8;2 to 9;1) and 23 older children, mean age 10 years 6 months (ranging 10;2 to 11;1). Age formed the single between-subjects factor, whilst response set size ('small' or 'large') formed the within-subject manipulation.

### Procedure

Children were tested individually in a quiet area of school. The task was introduced as in Experiment 1 of Towse & Mclachlan (in press). Children produced 70 responses per condition (one response per 2.5 seconds), using the range 1-10 and 1-15 inclusive. Set size conditions were presented in a counterbalanced order.

## Results

In this experiment, before the experimental conditions could be legitimately compared, randomisation scores require adjustment, as for Experiment 2 of Towse & Mclachlan (in press). To control for the natural variation in 'baseline' randomness values, Monte Carlo computer simulations were run on 2000 quasi-random sets of 70 responses to produce theoretical mean and standard deviation values for sets of 10 and 15 response items. Table 2 presents the normalised scores.

Table 2. Mean randomness scores as z-score deviations (standard deviations in parentheses).

Age group:	8 years		10 years	
No. of responses:	10	15	10	15
Randomness measure				
R	0.19 (1.34)	0.68 (1.76)	-0.26 (1.36)	0.56 (1.89)
TPI	-2.12 (1.46)	-2.96 (1.36)	-1.33 (1.93)	-2.53 (1.62)
Phi2	-2.48 (0.49)	-2.12 (0.44)	-2.56 (0.25)	-2.16 (0.33)
Phi7	-0.51 (1.14)	-0.48 (1.31)	-1.12 (1.24)	-0.51 (1.02)

Using a multivariate analytic approach that involves four measures of randomisation performance, with R, TPI, Phi2 and Phi7 scores (for computational details, see Towse & Neil, 1998), there was no main effect of age,  $F(4,44) = 1.34$ , multivariate  $\eta^2 = .108$ , while there was a significant effect of response set size,  $F(4,44) = 23.5$ ,  $p < .01$ , multivariate  $\eta^2 = .681$ . The interaction term was not significant,  $F < 1$ , multivariate  $\eta^2 = .066$ . Interpretation of the multivariate set size effect is complicated by changes in different directions for variables. Univariate tests showed that a larger response vocabulary impaired sequences in terms of the evenness of response usage (R),  $F(1,47) = 9.50$ ,  $p < .05$ , partial  $\eta^2 = .168$ , and in the length of ascending and descending sequences (TPI),  $F(1,47) = 22.0$ ,  $p < .01$ , partial  $\eta^2 = .319$ , but the avoidance of repetitions was less extreme,  $F(1,47) = 28.6$ ,  $p < .01$ , partial  $\eta^2 = .381$ . This latter effect arises in part because the absolute repetition frequency is rather invariant across set size,  $t(48) = 1.87$ ,  $p > .05$ ,  $\eta^2 = .068$ , with a tendency for more repetitions at the smaller set size. However, the differences fail to mirror the theoretical changes in magnitude and so the smaller size produces more extreme repetition avoidance.

Figure 1 shows the first order difference distribution for the two set size conditions and indicates a strong bias towards adjacent values and away from item repetitions. Figure 2 shows the lag between repetitions. The distribution for the larger response vocabulary is less peaked for the first 20 items. This difference is understandable in terms of the additional response choices, since with more items to repeat, longer lags are to be expected. It is nonetheless noteworthy that repetition intervals between 4 and 8 steps represent the most prevalent gap for both response vocabularies.

Figure 1. Distribution of first order differences (i.e. the numerical difference between successive responses). Upper panel indicates performance when randomising the numbers 1-10, lower panel indicates performance while randomising numbers 1-15.

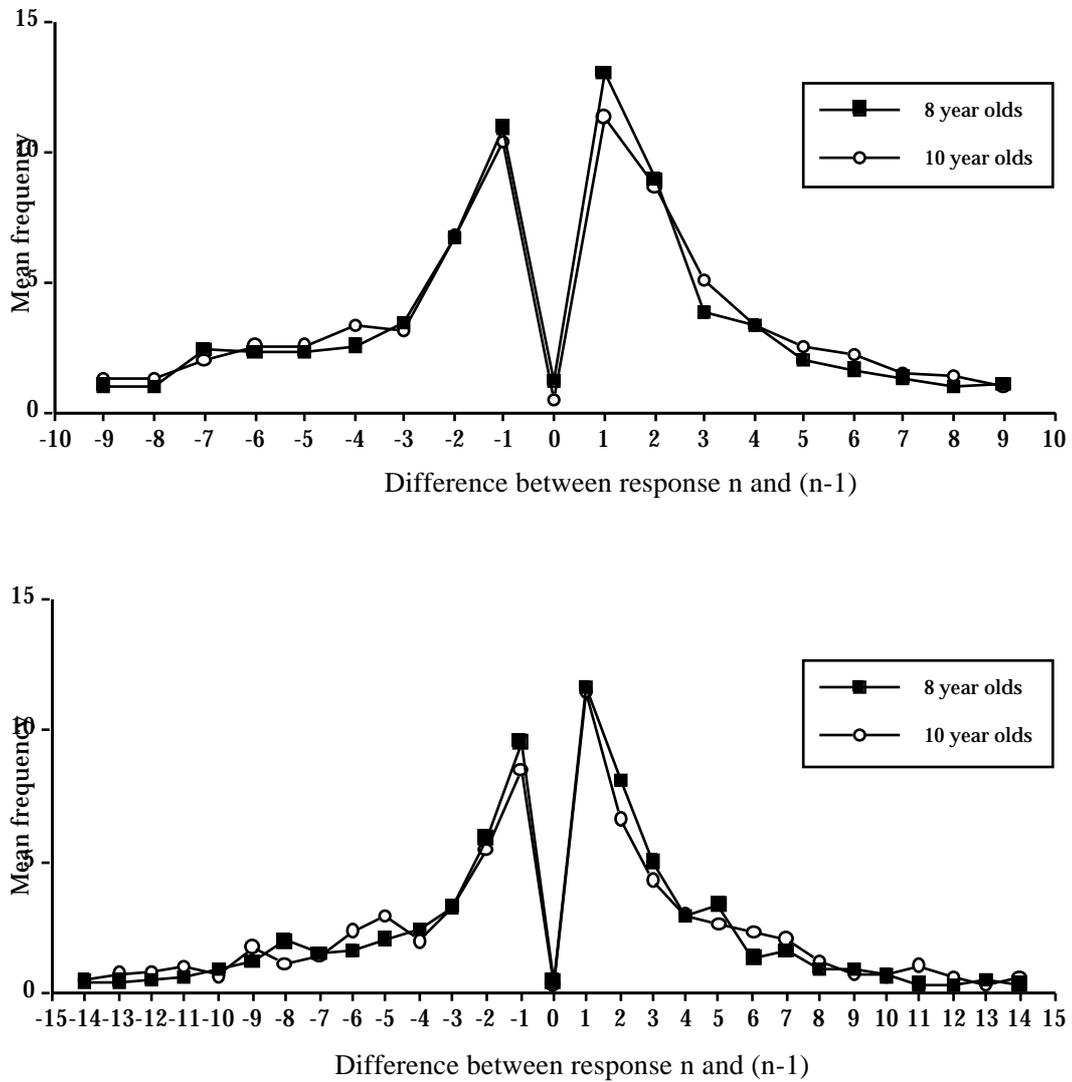
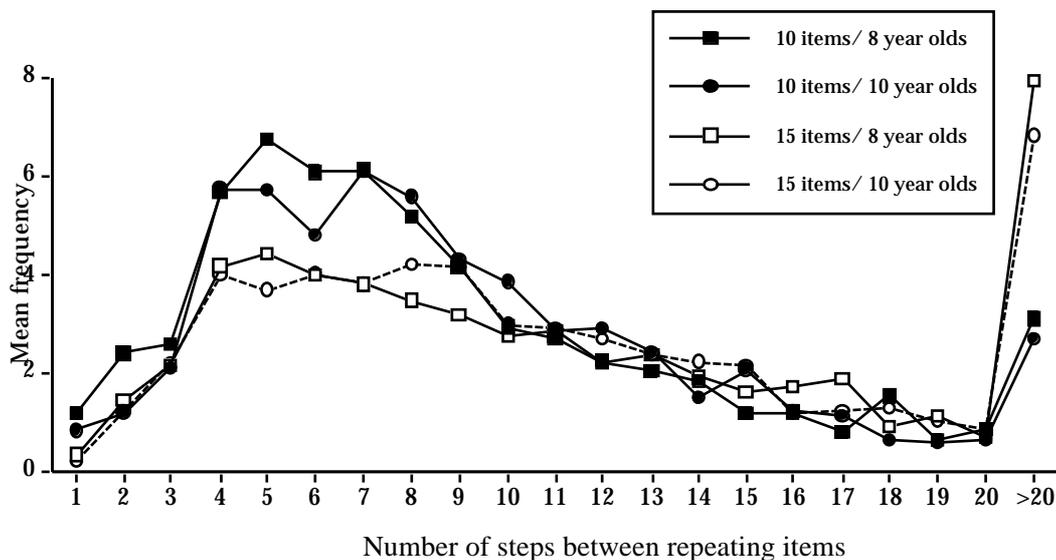


Figure 2. Distribution of distances between repeating item. For all response alternatives, the difference in the response positions for each repetition is determined and summed.



## Discussion

This study complements those reported elsewhere (Towse & Mclachlan, in press). It illustrates further that children's performance takes the same general form as for adults. It also confirms that children's random generation performance is sensitive to response set size. With more responses, alternatives are less likely to be sampled equally. This effect has been previously established among adults, but it is clearly not specific to adult performance.

It is also noteworthy that the set size also affected response repetitions, with less extreme avoidance with larger vocabularies. This might usefully be seen in the context of the invariant absolute probability of a repetition for both response vocabularies, and this is similar to the effect of set size noted in other experiments.

## References

- Towse, J. N. (1998). On random generation and the central executive of working memory. *British Journal of Psychology*, *89*, 77-101.
- Towse, J. N., & Mclachlan, A. (in press). An exploration of random generation among children. *British Journal of Developmental Psychology*.
- Towse, J. N., & Neil, D. (1998). Analyzing human random generation behavior: A review of methods used and a computer program for describing performance. *Behavior Research Methods, Instruments & Computers*, *30*, 583-91.