Appendix 1
Using random number tables

Randomization is necessary at several stages of most experiments. For instance we might want to:

(a) Select a sample of ten participants at random from a population of a hundred.

(b) Allocate five participants to an experimental group, five to a control group.

(c) Randomize the order of presentation of eight stimulus cards separately for each of ten different trials.

(d) Present pairs of random digits.

(e) Prepare fifty all-consonant nonsense syllable trigrams (i.e. letter combinations).

The basic principle in randomization is to ensure that all the possible alternatives have an equal chance of occurring. It is unsatisfactory for experimenters to try to generate random sequences by simply producing the alternatives in what appears to them to be a random order. There are for instance strong number preferences. Random number tables (e.g. Table A, pp. 158–60) are very valuable. They simply consist of a large set of digits (nowadays usually produced by computer) in which 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 each have the same probability of occurrence at each position in the table. Provided that this basic fact about the table is remembered, it is a matter of common sense to use the table so that it produces the kind of randomization required. One general point is that the table should ideally be entered at a random position ('pseudo-random' is good enough, e.g. stabbing a finger at it whilst looking away) and then movement from the point selected should be randomly up or down, left or right. The point behind this is that, if you always start at the top left-hand corner and went from left to right, then you would end up with the same sequence every time.

a Selecting a sample of ten participants at random from a population of a hundred

Number the participants in the population from 0 to 99. Enter the random number table in a pseudo-random manner and use pairs of digits. Travelling, say, downwards from the point selected in the table, write down the first 10 pairs of digits you come to. Pick out the participants corresponding to those numbers (NB the first 10 participants in the population are represented by 00, 01, 02, 03, 04, 05, 06, 07, 08 and 09).

b Allocating five participants to an experimental group, five to a control group

Let the even digits in the random number table represent the experimental group, the odd digits the control group. Again enter the random number table in a pseudo-random manner, but this time use single digits. Travel, say, left to right from the point selected in the table. If the first digit is odd, then the first participant goes in the control group. If it is even, then the first participant goes in the experimental group. Continue in the same way until five participants have been allocated to one of the two groups. The remaining participants go into the other group.

An alternative (simpler) procedure would be to spin a coin for each participant, 'heads' for experimental, 'tails' for control. Again continue until five participants had been allocated to one of the groups and allocate the remainder to the other group.

c Randomizing the order of presentation of eight stimulus cards separately for each of ten different trials

Number the eight stimulus cards 1 to 8. Use random number tables and enter them in a pseudo-random manner. Travelling, say, right to left from the point selected in the table note down the first occurrence of each of the digits 1 to 8.

To make this clear, suppose that the line chosen from the random number table is

97 08 14 24 01   51 95 46 30 32   3 (3) 19 00 14

Suppose we start at the circled 3 then, moving right to left, the sequence obtained is 3 2 6 4 5 1 8 7. Notice that 0 and 9 are ignored, as are second and subsequent occurrences of the digits 1 to 8. If necessary one would, of course, continue on the next line until the full sequence was obtained.

On trial one, then, stimulus 3 is presented first, then stimulus 2, then stimulus 6, etc. By continuing in the table one can obtain a total of ten different sequences which will decide the order of presentation for each of the ten different trials.

An alternative procedure would be to take the stimulus cards themselves and to shuffle them thoroughly between trials. It is essential to shuffle extremely thoroughly, however (say two minutes of continual shuffling).

d Presenting pairs of random digits

For this, you simply use the random number tables directly, entering the tables in the normal pseudo-random fashion and taking pairs of digits.

e Preparing fifty all-consonant nonsense syllable trigrams (i.e. 3-letter combinations)

If you simply want to produce sets of three consonants where the consonants occur purely randomly, then random number tables can be used. One of many ways of doing this would be to code the consonants as follows:

B-00, C-01, D-02, F-03, G-04, H-05, J-06, K-07, L-08, M-09,
N-10, P-11, Q-12, R-13, S-14, T-15, V-16, W-17, X-18, Z-19.

(NB Y is considered as a vowel-equivalent and is omitted from this list.) You enter the random number tables as before and, working with pairs of digits, simply note down the occurrence of any of the code numbers.

For example, working left or right along the line:

64 17 47 67 87 59 81 40 72 61 14 00 28

The code numbers occurring are 17, 14, 00; hence, decoding, the trigram is WSB.

As you will have noted, a large proportion of the random number table is not used with this method, and a little ingenuity will provide a more efficient method. If, for instance, we were to again use pairs of digits but simply note whether the first digit of a pair is odd or even, then we could use the code

B-odd-0, C-odd-1, D-odd-2, F-odd-3, G-odd-4, H-odd-5, J-odd-6, K-odd-7, L-odd-8, M-odd-9, N-even-0, P-even-1, Q-even-2, R-even-3, S-even-4, T-even-5, V-even-6, W-even-7, X-even-8, Z-even-9.

Then with the same line as before, we can make use of all pairs of digits, e.g. 64, 17, 47 decodes as SKW.

NB There are lists of nonsense syllables in specialized texts which are scaled in various ways, e.g. for association value, meaningfulness, etc.

Appendix 2
Pearson's correlation coefficient (r)

The main part of the text covered the correlation coefficient called Spearman's rho. This appendix is devoted to a second correlation coefficient known as **Pearson's r**; or sometimes as **Pearson's product-moment correlation coefficient**. Whereas Spearman's rho is based on rankings, Pearson's r is calculated from the scores themselves. It is somewhat more laborious to compute than Spearman's rho but tends to be preferred by statisticians. It is also the basis for a number of techniques used in more advanced statistics.

The basic idea behind it is very simple. Table 1 shows two sets of scores X and Y, with the X scores arranged in decreasing order of size. The table also gives means ($\bar{X}$ and $\bar{Y}$) and, in the third and fourth columns the deviations from these means ($x = (X - \bar{X})$ and $y = (Y - \bar{Y})$) for each X and Y score. The final, fifth column gives

Table 1 Showing the calculation of cross-products (xy)

X	Y	$x = (X - \bar{X})$	$y = (Y - \bar{Y})$	xy
19	12	+9	+4	+36
14	16	+4	+8	+32
10	8	0	0	0
7	7	−3	−1	+3
6	4	−4	−4	+16
4	1	−6	−7	+42

$\Sigma x = 60 \quad \Sigma Y = 48$

$\bar{X} = \frac{60}{6} = 10 \quad \bar{Y} = \frac{48}{6} = 8$

the product ($x \times y$) for each pair of deviations. It is these 'cross-products', as they are called, which are the heart of Pearson's r.

Consider, as in the present case, where there is a positive correlation between X and Y; that is where high X and high Y scores tend to go together, and where low X and low Y scores tend to go together. High scores will be above the mean and hence produce positive deviations which when multiplied together give positive cross-products (xys). But the low scores tend to produce negative X and negative Y deviations which when multiplied together also produce positive cross-products. So, for a positive correlation the sum of the cross-products (Σxy) will itself be positive, and if you think about it the higher the correlation the greater the value of Σxy.

When X and Y are negatively correlated however, high X scores tend to be paired with low Y scores (and vice-versa) which means that positive X deviations pair with negative Y deviations, leading to a negative cross-product. Similarly negative X and positive Y deviations tend to be paired with a resulting negative cross-product. So, for a negative correlation Σxy is itself negative. Similar reasoning suggests that with little or no correlation between X and Y the sum of the cross-products will tend toward zero.

So Σxy behaves in a way that we wish correlation coefficients to do, and all that remains is to ensure that the coefficient falls within the correct limits, i.e. maximum value of $+1$ and a minimum value of -1. The following formula accomplishes this:

$$\text{Pearson's r} = \frac{\Sigma xy}{\sqrt{(\Sigma x^2)(\Sigma y^2)}}$$

where $x = (X - \bar{X})$
and $y = (Y - Y)$

It is possible to test whether a Pearson's r correlation coefficient differs significantly from zero by using Table C.

Step-by-step procedure

Pearson's r

Step 1 Having listed X and Y scores in pairs determine the means $\bar{X}$ and $\bar{Y}$

Step 2 Determine the deviation scores (x) for X by subtracting the mean ($\bar{X}$) from each score

Step 3 Determine the deviation scores (y) for Y by subtracting the mean ($\bar{Y}$) from each score

Step 4 Square each X deviation in turn and find their sum

Step 5 Square each Y deviation in turn and find their sum

Step 6 Find $x \times y$ products for each pair of scores and find their sum

Step 7 Find r by applying formula

$$r = \frac{\Sigma xy}{\sqrt{(\Sigma x^2)(\Sigma y^2)}}$$

Step 8 If required, assess whether r differs significantly from zero by use of Table C.

Step 9 Translate the results back in terms of the experiment

Worked example

Pearson's r

X	Y	**Step 2** $x(=X-\bar{X})$	**Step 3** $y(=Y-\bar{Y})$	x^2	y^2	xy
12	7	+5	−1·5	25	2·25	−7·5
10	3	+3	−5·5	9	30·25	−16·5
9	8	+2	−0·5	4	0·25	−1·0
8	5	+1	−3·5	1	12·25	−3·5
7	7	0	−1·5	0	2·25	0
7	12	0	+3·5	0	12·25	0
6	10	−1	+1·5	1	2·25	−1·5
5	9	−2	+0·5	4	0·25	−1·0
4	13	−3	+4·5	9	20·25	−13·5
2	11	−5	+2·5	25	6·25	−12·5

$\Sigma X = 70$ $\quad \Sigma Y = 85$ $\quad \Sigma x^2 = 78$ $\quad \Sigma y^2 = 88{\cdot}5$ $\quad \Sigma xy = -57{\cdot}0$

$\bar{X} = 7{\cdot}0$ $\quad \bar{Y} = 8{\cdot}5$ $\quad$ **Step 4** $\quad$ **Step 5** $\quad$ **Step 6**

Step 1

Step 7 $$r = \frac{\Sigma xy}{\sqrt{(\Sigma x^2)(\Sigma y^2)}} = \frac{-57{\cdot}0}{\sqrt{78 \times 88{\cdot}5}} = -0{\cdot}69$$

Step 8 From Table C, r must be greater than 0·53 for $N = 10$. As $r = -0{\cdot}69$ the correlation between X and Y is significantly different from zero, at the $p = 0{\cdot}05$ level

Step 9 This would be expressed in terms of whatever X and Y represent, stressing that the correlation is negative and differs significantly from zero

Appendix 3
Statistical tables

Table A Random numbers

03 47 43 73 86	36 96 47 36 61	46 98 63 71 62	33 26 16 80 45	60 11 14 10 95
97 74 24 67 62	42 81 14 57 20	42 53 32 37 32	27 07 36 07 51	24 51 79 89 73
16 76 62 27 66	56 50 26 71 07	32 90 79 78 53	13 55 38 58 59	88 97 54 14 10
12 56 85 99 26	96 96 68 27 31	05 03 72 93 15	57 12 10 14 21	88 26 49 81 76
55 59 56 35 64	38 54 82 46 22	31 62 43 09 90	06 18 44 32 53	23 83 01 30 30
16 22 77 94 39	49 54 43 54 82	17 37 93 23 78	87 35 20 96 43	84 26 34 91 64
84 42 17 53 31	57 24 55 06 88	77 04 74 47 67	21 76 33 50 25	83 92 12 06 76
63 01 63 78 59	16 95 55 67 19	98 10 50 71 75	12 86 73 58 07	44 39 52 38 79
33 21 12 34 29	78 64 56 07 82	52 42 07 44 38	15 51 00 13 42	99 66 02 79 54
57 60 86 32 44	09 47 27 96 54	49 17 46 09 62	90 52 84 77 27	08 02 73 43 28
18 18 07 92 46	44 17 16 58 09	79 83 86 19 62	06 76 50 03 10	55 23 64 05 05
26 62 38 97 75	84 16 07 44 99	83 11 46 32 24	20 14 85 88 45	10 93 72 88 71
23 42 40 64 74	82 97 77 77 81	07 45 32 14 08	32 98 94 07 72	93 85 79 10 75
52 36 28 19 95	50 92 26 11 97	00 56 76 31 38	80 22 02 53 53	86 60 42 04 53
37 85 94 35 12	83 39 50 08 30	42 34 07 96 88	54 42 06 87 98	35 85 29 48 39
70 29 17 12 13	40 33 20 38 26	13 89 51 03 74	17 76 37 13 04	07 74 21 19 30
56 62 18 37 35	96 83 50 87 75	97 12 25 93 47	70 33 24 03 54	97 77 46 44 80
99 49 57 22 77	88 42 95 45 72	16 64 36 16 00	04 43 18 66 79	94 77 24 21 90
16 08 15 04 72	33 27 14 34 90	45 59 34 68 49	12 72 07 34 45	99 27 72 95 14
31 16 93 32 43	50 27 89 87 19	20 15 37 00 49	52 85 66 60 44	38 68 88 11 80
68 34 30 13 70	55 74 30 77 40	44 22 78 84 26	04 33 46 09 52	68 07 97 06 57
74 57 35 65 76	59 29 97 68 60	71 91 38 67 54	13 58 18 24 76	15 54 55 95 52
27 42 37 86 53	48 55 90 65 72	96 57 69 36 10	96 46 92 42 45	97 60 49 04 91
00 39 68 29 61	66 37 32 20 30	77 84 57 03 29	10 45 65 04 26	11 04 96 67 24
29 94 98 94 24	68 49 69 10 82	53 75 91 93 30	34 25 20 57 27	40 48 73 51 92
16 90 82 66 59	83 62 64 11 12	67 19 00 71 74	60 47 21 29 68	02 02 37 03 31
11 27 94 75 06	06 09 19 74 66	02 94 37 34 02	76 70 90 30 86	38 45 94 30 38
35 24 10 16 20	33 32 51 26 38	79 78 45 04 91	16 92 53 56 16	02 75 50 95 98
38 23 16 86 38	42 38 97 01 50	87 75 66 81 41	40 01 74 91 62	48 51 84 08 32
31 96 25 91 47	96 44 33 49 13	34 86 82 53 91	00 52 43 48 85	27 55 26 89 62

Table A Random numbers (continued)

66 67 40 67 14	64 05 71 95 86	11 05 65 09 68	76 83 20 37 90	57 16 00 11 66
14 90 84 45 11	75 73 88 05 90	52 27 41 14 86	22 98 12 22 08	07 52 74 95 80
68 05 51 18 00	33 96 02 75 19	07 60 62 93 55	59 33 82 43 90	49 37 38 44 59
20 46 78 73 90	97 51 40 14 02	04 02 33 31 08	39 54 16 49 36	47 95 93 13 30
64 19 58 97 79	15 06 15 93 20	01 09 10 75 06	40 78 78 89 62	02 67 74 17 33
05 26 93 70 60	22 35 85 15 13	92 03 51 59 77	59 56 78 06 83	52 91 05 70 74
07 97 10 88 23	09 98 42 99 64	61 71 62 99 15	06 51 29 16 93	58 05 77 09 51
68 71 86 85 85	54 87 66 47 54	73 32 08 11 12	44 95 92 63 16	29 56 24 29 48
26 99 61 65 53	58 37 78 80 70	42 10 50 67 42	32 17 55 85 74	94 44 67 19 94
14 65 52 68 75	87 59 36 22 41	26 78 63 06 55	13 08 27 01 50	15 29 39 39 43
17 53 77 58 71	71 41 61 50 72	12 41 94 96 26	44 95 27 36 99	02 96 74 30 83
90 26 59 21 19	23 52 23 33 12	96 93 02 18 39	07 02 18 36 07	25 99 32 70 23
41 23 52 55 99	31 04 49 69 96	10 47 48 45 88	13 41 43 89 20	97 17 14 49 17
60 20 50 81 69	31 99 73 68 68	35 81 33 03 76	24 30 12 48 60	18 99 10 72 34
91 25 38 05 90	94 58 28 41 36	45 37 59 03 09	90 35 57 29 12	82 62 54 65 60
34 50 57 74 37	98 80 33 00 91	09 77 93 19 82	74 94 80 04 04	45 07 31 66 49
85 22 04 39 43	73 81 53 94 79	33 62 46 86 28	08 31 54 46 31	53 94 13 38 47
09 79 13 77 48	73 82 97 22 21	05 03 27 24 83	72 89 44 05 60	35 80 39 94 88
88 75 80 18 14	22 95 75 42 49	39 32 82 22 49	02 48 07 70 37	16 04 61 67 87
90 96 23 70 00	39 00 03 06 90	55 85 78 38 36	94 37 30 69 32	90 89 00 76 33
53 74 23 99 67	61 32 28 69 84	94 62 67 86 24	98 33 41 19 95	47 53 53 38 09
63 38 06 86 54	99 00 65 26 94	02 82 90 23 07	79 62 67 80 60	75 91 12 81 19
35 30 58 21 46	06 72 17 10 94	25 21 31 75 96	49 28 24 00 49	55 65 79 78 07
63 43 36 82 69	65 51 18 37 88	61 38 44 12 45	32 92 85 88 65	54 34 81 85 35
98 25 37 55 26	01 91 82 81 46	74 71 12 94 97	24 02 71 37 07	03 92 18 66 75
02 63 21 17 69	71 50 80 89 56	38 15 70 11 48	43 40 45 86 98	00 83 26 91 03
64 55 22 21 82	48 22 28 06 00	61 54 13 43 91	82 78 12 23 29	06 66 24 12 27
85 07 26 13 89	01 10 07 82 04	59 63 69 36 03	69 11 15 83 80	13 29 54 19 28
58 54 16 24 15	51 54 44 82 00	62 61 65 04 69	38 18 65 18 97	85 72 13 49 21
34 85 27 84 87	61 48 64 56 26	90 18 48 13 26	37 70 15 42 57	65 65 80 39 07
03 92 18 27 46	57 99 16 96 56	30 33 72 85 22	84 64 38 56 98	99 01 30 98 64
62 95 30 27 59	37 75 41 66 48	86 97 80 61 45	23 53 04 01 63	45 76 08 64 27
08 45 93 15 22	60 21 75 46 91	98 77 27 85 42	28 88 61 08 84	69 62 03 42 73
07 08 55 18 40	45 44 75 13 90	24 94 96 61 02	57 55 66 83 15	73 42 37 11 61
01 85 89 95 66	51 10 19 34 88	15 84 97 19 75	12 76 39 43 78	64 63 91 08 25
72 84 71 14 35	19 11 58 49 26	50 11 17 17 76	86 31 57 20 18	95 60 78 46 75
88 78 28 16 84	13 52 53 94 53	75 45 69 30 96	73 89 65 70 31	99 17 43 48 76
45 17 75 65 57	28 40 19 72 12	25 12 74 75 67	60 40 60 81 19	24 62 01 61 16
96 76 28 12 54	22 01 11 94 25	71 96 16 16 88	68 64 36 74 45	19 59 50 88 92
43 31 67 72 30	24 02 94 08 63	38 32 36 66 02	69 36 38 25 39	48 03 45 15 22
50 44 66 44 21	66 06 58 05 62	68 15 54 35 02	42 35 48 96 32	14 52 41 52 48
22 66 22 14 86	26 63 75 41 99	58 42 36 72 24	58 37 52 18 51	03 37 18 39 11
96 24 40 14 51	23 22 30 88 57	95 67 47 29 83	94 69 40 06 07	18 16 36 78 86
31 73 91 61 19	60 20 72 93 48	98 57 07 23 69	65 95 39 69 58	56 80 30 19 44
78 70 73 99 84	43 89 94 36 45	56 69 47 07 41	90 22 91 07 12	78 35 34 08 72

84 37 90 61 56	70 10 23 98 05	85 11 34 76 60	76 48 45 34 60	01 64 18 39 96
36 67 10 08 23	98 93 35 08 86	99 29 76 29 81	33 34 91 58 93	63 14 52 32 52
07 28 59 07 48	89 64 58 89 75	83 85 62 67 89	30 14 78 56 27	86 63 59 80 02
10 15 83 87 60	79 24 31 66 56	21 48 24 06 93	91 98 94 05 49	01 47 59 38 00
55 19 68 97 65	03 73 52 16 56	00 53 55 90 27	33 42 29 38 87	22 13 88 83 34
53 81 29 13 39	35 01 20 71 34	62 33 74 82 14	53 73 19 09 03	56 54 29 56 93
51 86 32 68 92	33 98 74 66 99	40 14 71 94 58	45 94 19 38 81	14 44 99 81 07
35 91 70 29 13	80 03 54 07 27	96 94 78 32 66	50 95 52 74 33	13 80 55 62 54
37 71 67 95 13	20 02 44 95 94	64 85 04 05 72	01 32 90 76 14	53 89 74 60 41
93 66 13 83 27	92 79 64 64 72	28 54 96 53 84	48 14 52 98 94	56 07 93 89 30
02 96 08 45 65	13 05 00 41 84	93 07 54 72 59	21 45 57 09 77	19 48 56 27 44
49 83 43 48 35	82 88 33 69 96	72 36 04 19 76	47 45 15 18 60	82 11 08 95 97
84 60 71 62 46	40 80 81 30 37	34 39 23 05 38	25 15 35 71 30	88 12 57 21 77
18 17 30 88 71	44 91 14 88 47	89 23 30 63 15	56 34 20 47 89	99 82 93 24 98
79 69 10 61 78	71 32 76 95 62	87 00 22 58 40	92 54 01 75 25	43 11 71 99 31
75 93 36 57 83	56 20 14 82 11	74 21 97 90 65	96 42 68 63 86	74 54 13 26 94
38 30 92 29 03	06 28 81 39 38	62 25 06 84 63	61 29 08 93 67	04 32 92 08 09
51 29 50 10 34	31 57 75 95 80	51 97 02 74 77	76 15 48 49 44	18 55 63 77 09
21 31 38 86 24	37 79 81 53 74	73 24 16 10 33	52 83 90 94 76	70 47 14 54 36
29 01 23 87 88	58 02 39 37 67	42 10 14 20 92	16 55 23 42 45	54 96 09 11 06
95 33 95 22 00	18 74 72 00 18	38 79 58 69 32	81 76 80 26 92	82 80 84 25 39
90 84 60 79 80	24 36 59 87 38	82 07 53 89 35	96 35 23 79 18	05 98 90 07 35
46 40 62 98 82	54 97 20 56 95	15 74 80 08 32	16 46 70 50 80	67 72 16 42 79
20 31 89 03 43	38 46 82 68 72	32 14 82 99 70	80 60 47 18 97	63 49 30 21 30
71 59 73 05 50	08 22 23 71 77	91 01 93 20 49	82 96 59 26 94	66 39 67 98 60

Abridged from Table 33 of R. A. Fisher and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research*, Oliver & Boyd Ltd, Edinburgh, 1953, by permission of the authors and publishers.

Table B Sign test

L = frequency of the less frequent sign
T = total frequency of *both* pluses and minuses

The table gives the highest value of L significant at the 0·05 level for each value of T (two-tailed test)

T	L
5	–
6	0
7	0
8	0
9	1
10	1
11	1
12	2
13	2
14	2
15	3
16	3
17	3
18	4
19	4
20	5
21	5
22	5
23	6
24	6
25	7

Table C Significance of correlation coefficients
(Spearman's rho and Pearson's r)

N = number of pairs of scores

The table values are the smallest values of correlation coefficient significantly different from zero at the 0·05 level for different values of N (one-tailed test).
For N greater than 10 the value needed for significance is essentially the same for either test.

N	Spearman's rho	Pearson's r	N	Spearman's rho or Pearson's r
5	0·90	0·81	11	0·52
6	0·83	0·73	12	0·50
7	0·71	0·67	13	0·48
8	0·64	0·62	14	0·46
9	0·60	0·58	15	0·44
10	0·56	0·55	16	0·43
			17	0·41
			18	0·40
			19	0·39
			20	0·38
			21	0·37
			22	0·36
			23	0·35
			24	0·34
			25	0·34
			26	0·33
			27	0·32
			28	0·32
			29	0·31
			30	0·31

Note For N greater than 30 the value needed for significance can be taken as 0·31

Table D The normal distribution

Fractional area under the standard normal curve from 0 to z

z	0	1	2	3	4	5	6	7	8	9
0·0	·0000	·0040	·0080	·0120	·0160	·0199	·0239	·0279	·0319	·0359
0·1	·0398	·0438	·0478	·0517	·0557	·0596	·0636	·0675	·0714	·0754
0·2	·0793	·0832	·0871	·0910	·0948	·0987	·1026	·1064	·1103	·1141
0·3	·1179	·1217	·1255	·1293	·1331	·1368	·1406	·1443	·1480	·1517
0·4	·1554	·1591	·1628	·1664	·1736	·1700	·1772	·1808	·1844	·1879
0·5	·1915	·1950	·1985	·2019	·2054	·2088	·2123	·2157	·2190	·2224
0·6	·2258	·2291	·2324	·2357	·2389	·2422	·2454	·2486	·2518	·2549
0·7	·2580	·2612	·2642	·2673	·2704	·2734	·2764	·2794	·2823	·2852
0·8	·2881	·2910	·2939	·2967	·2996	·3023	·3051	·3078	·3106	·3133
0·9	·3159	·3186	·3212	·3238	·3264	·3289	·3315	·3340	·3365	·3389
1·0	·3413	·3438	·3461	·3485	·3508	·3531	·3554	·3577	·3599	·3621
1·1	·3643	·3665	·3686	·3708	·3729	·3749	·3770	·3790	·3810	·3830
1·2	·3849	·3869	·3888	·3907	·3925	·3944	·3962	·3980	·3997	·4015
1·3	·4032	·4049	·4066	·4082	·4099	·4115	·4131	·4147	·4162	·4177
1·4	·4192	·4297	·4222	·4236	·4251	·4265	·4279	·4292	·4306	·4319
1·5	·4332	·4345	·4357	·4370	·4382	·4394	·4406	·4418	·4429	·4441
1·6	·4452	·4463	·4474	·4484	·4495	·4505	·4515	·4525	·4535	·4545
1·7	·4554	·4564	·4573	·4582	·4591	·4599	·4608	·4625	·4625	·4633
1·8	·4641	·4649	·4656	·4664	·4671	·4678	·4686	·4699	·4699	·4706
1·9	·4713	·4719	·4726	·4732	·4738	·4744	·4750	·4761	·4761	·4767
2·0	·4772	·4778	·4783	·4788	·4793	·4798	·4803	·4808	·4812	·4817
2·1	·4821	·4826	·4830	·4834	·4838	·4842	·4846	·4850	·4854	·4857
2·2	·4861	·4864	·4868	·4871	·4875	·4878	·4881	·4884	·4887	·4890
2·3	·4893	·4896	·4898	·4901	·4904	·4906	·4909	·4911	·4913	·4916
2·4	·4918	·4920	·4922	·4925	·4927	·4929	·4931	·4932	·4934	·4936
2·5	·4938	·4940	·4941	·4943	·4945	·4946	·4948	·4949	·4951	·4952
2·6	·4953	·4955	·4956	·4957	·4959	·4960	·4961	·4962	·4963	·4964
2·7	·4965	·4966	·4967	·4968	·4969	·4970	·4871	·4972	·4973	·4974
2·8	·4974	·4975	·4976	·4977	·4977	·4978	·4979	·4979	·4980	·4981
2·9	·4981	·4982	·4982	·4983	·4984	·4984	·4985	·4985	·4986	·4986
3·0	·4987	·4987	·4987	·4988	·4988	·4989	·4989	·4989	·4990	·4990
3·1	·4990	·4991	·4991	·4991	·4992	·4992	·4992	·4992	·4992	·4993
3·2	·4993	·4993	·4994	·4994	·4994	·4994	·4994	·4995	·4995	·4995
3·3	·4995	·4995	·4995	·4996	·4996	·4996	·4996	·4996	·4996	·4997
3·4	·4997	·4997	·4997	·4997	·4997	·4997	·4997	·4997	·4997	·4998
3·5	·4998	·4998	·4998	·4998	·4998	·4998	·4998	·4998	·4998	·4998
3·6	·4998	·4998	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999
3·7	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999
3·8	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999	·4999
3·9	·5000	·5000	·5000	·5000	·5000	·5000	·5000	·5000	·5000	·5000

Table E The *t*-distribution

(5 per cent significance level for two-tailed test)

d.f.	t
1	12·706
2	4·303
3	3·182
4	2·776
5	2·571
6	2·447
7	2·365
8	2·306
9	2·262
10	2·228
11	2·201
12	2·179
13	2·160
14	2·145
15	2·131
16	2·120
17	2·110
18	2·101
19	2·093
20	2·086
21	2·080
22	2·074
23	2·069
24	2·064
25	2·060
26	2·056
27	2·052
28	2·048
29	2·045
30	2·042
40	2·021
60	2·000
120	1·980
∞	1·960

Abridged from Table 12 of E. S. Pearson and H. O. Hartley, *Biometrika Tables for Statisticians*, vol. 1, Cambridge University Press, 1954.

Table F The variance ratio (F)

(5 per cent significance level for two-tailed test)
N_1 are the degrees of freedom for greater variance N_2 are the degrees of freedom for smaller variance

	$N_1 =$	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	x
$N_2 =$	1	648	800	864	900	922	937	948	957	963	969	977	985	993	997	1001	1006	1010	1014	1018
	2	38·51	39.00	39·16	39·25	39·30	39·33	39·36	39·37	39·39	39·40	39·42	39·43	39·45	39·46	39·46	39·47	39·48	39·49	39·50
	3	17·44	16·04	15·44	15·10	14·88	14·74	14.62	14·54	14·47	14·42	14·34	14·25	14·17	14·12	14·08	14·04	13·99	13·95	13·90
	4	12·22	10·65	9·98	9·60	9·36	9·20	9·07	8·98	8·90	8·84	8·75	8·66	8·56	8·51	8·46	8·41	8·36	8·31	8·26
	5	10·01	8·43	7·76	7·39	7·15	6·98	6·85	6·76	6·68	6·62	6·52	6·43	6·33	6·28	6·23	6·18	6·12	6·07	6·02
	6	8·81	7·26	6·60	6·23	5·99	5·82	5·70	5·60	5·52	5·46	5·37	5·27	5·17	5·12	5·07	5·01	4·96	4·90	4·85
	7	8.07	6·54	5·89	5·52	5·29	5·12	4·99	4·90	4·82	4·76	4·67	4·57	4·47	4·42	4.36	4·31	4·25	4·20	4·14
	8	7·57	6·06	5·42	5·05	4·82	4·65	4·53	4·43	4·36	4·30	4·20	4·10	4·00	3·95	3·89	3·84	3·78	3·73	3·67
	9	7·21	5·71	5·08	4·72	4·48	4.32	4·20	4·10	4·03	3·96	3·87	3·77	3·67	3·61	3·56	3·51	3·45	3·39	3·33
	10	6·94	5·46	4·83	4·47	4.24	4·07	3·95	3·85	3·78	3·72	3·62	3·52	3·42	3·37	3·31	3·26	3·20	3·14	3·08
	11	6·55	5.10	4·47	4.12	3·89	3·73	3·61	3·51	3·44	3·37	3·28	3·18	3·07	3·02	2·96	2·91	2·85	2·79	2·72
	13	6.20	4·76	4.15	3·80	3·58	3·41	3·29	3·20	3·12	3·06	2·96	2·86	2·76	2·70	2·64	2·58	2·52	2·46	2·40
	20	5·87	4·46	3·86	3·51	3·29	3·13	3·01	2·91	2·84	2·77	2·68	2·57	2·46	2·41	2·35	2·29	2·22	2·16	2·09
	24	5·72	4·32	3·72	3·38	3·15	2·99	2·87	2·78	2·70	2·64	2·54	2·44	2·33	2·27	2·21	2·15	2·08	2·01	1·94
	30	5·57	4·18	3·59	3·25	3·03	2·87	2·75	2·65	2·57	2·51	2·41	2·31	2·20	2·14	2·07	2·01	1·94	1·87	1·79
	40	5·42	4·05	3·46	3·13	2·90	2·74	2·62	2·53	2·45	2·39	2·29	2·18	2·07	2·01	1·94	1·88	1·80	1·72	1·64
	60	5·29	3·93	3·34	3·01	2·79	2·63	2·51	2·41	2·33	2·27	2·17	2·06	1·94	1·88	1·82	1·74	1·67	1·58	1·48
	120	5.15	3·80	3·23	2·89	2·67	2·52	2·39	2·30	2·22	2·16	2·05	1·94	1·82	1·76	1·69	1·61	1·53	1·43	1·31
	x	5·02	3·69	3·12	2·79	2·57	2·41	2·29	2·19	2·11	2·05	1·94	1·83	1·71	1·64	1·57	1·48	1·39	1·27	1·00

Abridged from M. Merrington and C. M. Thompson, 'Tables of percentage points of the inverted beta (F) distribution'. *Biometrika*, vol. 33, 1943, pp. 73–8.

Table G Chi square

(5 per cent significance level for one-tailed test)

d.f.	χ^2
1	3·841
2	5·991
3	7·815
4	9·488
5	11·071
6	12·592
7	14·067
8	15·507
9	16·919
10	18·307
11	19·675
12	21·026
13	22·362
14	23·685
15	24·996
16	26·296
17	27·587
18	28·869
19	30·144
20	31·410
21	32·671
22	33·924
23	35·173
24	36·415
25	37·653
26	38·885
27	40·113
28	41·337
29	42·557
30	43·773
40	55·759
50	67·505
60	79·082
80	101·879
100	124·342

Abridged from Table 8 of E. S. Pearson and H. O. Hartley, *Biometrika Tables for Statisticians*, vol. 1, Cambridge University Press, 1954.

Table H Mann-Whitney test

(5 per cent significance level for two-tailed test)

N_B =	4	5	6	7	8
N_A = **2**	—	—	—	—	0
3	—	0	1	1	2
4	0	1	2	3	4
5	—	2	3	5	6
6	—	—	5	6	8
7	—	—	—	8	10
8	—	—	—	—	13

Adapted and abridged from H. B. Mann and D. R. Whitney, 'On a test of whether one of two random variables is stochastically larger than the other', *Annals of Mathematical Statistics*, vol. 18, 1947, pp. 52–4.

N_B =	9	10	11	12	13	14	15	16	17	18	19	20
N_A = **1**												
2	0	0	0	1	1	1	1	1	2	2	2	2
3	2	3	3	4	4	5	5	6	6	7	7	8
4	4	5	6	7	8	9	10	11	11	12	13	13
5	7	8	9	11	12	13	14	15	17	18	19	20
6	10	11	13	14	16	17	19	21	22	24	25	27
7	12	14	16	18	20	22	24	26	28	30	32	34
8	15	17	19	22	24	26	29	31	34	36	38	41
9	17	20	23	26	28	31	34	37	39	42	45	48
10	20	23	26	29	33	36	39	42	45	48	52	55
11	23	26	30	33	37	40	44	47	51	55	58	62
12	26	29	33	37	41	45	49	53	57	61	65	69
13	28	33	37	41	45	50	54	59	63	67	72	76
14	31	36	40	45	50	54	59	64	67	74	78	83
15	34	39	44	49	54	59	64	70	75	80	85	90
16	37	42	47	53	59	63	70	75	81	86	92	98
17	39	45	51	57	63	67	75	81	87	93	99	105
18	42	48	55	61	67	74	80	86	93	99	106	112
19	45	52	58	65	72	78	85	92	99	106	113	119
20	48	55	62	69	76	83	90	98	105	112	119	127

Adapted and abridged from Tables 1, 3, 5 and 7 of D. Aube, 'Extended tables for the Mann-Whitney statistic', *Bulletin of the Institute of Educational Research at Indiana University*, vol. 1, 1953, no. 2.

Table J Wilcoxon test

(5 per cent significance for two-tailed test)

N	T
6	1
7	2
8	4
9	6
10	8
11	11
12	14
13	17
14	21
15	25
16	30
17	35
18	40
19	46
20	52
21	59
22	66
23	73
24	81
25	90

Adapted from Table 2 of F. Wilcoxon and R. A. Wilcox, *Some Rapid Approximate Statistical Procedures*, American Cyanamid Company, 1964.