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Psychology
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Paper 1: Social and Cognitive
Psychology

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Formulae and Statistical
Tables

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**Standard deviation
(sample estimate)**

$$\sqrt{\left(\frac{\sum (x - \bar{x})^2}{n - 1}\right)}$$

**Spearman's rank correlation
coefficient**

$$1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

Level of significance for a one-tailed test				
0.05		0.025	0.01	0.005
Level of significance for a two-tailed test				

N	0.10	0.05	0.025	0.01	0.005
5	0.900	1.000	1.000	1.000	1.000
6	0.829	0.886	0.943	1.000	1.000
7	0.714	0.786	0.893	0.929	0.964
8	0.643	0.738	0.833	0.881	0.905
9	0.600	0.700	0.783	0.833	0.867
10	0.564	0.648	0.745	0.794	0.830

	Level of significance for a one-tailed test					Level of significance for a two-tailed test				
	0.05		0.025		0.01		0.005		0.0025	
N	0.10		0.05		0.025		0.01		0.005	
11	0.536		0.618		0.709		0.755		0.800	
12	0.503		0.587		0.678		0.727		0.769	
13	0.484		0.560		0.648		0.703		0.747	
14	0.464		0.538		0.626		0.679		0.723	
15	0.446		0.521		0.604		0.654		0.700	
16	0.429		0.503		0.582		0.635		0.679	

Level of significance for a one-tailed test					Level of significance for a two-tailed test				
0.05					0.025				
0.01					0.005				
0.0025					0.005				
N					17				
0.10	0.05	0.025	0.01	0.005	0.414	0.485	0.566	0.615	0.662
18	0.401	0.472	0.550	0.600	0.643	19	0.391	0.460	0.535
20	0.380	0.447	0.520	0.570	0.612	21	0.370	0.435	0.508
22	0.361	0.425	0.496	0.544	0.586				

Level of significance for a one-tailed test					Level of significance for a two-tailed test				
0.05					0.0025				
0.025					0.01				
0.01					0.005				
N					0.005				
0.10					0.0532				
0.353					0.573				
0.344					0.562				
0.337					0.551				
0.331					0.541				
0.324					0.531				
0.375					0.522				
0.415					0.521				
0.406					0.511				
0.476					0.501				
0.486					0.491				
0.425					0.483				
0.457					0.440				
0.390					0.448				
0.398					0.440				
0.331					0.483				
0.324					0.522				
28									

Level of significance for a one-tailed test				
0.05	0.025	0.01	0.005	0.0025
Level of significance for a two-tailed test				

N	0.10	0.05	0.025	0.01	0.005
29	0.312	0.368	0.433	0.475	0.513
30	0.306	0.362	0.425	0.467	0.504

The calculated value must be equal to or exceed the critical value in this table for significance to be shown.

Chi-squared distribution formula

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$$df = (r - 1)(c - 1)$$

Level of significance for a one-tailed test						
Level of significance for a two-tailed test						
df	0.20	0.10	0.05	0.025	0.01	0.001
1	1.64	2.71	3.84	5.02	6.64	10.83
2	3.22	4.61	5.99	7.38	9.21	13.82
3	4.64	6.25	7.82	9.35	11.35	16.27
4	5.99	7.78	9.49	11.14	13.28	18.47
5	7.29	9.24	11.07	12.83	15.09	20.52

Level of significance for a one-tailed test						Level of significance for a two-tailed test					
0.10						0.20					
0.05						0.10					
0.025						0.05					
0.01						0.025					
0.005						0.01					
0.0005						0.001					
df	6	7	8	9	10	df	6	7	8	9	10
	8.56	9.80	11.03	12.24	13.44		8.56	9.80	11.03	12.24	13.44
	10.65	12.02	13.36	14.68	15.99		10.65	12.02	13.36	14.68	15.99
	12.59	14.07	15.51	16.92	18.31		12.59	14.07	15.51	16.92	18.31
	14.45	16.01	17.54	19.02	20.48		14.45	16.01	17.54	19.02	20.48
	16.81	18.48	20.09	21.67	23.21		16.81	18.48	20.09	21.67	23.21
	22.46	24.32	26.12	27.88	29.59		22.46	24.32	26.12	27.88	29.59

Level of significance for a one-tailed test						Level of significance for a two-tailed test					
0.10						0.05					
0.05						0.025					
0.01						0.005					
0.005						0.001					
df	0.20	0.10	0.05	0.025	0.01	0.001	0.20	0.10	0.05	0.025	0.01
11	14.63	17.28	19.68	21.92	24.73	31.26	15.01	17.53	19.68	21.92	24.73
12	15.81	18.55	21.03	23.34	26.22	32.91	16.01	18.55	21.03	23.34	26.22
13	16.99	19.81	22.36	24.74	27.69	34.53	16.91	19.81	22.36	24.74	27.69
14	18.15	21.06	23.69	26.12	29.14	36.12	17.78	21.06	23.69	26.12	29.14
15	19.31	22.31	25.00	27.49	30.58	37.70	18.60	22.31	25.00	27.49	30.58

Level of significance for a one-tailed test						Level of significance for a two-tailed test					
0.10						0.05					
0.05						0.025					
0.01						0.005					
0.005						0.001					
df						0.20					
16						20.47					
17						21.62					
18						22.76					
19						23.90					
20						25.04					
						28.41					
						31.41					
						34.17					
						37.57					
						45.32					

Level of significance for a one-tailed test						Level of significance for a two-tailed test					
0.10						0.20					
0.05						0.10					
0.025						0.05					
0.01						0.025					
0.005						0.01					
0.0005						0.001					
df	20	25	30	35	40	45	50	55	60	65	70
21	26.17	29.62	32.67	35.48	38.93	46.80	48.27	49.73	51.18	52.62	54.19
22	27.30	30.81	33.92	36.78	40.29	48.27	49.73	51.18	52.62	54.19	55.81
23	28.43	32.01	35.17	38.08	41.64	49.73	51.18	52.62	54.19	55.81	57.43
24	29.55	33.20	36.42	39.36	42.98	51.18	52.62	54.19	55.81	57.43	59.05
25	30.68	34.38	37.65	40.65	44.31	52.62	54.19	55.81	57.43	59.05	60.67

Level of significance for a one-tailed test					
Level of significance for a two-tailed test					
0.10	0.05	0.025	0.01	0.005	0.0005
df	0.20	0.10	0.05	0.025	0.01
26	31.80	35.56	38.89	41.92	45.64
27	32.91	36.74	40.11	43.20	46.96
28	34.03	37.92	41.34	44.46	48.28
29	35.14	39.09	42.56	45.72	49.59
30	36.25	40.26	43.77	46.98	50.89
59	59.25	60.26	63.77	66.98	70.89

Level of significance for a one-tailed test					
0.10	0.05	0.025	0.01	0.005	0.0005
Level of significance for a two-tailed test					

df	0.20	0.10	0.05	0.025	0.01	0.001
40	47.27	51.81	55.76	59.34	63.69	73.40
50	58.16	63.17	67.51	71.42	76.15	86.66
60	68.97	74.40	79.08	83.30	88.38	99.61
70	79.72	85.53	90.53	95.02	100.43	112.32

The calculated value must be equal to or exceed the critical value in this table for significance to be shown.

Mann-Whitney U test formulae

$$U_a = n_a n_b + \frac{n_a(n_a + 1)}{2} - \sum R_a$$

$$U_b = n_a n_b + \frac{n_b(n_b + 1)}{2} - \sum R_b$$

(U is the smaller of U_a and U_b)

Critical values for the Mann-Whitney U test
 $p \leq 0.05$ (one-tailed), $p \leq 0.10$ (two-tailed)

N_b

5	6	7	8	9	10	11	12
---	---	---	---	---	----	----	----

N_a

5	4	5	6	8	9	12	14	17	20	24	27	31	34
6	5	7	8	10	12	14	16	17					
7	6	8	11	13	15	17	19	21					
8	8	10	13	15	18	20	23	26					
9	9	11	13	18	21	24	27	30					
10	11	12	15	20	24	27	31	34					

N_b							
5	6	7	8	9	10	11	12

N_a							
11	12	16	19	23	27	31	34
12	13	17	21	26	30	34	38
13	15	19	24	28	33	37	42
14	16	21	26	31	36	41	46
15	18	23	28	33	39	44	50
16	19	25	30	36	42	48	54
60							

$p \leq 0.05$ (one-tailed), $p \leq 0.10$ (two-tailed) continued.

N_b

5	6	7	8	9	10	11	12
---	---	---	---	---	----	----	----

N_a

17	20	26	33	39	45	51	57	64
18	22	28	35	41	48	55	61	68
19	23	30	37	44	51	58	65	72
20	25	32	39	47	54	62	69	77

N_b							
13	14	15	16	17	18	19	20

N_a							
5	6	7	8	9	10	15	16
18	23	28	33	39	44	48	51
19	25	30	36	42	48	55	58
20	26	33	39	45	51	55	62
22	28	35	41	48	55	55	62
23	30	37	44	51	58	58	62
25	32	39	47	54	62	62	62

$p \leq 0.05$ (one-tailed), $p \leq 0.10$ (two-tailed) continued.

N_b							
13	14	15	16	17	18	19	20

N_a	11	12	13	14	15	16
	42	47	51	56	61	65
	46	51	55	60	64	68
	50	54	57	61	65	69
	54	60	65	70	75	80
	57	64	70	77	82	87
	71	77	82	87	92	97
	77	83	88	94	100	107

$p \leq 0.05$ (one-tailed), $p \leq 0.10$ (two-tailed) continued.

N_b

13	14	15	16	17	18	19	20
----	----	----	----	----	----	----	----

N_a	17	70	77	83	89	96	102	109	115
	18	75	82	88	95	102	109	116	123
	19	80	87	94	101	109	116	123	130
	20	84	92	100	107	115	123	130	138

$p \leq 0.01$ (one-tailed), $p \leq 0.02$ (two-tailed)

N_b							
5	6	7	8	9	10	11	12

N_a							
5	1	2	3	4	6	7	8
6	2	3	4	6	7	11	14
7	3	4	6	7	9	11	12
8	4	6	7	9	11	13	15
9	5	7	9	11	14	16	18
10	6	8	11	13	16	19	22
	10	11	13	16	21	24	

$p \leq 0.01$ (one-tailed), $p \leq 0.02$ (two-tailed) continued.

N _b							
5	6	7	8	9	10	11	12

N _a							
11	7	9	12	15	18	22	25
12	8	11	14	17	21	24	28
13	9	12	16	20	23	27	31
14	10	13	17	22	26	30	34
15	11	15	19	24	28	33	37
16	12	16	21	26	31	36	41
16	46	42	38	35	31	28	

$p \leq 0.01$ (one-tailed), $p \leq 0.02$ (two-tailed) continued.

5
6
7
8
9
10
11
12

N_b

17	13	18	23	28	33	38	44	49
18	14	19	24	30	36	41	47	53
19	15	20	26	32	38	44	50	56
20	16	22	28	34	40	47	53	60

N_a

N_b

13	14	15	16	17	18	19	20
----	----	----	----	----	----	----	----

N_a

5	9	10	11	12	13	14	15	16
6	12	13	15	16	18	19	20	22
7	16	17	19	21	23	24	26	28
8	20	22	24	26	28	30	32	34
9	23	26	28	31	33	36	38	40
10	27	30	33	36	38	41	44	47

$p \leq 0.01$ (one-tailed), $p \leq 0.02$ (two-tailed) continued.

N_b							
13	14	15	16	17	18	19	20

N_a							
11	31	34	37	41	44	47	50
12	35	38	42	46	49	53	56
13	39	43	47	51	55	59	63
14	43	47	51	56	60	65	69
15	47	51	56	61	66	70	75
16	51	56	61	66	71	76	82
16	51	56	61	66	71	76	87

$p \leq 0.01$ (one-tailed), $p \leq 0.02$ (two-tailed) continued.

N_b

13	14	15	16	17	18	19	20
----	----	----	----	----	----	----	----

N_a

17	55	60	66	71	77	82	88	93
18	59	65	70	76	82	88	94	100
19	63	69	75	82	88	94	101	107
20	67	73	80	87	93	100	107	114

$p \leq 0.025$ (one-tailed), $p \leq 0.05$ (two-tailed)

N_b							
5	6	7	8	9	10	11	12

N_a								
5	2	3	5	6	7	8	9	11
6	3	5	6	8	10	11	13	14
7	5	6	8	10	12	14	16	18
8	6	8	10	13	15	17	19	22
9	7	10	12	15	17	20	23	26
10	8	11	14	17	20	23	26	29

N _b							
5	6	7	8	9	10	11	12

N _a							
11	9	13	16	19	23	26	30
12	11	14	18	22	26	29	33
13	12	16	20	24	28	33	37
14	13	17	22	26	31	36	40
15	14	19	24	29	34	39	44
16	15	21	26	31	37	42	47
16	15	21	26	31	37	42	53

$p \leq 0.025$ (one-tailed), $p \leq 0.05$ (two-tailed) continued.

N_b

5	6	7	8	9	10	11	12
---	---	---	---	---	----	----	----

N_a

17	17	22	28	34	39	45	51	57
18	18	24	30	36	42	48	55	61
19	19	25	32	38	45	52	58	65
20	20	27	34	41	48	55	62	69

N_b							
13	14	15	16	17	18	19	20

N_a							
5	6	7	8	9	10	33	36
12	16	20	24	28	33	36	39
13	17	22	26	31	37	42	45
14	19	24	29	34	39	45	52
15	21	26	31	37	42	48	55
17	22	28	34	39	45	52	
18	24	30	36	42	48		
19	25	32	38	45			
20	27	34	41	48			

$p \leq 0.025$ (one-tailed), $p \leq 0.05$ (two-tailed) continued.

N_b							
13	14	15	16	17	18	19	20

N_a							
11	37	40	44	47	51	55	58
12	41	45	49	53	57	61	65
13	45	50	54	59	63	67	72
14	50	55	59	64	67	74	78
15	54	59	64	70	75	80	85
16	59	64	70	75	81	86	92
16	59	64	70	75	81	86	98

$p \leq 0.025$ (one-tailed), $p \leq 0.05$ (two-tailed) continued.

N_b

13	14	15	16	17	18	19	20
----	----	----	----	----	----	----	----

N_a

17	63	67	75	81	87	93	99	105
18	67	74	80	86	93	99	106	112
19	72	78	85	92	99	106	113	119
20	76	83	90	98	105	112	119	127

$p \leq 0.005$ (one-tailed), $p \leq 0.01$ (two-tailed)

N_b

5	6	7	8	9	10	11	12
---	---	---	---	---	----	----	----

N_a

5	6	7	8	9	10	11	13	16	18	21
0	1	2	3	4	6	7	9	13	16	18
1	1	3	4	6	7	9	11	13	16	21
1	2	3	4	6	7	9	11	13	16	21
2	4	5	7	9	11	13	16	18	21	
3	6	9	10	12	15					
4	9	12	15							
6	18	21								
10	21									

N _b							
5	6	7	8	9	10	11	12

N _a								
	11	12	13	14	15	16	18	22
	5	6	7	7	8	9	10	11
	7	9	10	11	12	13	15	18
	10	12	13	15	16	18	20	22
	13	15	17	20	24	27	31	36
	16	18	20	22	24	27	31	36
	24	27	31	34	37	41		

$p \leq 0.005$ (one-tailed), $p \leq 0.01$ (two-tailed) continued.

5	6	7	8	9	10	11	12
---	---	---	---	---	----	----	----

N_b

17	10	15	19	24	29	34	39	44
18	11	16	21	26	31	37	42	47
19	12	17	22	28	33	39	45	51
20	13	18	24	30	36	42	48	54

N_a

N_b

13	14	15	16	17	18	19	20
----	----	----	----	----	----	----	----

N_a	5	7	7	8	9	10	11	12	13
	6	10	11	12	13	15	16	17	18
	7	13	15	16	18	19	21	22	24
	8	17	18	20	22	24	26	28	30
	9	20	22	24	27	29	31	33	36
	10	24	26	29	31	34	37	39	42

N _b							
13	14	15	16	17	18	19	20

N _a							
11	12	13	14	15	16		
27	31	34	38	42	45		
30	34	38	42	46	50		
33	37	42	46	51	55		
36	41	45	50	55	60		
39	44	49	54	60	65		
42	47	53	58	64	70		
45	51	56	63	69	74		
48	54	60	67	73	79		

$p \leq 0.005$ (one-tailed), $p \leq 0.01$ (two-tailed) continued.

N _b							
13	14	15	16	17	18	19	20

N _a							
17	49	54	60	65	70	75	81
18	53	58	64	70	75	81	87
19	56	63	69	74	81	87	93
20	60	67	73	79	86	92	99
							105

The calculated value must be equal to or less than the critical value in this table for significance to be shown.

Wilcoxon Signed Ranks test

process

- Calculate the difference between two scores by taking one from the other
- Rank the differences giving the smallest difference Rank 1

Note: do not rank any differences of 0 and when adding the number of scores, do not count those with a difference of 0, and ignore the signs when calculating the difference

- Add up the ranks for positive differences
- Add up the ranks for negative differences
- **T** is the figure that is the smallest when the ranks are totalled (may be positive or negative)
- **N** is the number of scores left, ignore those with 0 difference

Level of significance for a one-tailed test		
0.05	0.025	0.01

Level of significance for a two-tailed test			
n			N = 5
0.1	0.05	0	6
		2	7
		3	8
		5	9
		8	
0.05	0.025	0	
		0	
		2	
		3	
		5	
		8	
0.02	0.01	–	
		–	

Critical values for the Wilcoxon Signed Ranks test

continued.

Level of significance for a one-tailed test		
0.05	0.025	0.01

Level of significance for a two-tailed test		
n	0.1	0.05
N = 10	11	8
11	13	10
12	17	13

9	7	5
---	---	---

The calculated value must be equal to or less than the critical value in this table for significance to be shown.