

REASONING WITH STATISTICS

How to Read Quantitative Research
FOURTH EDITION
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Table 8.1 Example of a Single-Factor Analysis of Variance (Skeletal Data)

Total SS (Sum of Squares)			General Formula				
Score deviations (d_x) from grand mean (54)			$F = \frac{MS \text{ between}}{MS \text{ within}}$				
Group I	d_x	d_x^2	Summary Table				
49	-5	25	Source	SS	d.f.	MS	F
52	-2	4	Between	130	2	65	16.25
52	-2	4	Within	48	12	4	
53	-1	1	Total	178			
49	-5	25	Within SS				
Group II			Source deviations (d_w) from group means:				
56	2	4	I	II	III		
57	3	9	-2	-2	1		
57	3	9	1	-1	-1		
60	6	36	1	-1	3		
60	6	36	2	2	-3		
Group III			-2	2	0		
54	0	0	Deviations squared (d_w^2):				
52	-2	4	4	4	1		
56	2	4	.1	1	1		
50	-4	16	1	1	9		
53	-1	1	4	4	9		
Total SS = 178 = ($\sum d_x^2$)			<u>.4</u>	<u>.4</u>	<u>0</u>		
			Sums	14	14	20	
			Within SS =	14 +	14 +	20 =	48 ($\sum d_w^2$)
Between SS			Between SS				
Group means				I	II	III	
Group deviation from grand mean			(M)	51	58	53	
Square deviation			(d_b)	-3	4	-1	
Group n times d_b^2			(d_b^2)	9	16	1	
			(nd_b^2)	45	80	5	
Between SS = 45 + 80 + 5 = 130 ($\sum nd_b^2$)							

Table 9.2 Means for the Sample Experiment (2-FACTOR)

		Cartoon		
		No aggression (N)	Aggression (A)	
Sex	Male (<i>m</i>)	$M_{Nm} = 51$	$M_{Am} = 59$	$M_m = 55$
	Female (<i>f</i>)	$M_{Nf} = 45$	$M_{Af} = 49$	$M_f = 47$
		$M_N = 48$	$M_A = 54$	
Grand $M = 51$				

Table 9.3 Example of a Multiple-Factor Analysis of Variance (Skeletal Data)

TOTAL SS (SUM OF SQUARES)

—where d_e equals deviation of scores about the grand mean (51).

Group <i>Am</i>	d_e	d_e^2	Group <i>Nm</i>	d_e	d_e^2
57	6	36	49	-2	4
58	7	49	52	1	1
58	7	49	52	1	1
61	10	100	53	2	4
61	10	100	49	-2	4
		$\Sigma = 334$			$\Sigma = 14$

Group <i>Af</i>	d_e	d_e^2	Group <i>Nf</i>	d_e	d_e^2
47	-4	16	43	-8	64
50	-1	1	46	-5	25
50	-1	1	46	-5	25
51	0	0	47	-4	16
47	-4	16	43	-8	64
		$\Sigma = 34$			$\Sigma = 194$

Total SS = $\Sigma d_e^2 = 576$

CARTOON MAIN EFFECT SS

—where d_c equals deviation of scores about the grand mean.

	Cartoon	
	A	N
Mean	54	48
Deviation (d_c)	+3	-3
d_c^2	9	9
nd_c^2	90	90
SS = $\Sigma nd_c^2 = 180$		

SEX MAIN EFFECT SS

—where d_s equals deviation of sex means from the grand mean.

	Sex	
	<i>m</i>	<i>f</i>
Mean	55	47
Deviation (d_s)	+4	-4
d_s^2	16	16
nd_s^2	160	160
SS = $\Sigma nd_s^2 = 320$		

Table 9.3 (cont'd.)

ERROR (WITHIN) SS
 —where d_w equals deviation of scores from group means.

Group	d_w	d_w^2	Group	d_w	d_w^2
Group Am	-2	4	Group Nm	-2	4
	-1	1		+1	1
	-1	1		+1	1
	+2	4		+2	4
	+2	4		-2	4
Group Af	-2	4	Group Nf	-2	4
	+1	1		+1	1
	+1	1		+1	1
	+2	4		+2	4
	-2	4		-2	4

$SS = \sum d_w^2 = 56$

INTERACTION SS
 —where d_i equals deviations from the grand mean of means with main effects removed.

	Group			
	Am	Af	Nm	Nf
Original mean:	59	49	51	45
Cartoon effect removed:	56	46	54	48
Sex effect removed:	52	50	50	52
Deviation (d_i) from grand mean:	+1	-1	-1	+1
d_i^2 :	1	1	1	1
nd_i^2 :	5	5	5	5

$SS = \sum nd_i^2 = 20$

SUMMARY TABLE

Source	SS	df	MS	F*
Cartoons	180	1	180.0	51.43
Sex	320	1	320.0	91.43
Cartoon × sex	20	1	20.0	5.71
Error	56	16	3.5	
Total	576	19		

* MS of effect ÷ MS error.

Table 9.4 Consequences of Removing Main-effects Sources of Variation

Cartoon Effect Removed:

Sex	Cartoon		
	N	A	
m	54	56	(55)
f	48	46	(47)
	(51)	(51)	

Cartoon means are now equal

Sex Effect Removed:

Sex	Cartoon		
	N	A	
m	50	52	(51)
f	52	50	(51)

Sex means are now also equal

Table 9.5 Tabular Report of the Interaction Interpretation in the Sample Study

Sex	Cartoon	
	N	A
m	51 _b	59 _c
f	45 _a	49 _b

(Means with common subscripts are not significantly [$p < .05$] different from one another.)

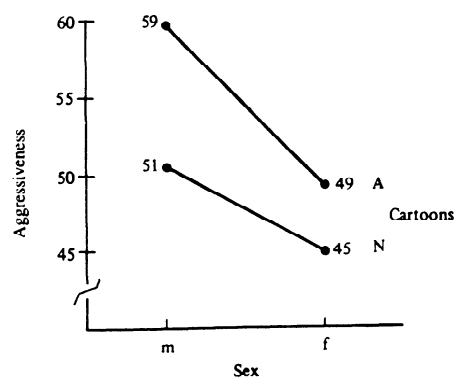


FIGURE 9.2 The interaction found in the sample study