Chapter 19—Chi-Square

19.1 Popularity of Psychology professors:

	Anderson	Klansky	Kamm	Total
Observed	25	32	10	67
Expected	22.3	22.3	22.3	67

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

$$= \frac{(25-22.3)^2}{22.3} + \frac{(32-22.3)^2}{22.3} + \frac{(10-22.3)^2}{22.3}$$

$$= 11.33$$

$[\chi^2_{.05}(2) = 5.99]$

We will reject the null hypothesis and conclude that students do not enroll at random.

19.3 Sorting one-sentence characteristics into piles:

	1	2	3	4	5	Total
Observed	8	10	20	8	4	50
Expected	5	10	20	10	5	50
Exp. %	10%	20%	40%	20%	10%	100%

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

$$= \frac{(8-5)^2}{5} + \frac{(10-10)^2}{10} + \frac{(20-20)^2}{20} + \frac{(8-10)^2}{10} + \frac{(4-5)^2}{5}$$

$$= 2.4$$

$[\chi^2_{.05}(4) = 9.49]$

Do not reject the null hypothesis that my daughter's sorting behavior is in line with my theory.

19.5 Racial choice in dolls (Clark & Clark, 1939):

	Black	White	Total
Observed	83	169	252
Expected	126	126	252

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$
$$= \frac{(83-126)^2}{126} + \frac{(169-126)^2}{126}$$
$$= 29.35$$
$[\chi^2_{.05}(1) = 3.84]$

We can reject H_0 and conclude that the children did not choose dolls at random, but chose white dolls more often than black.

19.7 Combining the two experiments:

	Black	**White**	**Total**
1939	83	169	252
	(106.42)	(145.58)	
1970	61	28	89
	(37.58)	(51.42)	
Totals	144	197	341

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$
$$= \frac{(83-106.42)^2}{106.42} + \frac{(169+145.58)^2}{145.58} + \frac{(61-37.58)^2}{37.58} + \frac{(28-51.42)^2}{51.42}$$
$$= 34.184$$
$\chi^2_{.05}(1) = 3.84$

Reject the null hypothesis and conclude that the distribution of choices between Black and White dolls was different in the two studies. Choice is *not* independent of the study, and could easily be related to the time at which the studies were run. We are no longer asking whether one color of doll is preferred over the other color, but whether the *pattern* of preference is constant across studies. In analysis of variance terms we are dealing with an interaction.

19.9 There are several ways this study could be modified. We could simply rerun the present analysis by defining smokers and non-smokers on the basis of the partner's smoking behavior. Alternatively, we could redefine the Smoker variable as "neither," "mother," "father," or "both."

19.11 Howell and Huessy (1985) study of attention deficit disorder:

Classification	Remedial English	Nonremedial English	Total
Normal	22 (28.374)	187 (180.626)	209
ADD	19 (12.626)	74 (80.374)	93
Total	41	261	302

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

$$= \frac{(22-28.374)^2}{28.374} + \frac{(187-180.626)^2}{180.626} + \frac{(19-12.626)^2}{12.626} + \frac{(74-80.374)^2}{80.374}$$

$$= 5.38$$

$$\chi^2_{.05}(1) = 3.84$$

We can reject the null hypothesis and conclude that achievement level during high school varies as a function of performance during elementary school.

19.13 A one-way chi-square test on the data in the first column of Exercise 19.12 would be asking if the students are evenly distributed among the eight categories. What we really tested in Exercise 19.12 is whether that distribution, *however it appears*, is the same for those who later took remedial English as it is for those who later took non-remedial English.

19.15 Inescapable shock and implanted tumor rejection:

	Inescapable Shock	Escapable Shock	No Shock	Total
Reject	8 (14.52)	19 (14.52)	18 (15.97)	45
No Reject	22 (15.48)	11 (15.48)	15 (17.03)	48
Total	30	30	33	93

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

$$= \frac{(8-14.52)^2}{14.52} + \frac{(19-14.52)^2}{14.52} + \cdots + \frac{(15-17.03)^2}{17.03}$$

$$= 8.852$$

$$\chi^2_{.05}(2) = 5.99$$

The ability to reject a tumor is affected by the shock condition.

I like this example particularly because it makes it clear that psychological variables have very clear effects on physical health. We often say this, but here are some quite dramatic data.

19.17 This is another place where we see the important relationship between sample size and power.

19.19 Testosterone and childhood delinquency:

	High Testosterone	**Normal Testosterone**	**Total**
Not Delinquent	366 (391.824)	3554 (3528.176)	3920
Delinquent	80 (54.176)	462 (487.824)	542
	446	4016	4462

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

$$= \frac{(366-391.824)^2}{391.824} + \ldots + \frac{(462-487.824)^2}{487.824}$$

$$= 15.57$$

$$\chi^2_{.05}(1) = 3.84$$

a) These results show that there is a significant relationship between the two variables—$\chi^2 = 15.57$.

b) Testosterone levels in adults are related to the behavior of those individuals when they were children.

c) This result shows that we can tie the two variables (delinquency and testosterone) together historically. I would assume that people who have high testosterone levels now also had high levels when they were children, but that is just an assumption.

19.21 We could ask a series of similar questions, evenly split between “right” and “wrong” answers. We could then sort the replies into positive and negative categories and ask whether faculty were more likely than students to give negative responses.

19.23 Racial differences in desired weight gain.

For white females, the odds of wishing to lose weight were 352/183 = 1.9235, meaning that while females are nearly twice as likely to wish to lose weight as to stay the same or gain weight.

For African-American females, the corresponding ratio is 47/52 = .9038.

The odds ratio is 1.9235/.9038 = 2.1281. This means that the odds of wishing to lose weight were more than twice as high among white females as compared to African American females.