

Unit 13: Two-Way Tables



PREREQUISITES

Students should know how to compute percentages.

ADDITIONAL TOPIC COVERAGE

Additional coverage on two-way tables can be found in *The Basic Practice of Statistics*, Chapter 6, Two-Way Tables.

ACTIVITY DESCRIPTION

Following the activity description, there is a questionnaire with three questions. Feel free to use this questionnaire or to use a modified version. If your class consists entirely of students of one class (freshman, sophomore, junior, senior), you might replace question 1 with the following question on gender:

What is your gender? Male Female.

If you decide to add questions, give students an opportunity to create the questions. Questions 2 and 3 are directly related to the video. In these questions students are asked to rate the physical beauty of their campus (or school) and their current level of happiness. Regardless of how you modify the questionnaire, be sure to include these two questions.

After the class data have been collected, they should be entered into an Excel or statistical software spreadsheet and distributed to the class. Sample data are available if you decide not to collect data from your class. The sample answers to the activity are based on these data. Once students have collected the data, they can complete the activity. This activity can be done either individually or in groups.

The categorical data collected from the Happiness Survey is ordinal data. In other words, there is an inherent order in the categories. When making tables or graphic displays using software, students will need to impose that order (unless the categories' alphabetical order is the same as the inherent order). So, for all tables and graphic displays that involve the variable Physical Beauty, check that the categories Bad, OK, and Good appear in that order (or the reverse order) and not in alphabetical order Bad, Good, and OK.

HAPPINESS SURVEY

Circle your answers to the following questions:

What is your class year?

Fr So Jr Sr

Rate the physical beauty of your campus (or school):

Bad OK Good

Rate your level of happiness today:

Unhappy So-so Happy

Happiness	Physical Beauty	Class
Happy	Good	Jr
Happy	Good	Jr
Unhappy	Good	Jr
Unhappy	Good	Sr
Happy	OK	Jr
Happy	Good	Sr
Happy	Good	Sr
Unhappy	Bad	Sr
Happy	Good	Jr
Happy	Good	Jr
So So	Good	Sr
Happy	OK	Jr
Happy	OK	Sr
Happy	OK	Sr
Happy	Good	Sr
So So	Good	Sr
Happy	OK	Sr
Happy	OK	Sr
Unhappy	Good	Sr
Happy	OK	Sr
Happy	OK	Jr
Happy	Bad	Sr
Happy	Good	Sr

Table T1. Sample Data collected from a college introductory statistics class.

THE VIDEO SOLUTIONS

1. Sample answers: race, gender, car color.
2. Somerville included a Happiness Survey.
3. The row variable was Happiness – the values of happiness were used to label the rows of the table. The column variable was Physical Beauty and its values were used to label the columns of the table.
4. The percentage of respondents rating Somerville’s physical beauty as Bad went down as the level of happiness went up.

UNIT ACTIVITY SOLUTIONS

1. Sample answer (based on sample data):

		Physical Beauty			Total
		Bad	OK	Good	
Happiness	Happy	1	8	8	17
	So So	0	0	2	2
	Unhappy	1	0	3	4
Total		2	8	13	23

2. Sample answer: $17/23 \times 100\% = 73.9\%$

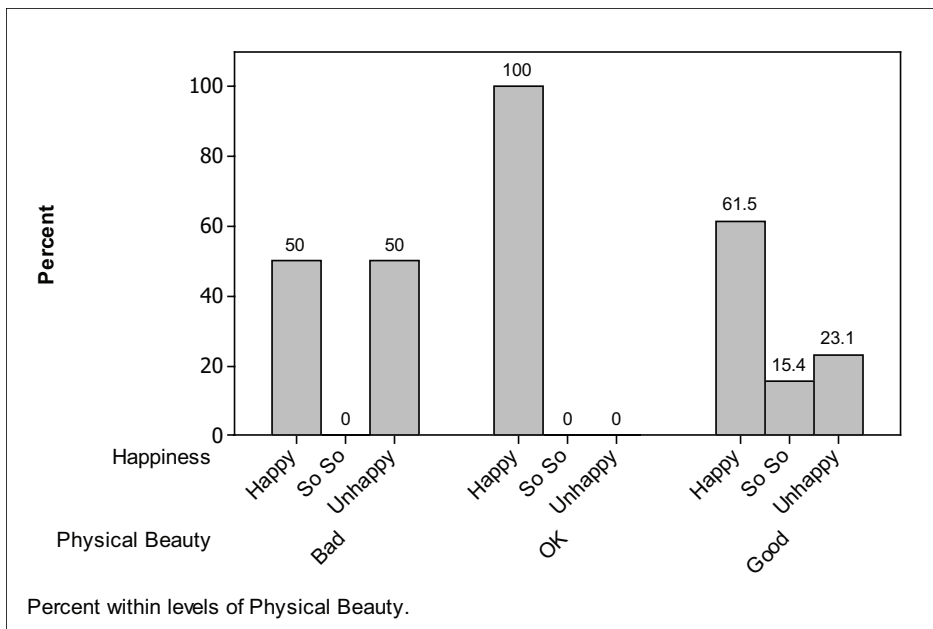
3. Sample answer: $13/23 \times 100\% = 56.5\%$

4. a.

% within Happiness		Physical Beauty			Total
		Bad	OK	Good	
Happiness	Happy	5.90%	47.10%	47.10%	100%
	So So	0.0%	0.0%	100.00%	100%
	Unhappy	25.00%	0.0%	75.00%	100%

b. Sample answer: Percent of happy students who rated campus physical beauty as Good: $8/17 \times 100\% = 47.1\%$. Percent of unhappy students who rated campus physical beauty as Good: $3/4 \times 100\% = 75.0\%$. A higher percentage of the unhappy students rated campus beauty as Good. However, there were only four students who rated themselves as unhappy.

5. a. Sample answer: Students' bar charts should show three distributions, one for each level of physical beauty. (See *chart on next page...*)



b. Sample answer: Fifty percent of the students who rated the physical beauty of the campus as bad were happy and fifty percent were unhappy. A higher percentage of students who rated campus physical beauty as Good were happy (61.5%) compared to those who rated campus physical beauty as bad. All eight of the students who rated campus physical beauty as OK were happy.

6. Sample answer. The class consisted only of juniors and seniors; 65.2% were seniors and 34.8% were juniors. The two-way tables below show the breakdown of Class with Happiness and Physical Beauty.

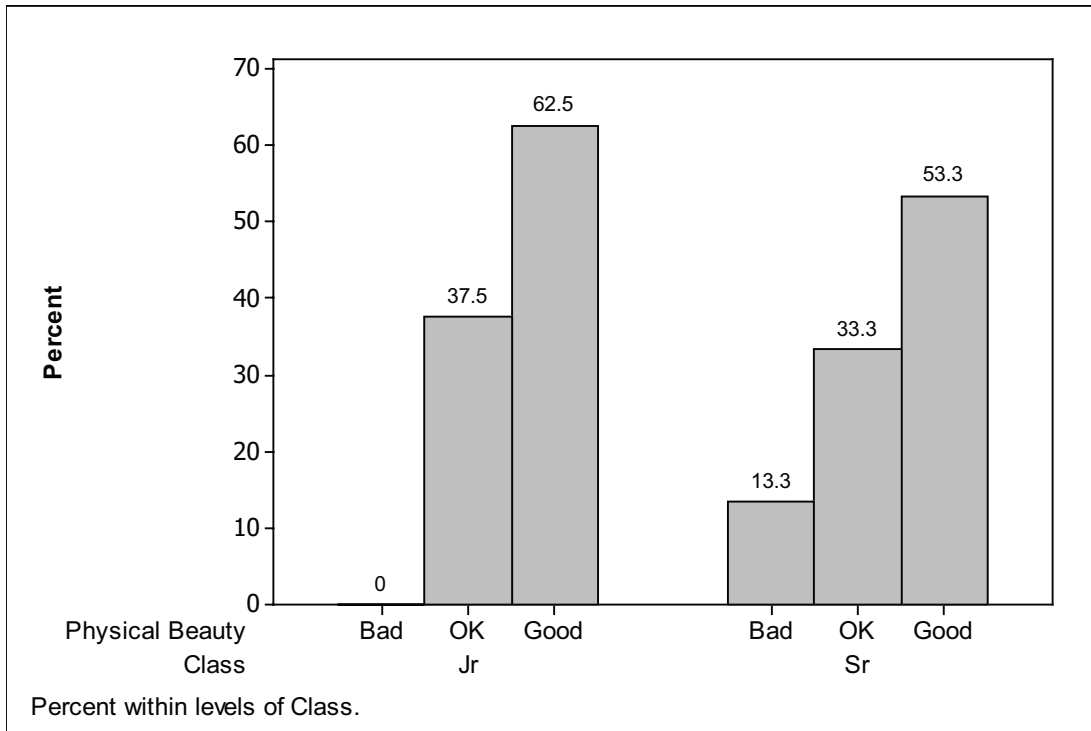
Count		Happiness			Total
		Happy	So So	Unhappy	
Class	Junior	7	0	1	8
	Senior	10	2	3	15
Total		17	2	4	23

Count		Physical Beauty			Total
		Bad	OK	Good	
Class	Junior	0	3	5	8
	Senior	2	5	8	15
Total		2	8	13	23

The juniors were happier than the seniors; 87.5% of the juniors rated themselves as happy compared to only 66.7% of the seniors. Below is a two-way table showing the distribution of Happiness conditioned on Class.

% within Class		Happiness			Total
		Happy	So So	Unhappy	
Class	Junior	87.50%	0.0%	12.50%	100.00%
	Senior	66.70%	13.30%	20.00%	100.00%

The graphic display below shows the distribution of Physical Beauty for each level of Class.



Notice that a higher percentage of juniors rated the campus physical beauty as Good compared to seniors; 62.5% of the juniors rated campus physical beauty as Good compared to 53.3% of the seniors. Notice also that none of the juniors rated campus physical beauty as Bad compared to 13.3% of the seniors. So, it appears that juniors have a “rosier” outlook than the seniors, both in terms of their happiness but also in how they see the beauty of their surroundings.

EXERCISE SOLUTIONS

1. a.

		Intelligence			Total
		Below Average	Average	Above Average	
Gender	Female	437	2243	4072	6752
	Male	456	1643	4593	6692
Total		893	3886	8665	13444

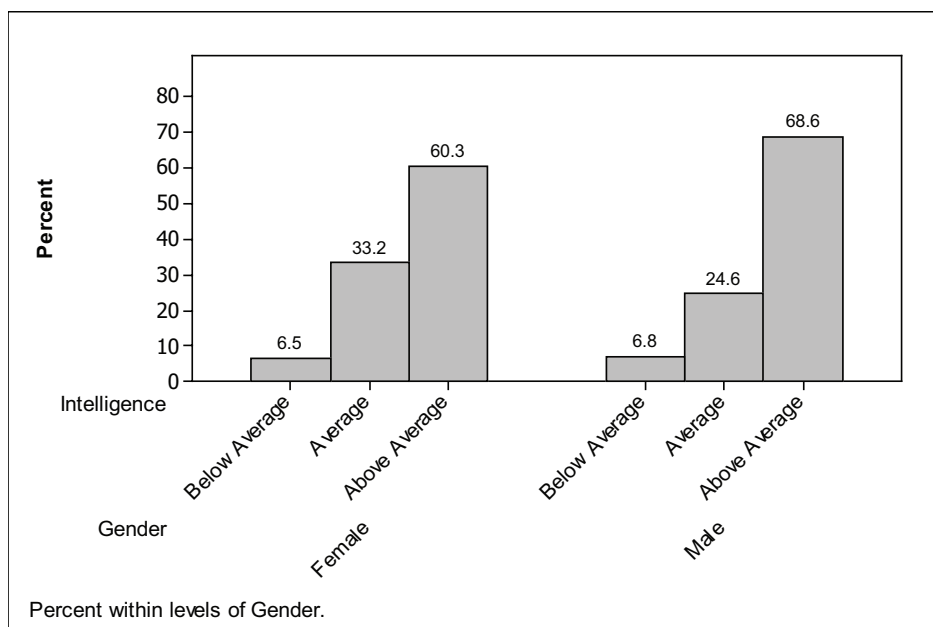
b. Male: $6692/13444 \times 100\% = 49.8\%$; Female: $6752/13444 \times 100\% = 50.2\%$

c. Above Average: $8665/13444 \times 100\% = 64.5\%$. A sizable majority felt that their intelligence was above average compared to others their age.

2. a.

		Intelligence			Total
		Below Average	Average	Above Average	
Gender	Female	$437/6752 \times 100\%$ 6.47%	$2243/6752 \times 100\%$ 0.3322	$4072/6752 \times 100\%$ 60.31%	100%
	Male	$456/6692 \times 100\%$ 6.81%	$1643/6692 \times 100\%$ 24.60%	$4593/6692 \times 100\%$ 68.60%	100%

b.



c. Sample answer: The percentages of male and female students who rated their intelligence as below average compared to others their age were about the same, 6.5% for females and 6.8% for males. A higher percentage of female students rated their intelligence as average compared to males, 33.2% for females and only 24.6% for males. A higher percentage of male students rated themselves as having above average intelligence than female students, 68.6% for males compared to only 60.3% for females. However, it should be noted a majority of both male and female 12th graders responded that they had above average intelligence compared to others their age.

3. a. Notice that the total in the table below is 100.2%. This is due to rounding the percentages.

		Political Preference					Total
		Rep	Ind	Dem	Oth	No Pref /Hvnt Decid	
Gender	Female	9.6	5.5	12.4	0.7	22.1	50.3
	Male	12.3	6.6	10.1	1.4	19.5	49.9
Total		21.9	12.1	22.5	2.1	41.6	100.2

b.

		Political Preference					Total
		Rep	Ind	Dem	Oth	No Pref /Hvnt Decid	
Gender	Female	19.2	10.9	24.6	1.3	44	44
	Male	24.6	13.2	20.2	2.8	39.2	39.2

c.

		Political Preference					Total
		Rep	Ind	Dem	Oth	No Pref /Hvnt Decid	
Gender	Female	44	45.4	55.1	32.7	53.1	53.1
	Male	56	54.6	44.9	67.3	46.1	46.1

4. a. Percentage of respondents who were female and Democrats: 12.4%

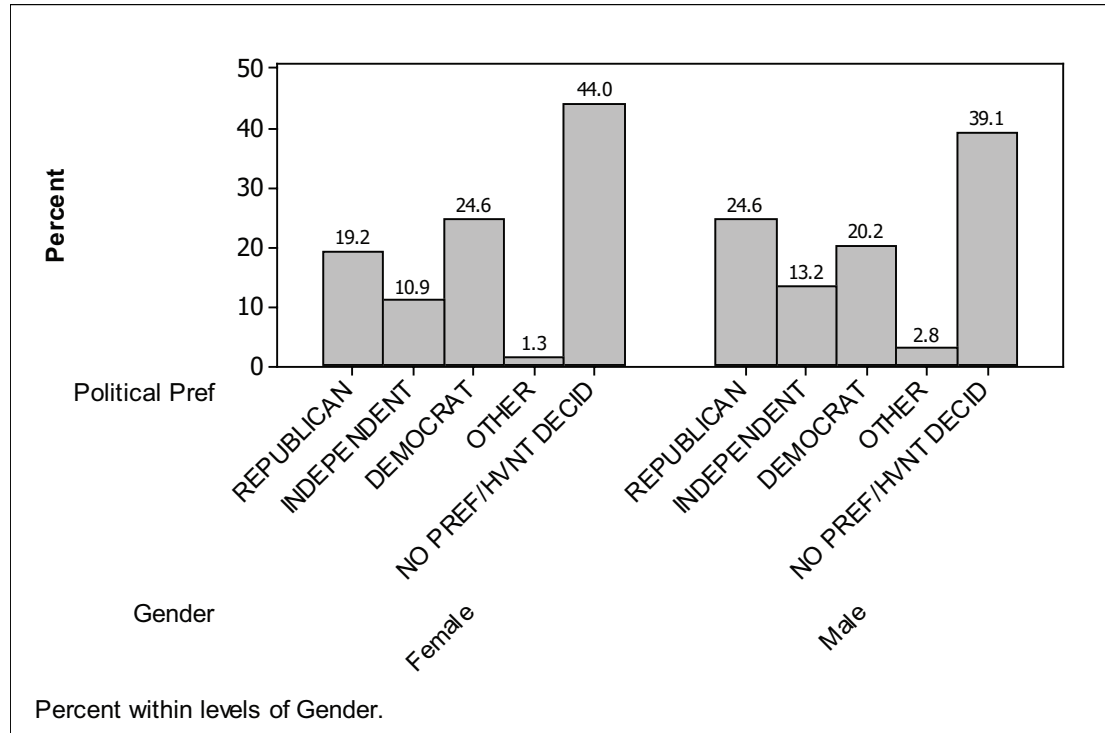
Percentage of respondents who were males and Independents: 6.6%

b. Males were more likely to identify themselves as Republican than females; 24.6% of the males responded Republican compared to only 19.2% of the females.

c. Republicans were more likely to be male; 56% of the students who responded they were Republicans were male and only 44.0% were female.

In this question, the condition is Republican; there were 2895 students in this category. Then these 2895 students were broken down by gender. In (b) students are first broken down by gender; there were 6637 females and 6583 males. Then we see how many of each gender were Republican.

d. Sample answer: A higher percentage of male students (24.6%) responded Republican compared to females (19.2%). A higher percentage of female students (24.6%) responded Democrat compared to males. It is interesting to note that the same percentage of females responded Democrat as males who responded Republican. A considerably higher percentage of females (44.0%) reported having no preference or were undecided compared to males (39.1%). A very low percentage of either gender responded “Other” for political preference.



REVIEW QUESTIONS SOLUTIONS

1. a.

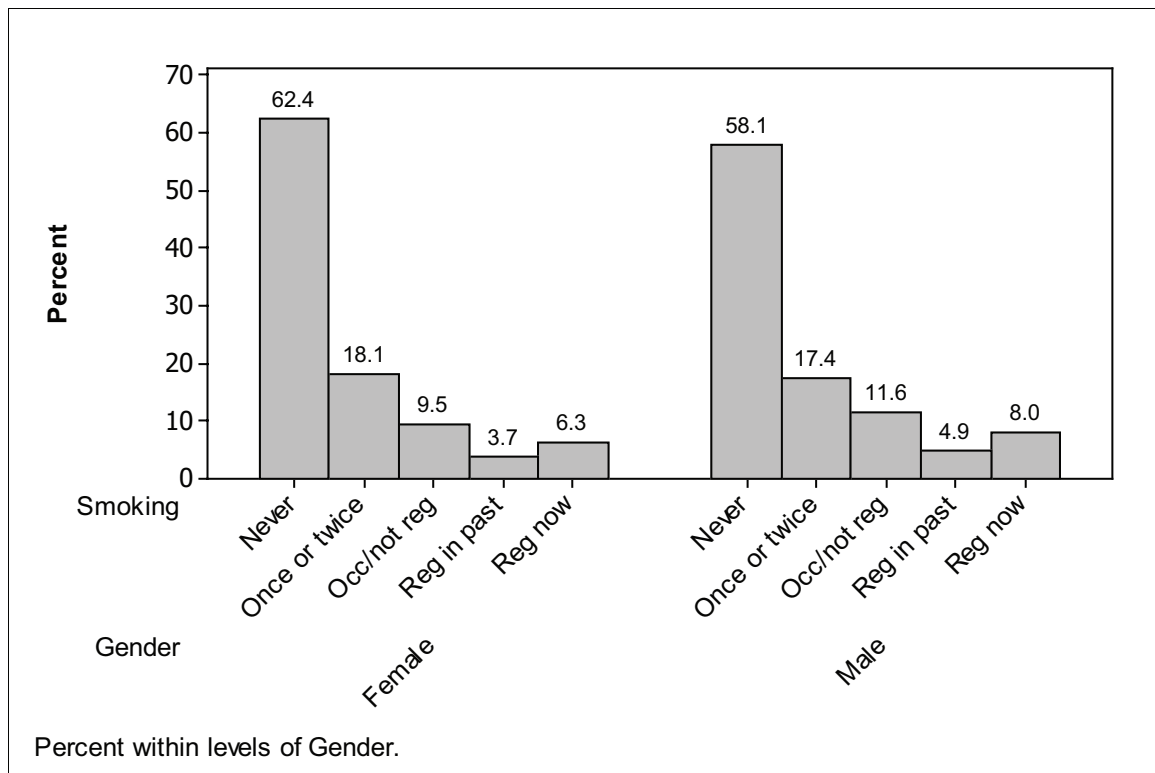
		Smoking					Total
		Never	Once or twice	Occ/ not reg	Reg in past	Reg now	
Gender	Female	4244	1228	649	253	428	6802
	Male	3957	1182	793	337	543	6812
Total		8201	2410	1442	590	971	13614

b. Females who never smoked: $4244/6802 \times 100\% = 62.4\%$

Males who never smoked: $3957/6812 \times 100\% = 58.1\%$

A higher percentage of the female respondents (62.4%) did not smoke compared to the male respondents (58.1%).

c.



2. a. 13,627

b. Never smoked: $8229/13627 \times 100\% = 60.4\%$

Smoked at least once: $100\% - 60.4\% = 39.6\%$

c. $3465/13627 \times 100\% = 25.4\%$

3. a. $3465/4751 \times 100\% = 72.9\%$

b. $(926 + 46)/2221 \times 100\% = 43.8\%$

4. a. $(489 + 168)/967 \times 100\% = 67.9\%$

b. $(330 + 126)/591 \times 100\% = 77.2\%$

c. $(3792 + 3465)/8229 \times 100\% = 88.2\%$

5. a. Grade D: sum = 99%; Grade C-, C, or C+ : sum = 100%;

Grade B-, B, or B+: sum = 100%; Grade A- or A: sum = 99%. The failure to sum to 100% is due to round-off error.

b. Sample answer: Here are the most striking patterns showing a relationship between grades and alcohol consumption. As grades increase, the percentage of students who had not consumed alcohol increases. As grades increase, the percentage of students who had consumed alcohol 6 or more times in the last 30 days decreases.