Does Eye Color Depend on Gender?

IT MIGHT DEPEND ON WHO OR HOW YOU ASK.

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Datasets and Stories Article

- Froelich, A.G. & Stephenson, W.R. (2013) Does eye color depend on gender? It might depend on who or how you ask. Journal of Statistics Education, v. 21, n. 2.
- Link to article: www.amstat.org/publications/jse/v21n2/froelich_ds.pdf

Using Student Data in Introductory Statistics

- Purpose: To increase student interest and obtain source of real data.
- Use data set in introductory and intermediate statistics courses for data analysis and inference.
- Use data set in computing course as an example of data cleaning.

The 5 Ws of the Data Set

- Who: 2068 Stat 101 students
- What: 15 different quantitative and categorical variables.
- When: From Spring 2004 through Spring 2007
- Where: Iowa State University
- Why: To motivate topics in descriptive and inferential statistics.
- How: Survey through website. Student names were collected and kept separate from data. Students received a small number of homework points for completing survey.

The Variables

- Gender
- Age (in years)
- Height (in inches)
- Year in School
- Eye Color
- Miles from Home Town to Ames, IA
- Number of Brothers
- Number of Sisters

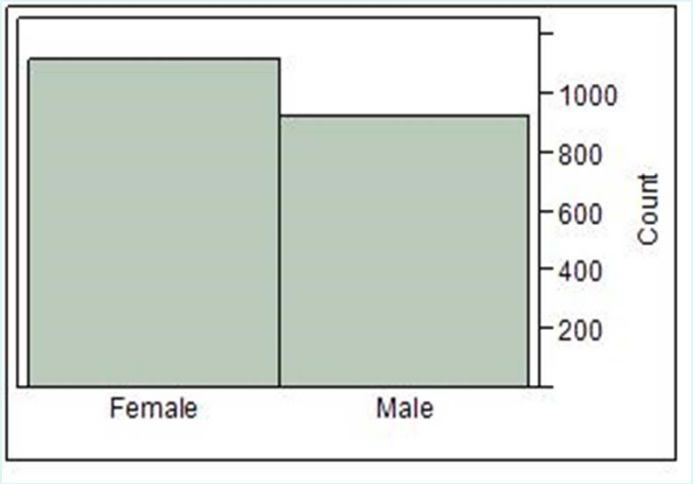
The Variables

- Number of hours spent on computer per week
- Exercise? (Yes or No)
- Number of hours per week spent exercising
- Number of music CDs owned
- Number of hours per week spent playing computer games
- Number of hours per week spent watching TV
- *Birth weight (in pounds and ounces)*

Gender and Eye Color

- Student reported eye color
  - Drop down menu with 5 options
    - Blue, Brown, Green, Hazel, Other
  - Other chosen by few students (42 out of 2068) – dropped from analysis
- Gender
  - Drop down menu with 2 options – Male, Female

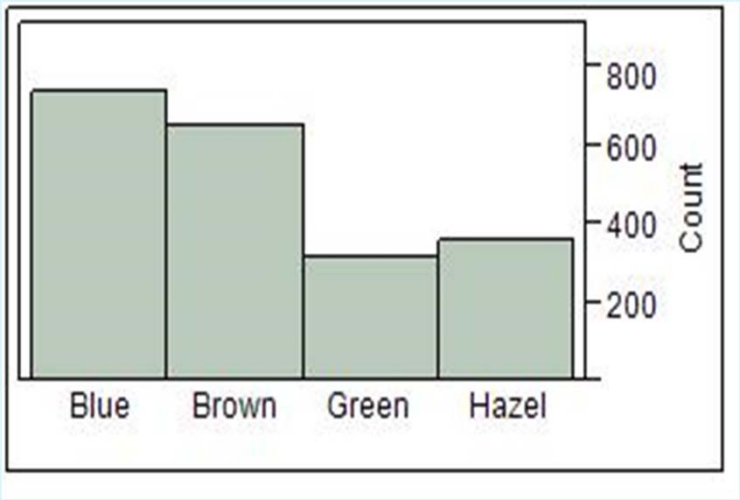
Analysis of Gender



Gender	Number	Proportion
Female	1107	0.5464
Male	919	0.4536
Total	2026	1.0000

- In our data, there are more females than males.
- Why?

Analysis of Eye Color



Eye Color	Number	Proportion
Blue	729	0.35982
Brown	642	0.31688
Green	308	0.15202
Hazel	347	0.17127
Total	2026	1.00000

- The proportion of students reporting blue or brown eyes are similar.
- The proportion of students reporting green or hazel eyes are similar.
- The proportion of students reporting blue, brown or green/hazel are similar.

Contingency Table of Eye Color and Gender

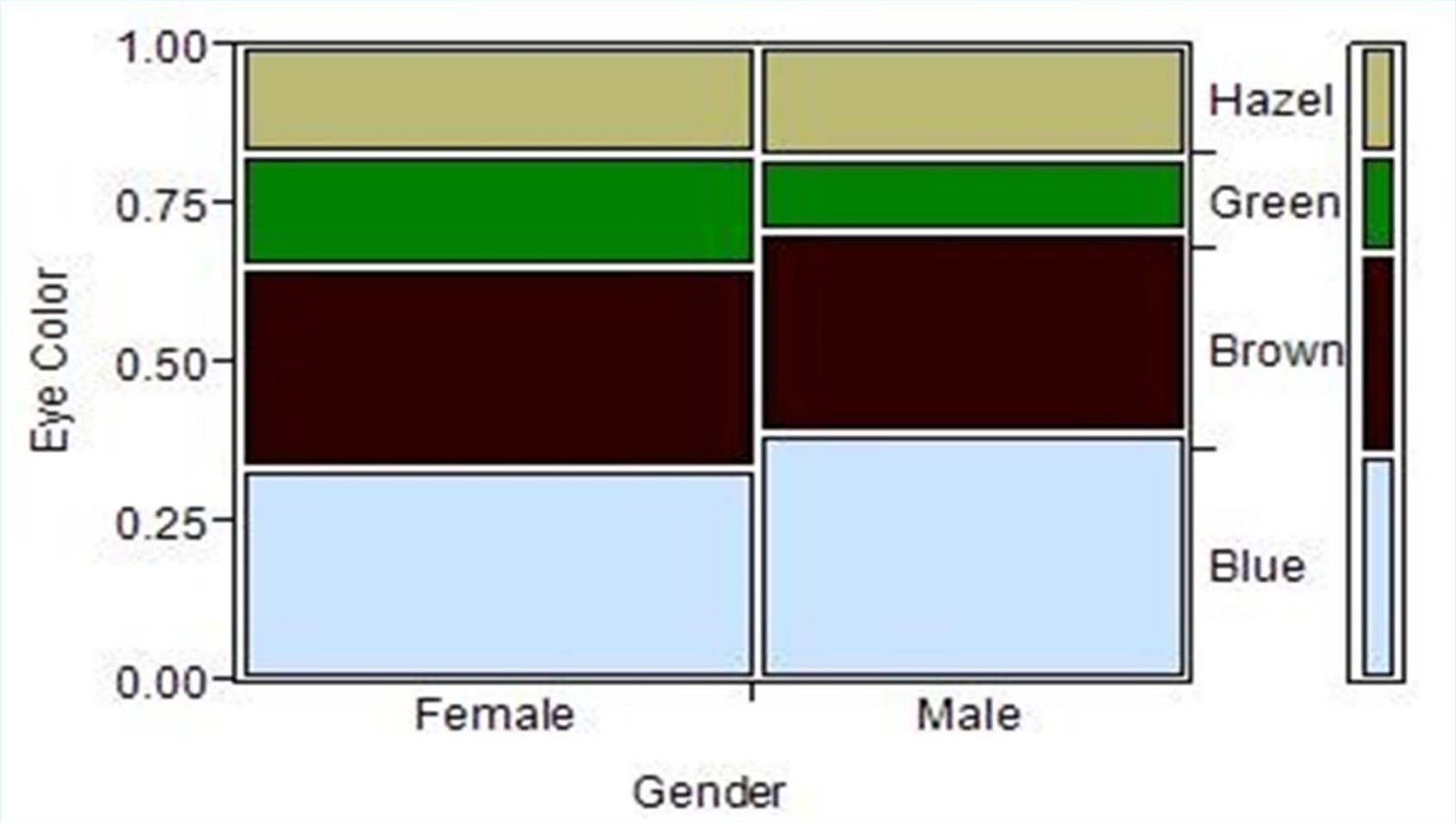
	Eye Color				
Gender	Blue	Brown	Green	Hazel	Total
Female	370	352	198	187	1107
Male	359	290	110	160	919
Total	729	642	308	347	2026

Conditional Distribution of Eye Color Given Gender

	Eye Color			
Gender	Blue	Brown	Green	Hazel
Given Female	33.42	31.80	17.89	16.89
Given Male	39.06	31.56	11.97	17.41
Marginal	35.98	31.69	15.20	17.13

All values are percentages.

Mosaic Plot of Conditional Distribution of Eye Color Given Gender



Findings

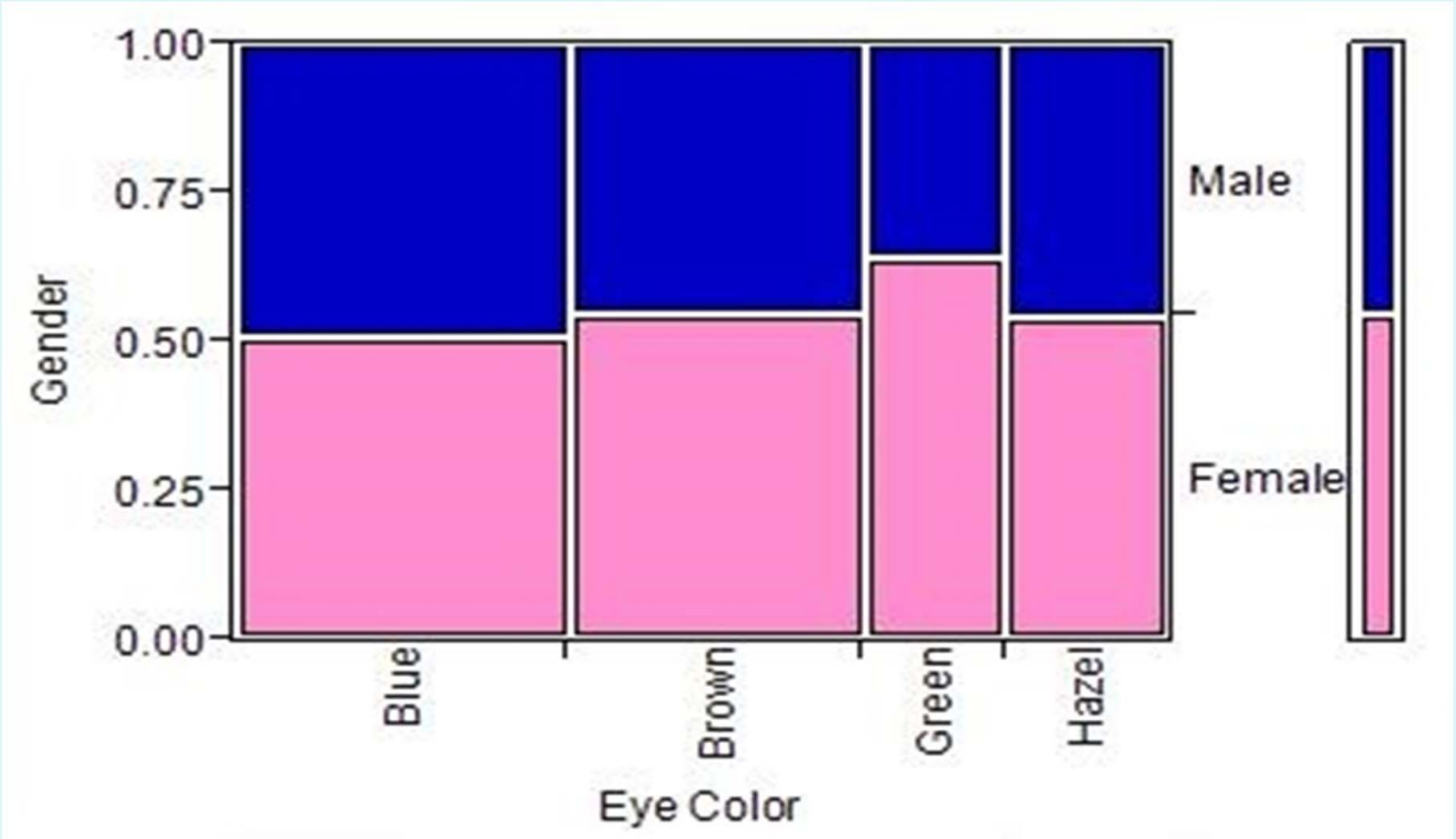
- Brown and Hazel
  - Similar percentages report these two eye colors from both gender.
- Blue and Green
  - Larger percentage of Males report Blue.
  - Larger percentage of Females report Green.

Contingency Table of Eye Color and Gender

	Eye Color				
Gender	Given Blue	Given Brown	Given Green	Given Hazel	Marginal
Female	50.75	54.83	64.29	53.89	54.64
Male	49.25	45.17	35.71	46.11	45.36

All values are percentages.

Mosaic Plot of Conditional Distribution of Gender Given Eye Color



Findings

- Brown and Hazel
  - Distribution similar to overall distribution of gender.
- Blue and Green
  - Distribution tilted towards Males for Blue.
  - Distribution tilted towards Females for Green.

Chi-square Test of Independence

- Are reported eye color and gender independent variables in the population of Stat 101 students at ISU?
  - Assume sample is representative of population.
- Test Statistic: $X^2 = 16.292$
- P-value: $P(\chi^2 > 16.292) = 0.001$
- Conclusion – Reported eye color and gender are dependent variables in the population of Stat 101 students at ISU.

Contradictory Results

- Biologically, gender and eye color are thought to be independent traits.
  - Genetic basis for eye color not completely known.
    - Not simple dominant – recessive trait.
  - Known genes for eye color not on X or Y chromosome.
  - Genetic studies of eye color do not find dependence with gender.
- In our data, reported eye color are gender were found to be dependent.
  - Why?

Discussion of Results

- Student difficulties with results.
  - Result due to larger percentage of females in data.
    - Results take this difference into account.
  - Results due to bad luck.
    - We obtained an unusual sample.
    - While possible, not probable.

Possible Explanations

- Number of eye color options
  - Genetic studies classify according to 3 colors (blue, brown, green/hazel)
  - Estimate effect in our data by combining green and hazel to form one category
    - $X^2 = 8.988$
    - p-value = 0.0112
  - Reported eye color and gender are still dependent, but evidence of dependence is not as strong.

Possible Explanations

- Use of student reported eye colors
  - Genetic studies of eye color use expert opinion to classify eye colors.
  - Differences in color perception among students related to gender?

Possible Explanations

- Color Blindness – Color Vision Defect
  - Most common is red-green color vision defects
  - Missing one class of photopigments: medium (green) or long (red).
  - No difficulty seeing blue (short) – vision defect appears as colors move from blue towards green and red.
  - Difficult to distinguish between green and hazel and to distinguish between these colors and blue.

Possible Explanations

- Incidence of color blindness
  - Approx. 8-10% of males and less than 1% of females
  - Approx 73 to 92 of our 919 males students would be estimated to have a red-green color vision defect.
  - Due to defect, these males could be more likely to over-report blue eye color.

Possible Explanations

- Distribution of true eye colors between two genders in population of Stat 101 students at ISU is different.
  - Data collection does not allow us to draw this conclusion from this analysis.
  - Could be unknown differences in racial or ethnic backgrounds of female and male students in Stat 101 at ISU.
    - Distribution of eye color varies according to racial or ethnic background.

Lesson for Students

- There are no simple survey questions.
  - What is your eye color?
  - How many brothers/sisters do you have?
- Data collection methods must match intended use.
- Conclusions must take into account data collection methods.

Extensions

- Gender and Eye Color
  - Use three eye color categories: Blue, Green/Hazel, Brown
  - Collect data in class – allows for outside corroboration of eye colors
  - Ask students or test for color vision defects
  - Ask students for racial or ethnic background

Extensions

- Ideas for student data
  - Social Media accounts (Facebook, Twitter, Instagram, etc.)
  - Cell Phone company (Verizon, AT&T, etc.)
  - Mobile Operating System (iOS, Android, Windows, etc.)
  - Cell Phone (iPhone, Samsung, etc.)