The Effect of Anchoring on Cal Poly Undergraduate Statistics Student Estimates of Nelson Mandela's Age of Death

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Summary

In order to study the effects of anchoring, 113 Cal Poly STAT 365 Section 1, STAT 365 Section 2, or STAT 130 students were randomly assigned to two groups. They were given either a small or large "anchor" before providing a guess of Nelson Mandela's age of death. Analysis of the data found evidence that anchoring had a significant effect on an individual STAT 365 or STAT 130 student's estimate of Mandela's age of death, with strong evidence showing similar students given small "anchors" tend to provide lower estimates than those given larger "anchors."

1. Introduction

According to the Program on Negotiation of Harvard Law School, the anchoring effect "is a cognitive bias that describes the common human tendency to rely too heavily on the first piece of information offered ("the anchor") when making decisions" ("The Anchoring Effect"). This experiment aimed to observe whether providing certain age value "anchors" to participants beforehand that were either exceptionally small or exceptionally large would influence the direction of participants' answers when asked to guess Nelson Mandela's age of death.

In particular, we asked the following primary questions of the data:

> *Does seeing the larger "anchor" value tend to produce larger age guesses, on average, than seeing the smaller "anchor" value? If so, how much larger?*
>
> *Does seeing the larger "anchor" value make a student more likely to provide an age guess of 75 or older than seeing the smaller "anchor" value? If so, how much more likely?*

Additionally, we asked two secondary questions:

> *Did students in the two sections of STAT 365 differ significantly with regard to average age guess or percentage who made a guess of 75 or older?*
>
> *Did students in STAT 365 differ significantly from students in STAT 130 with regard to average age guess or percentage who made a guess of 75 or older?*

2. Experimental Methods

The study was performed on a sample of two sections of statistics students from the STAT 365 and STAT 130 courses at Cal Poly State University, San Luis Obispo. Within each section, each student was randomly assigned to two treatment groups based on whether they were assigned to an even or odd number with each group having e. Each student was then given a survey based on the group they were assigned to. The students assigned to an even digit were then asked the following question as an "anchor":

> "Was Nelson Mandela, the first president of South Africa following apartheid, older or younger than age 16 when he died?"

Likewise, the odd students were asked the following question as an "anchor":

> "Was Nelson Mandela, the first president of South Africa following apartheid, older or younger than age 160 when he died?"

Finally, both groups were asked to complete the following task:

> "Make a guess for Mandela's age (in years) when he died."

In total, there were 113 students. 60 students were randomly assigned to the even group, and 53 students were randomly assigned to the odd group. 64 students were in STAT 365, and 49 students were in STAT 130. STAT 365 students, but not STAT 130 students, could be further categorized by section, with 34 students in section 1 and 30 students in section 2. These subdivisions were not the result of random assignment.

3. Primary Question Analysis and Results

3.1 Primary descriptive statistics

Based on preliminary visualizations of the data in Figures 3.1 and 3.2, it appears that in the sample, the even group, which was given a lower age "anchor," tends to have lower age guess values than the odd group, which was given the higher age "anchor."

Figure 3.1: Side-by-side boxplot of Guessed Age of Death by Group (Even/Odd)

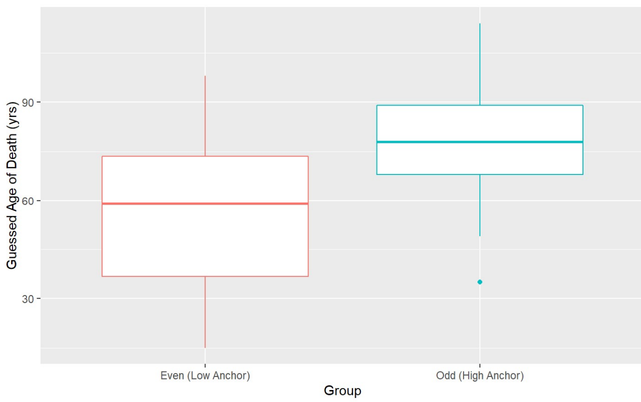
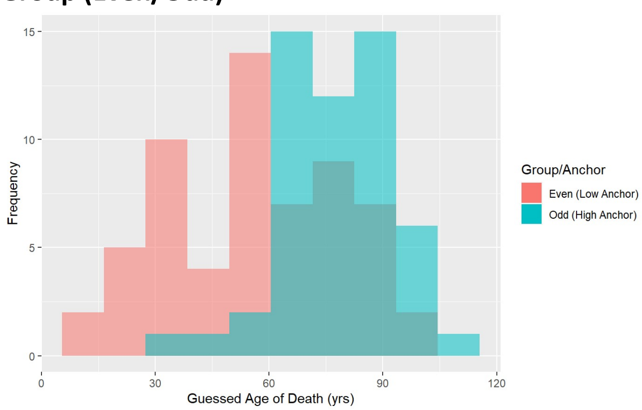


Figure 3.2: Distributions of Guessed Age of Death by Group (Even/Odd)



As seen in Table 3.1, the sample mean guess for the even group, 56.517, is lower than the sample mean guess for the odd group, 78.302, by 21.785 years. This is a difference of about 0.992 standard deviations, using the overall sample standard deviation of 21.951.

Table 3.1: Descriptive statistics of Guess by Group

Group	Count	Mean	SD	% >=75
Even (Low Anchor)	60	56.517	22.130	25.000
Odd (High Anchor)	53	78.302	15.011	52.830
Both	113	66.735	21.951	38.053

Additionally, the sample percentage of guesses greater than 75 years for the odd group, 52.830%, is greater than that of the even group, 25.000%, by 27.830 percentage points.

3.2 Primary inferential findings

Firstly, to answer whether viewing the larger "anchor" value tends to produce larger age guesses on average than when seeing the smaller "anchor" value, we looked for a significant effect utilizing a standard two-sample t-test for the means.

From the two-sample t-test, we found that there is extremely strong evidence (p-value=2.08E-08) that seeing the larger "anchor" value tends to produce larger age guesses on average than seeing the smaller "anchor" value.

As a result of finding a significant effect of "anchor" on age guess, we calculated a 95% confidence interval for the difference in age guess between individuals viewing a large "anchor" versus a small "anchor." Based on the confidence interval, we are 95% confident that viewing a large "anchor" results in an average Mandela age of death guess between 14.640 and 28.930 years greater than viewing a small "anchor."

Next, to answer whether viewing the larger "anchor" value makes a student more likely to provide an age guess of 75 or older than seeing the smaller "anchor" value, we looked for a significant effect utilizing a standard two-sample z-test for proportions.

From the two-sample z-test, we found that there is strong evidence (p-value=0.001) that those who see a larger "anchor" are on average more likely to make an age guess over 75 than those given a smaller "anchor."

After finding a significant effect of "anchor" on proportion of age guesses over 75, we calculated a 95% confidence interval for the difference in percentage points. Based on the confidence interval, we are 95% confident that the expected percentage of individuals of making an age guess over 75 is between 44.241 and 9.891 percentage points greater for those viewing a larger "anchor" than for those viewing a smaller "anchor."

4. Secondary Question Analysis and Results

4.1 Secondary descriptive statistics

The first secondary question compares the guesses between the two sections of STAT 365, section 1 and section 2. As seen in the visualizations in Figures 4.1 and 4.2, it appears that most sample guesses in section 1 tend to be lower than guesses in section 2, though the range is similar for both sections.

Figure 4.1: Side-by-side boxplot of Guessed Age of Death by STAT 365 Section

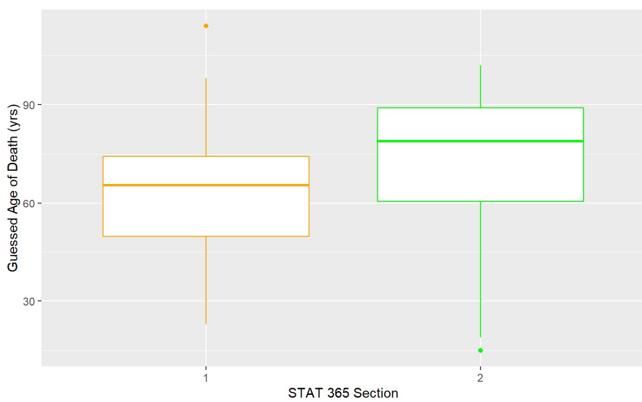
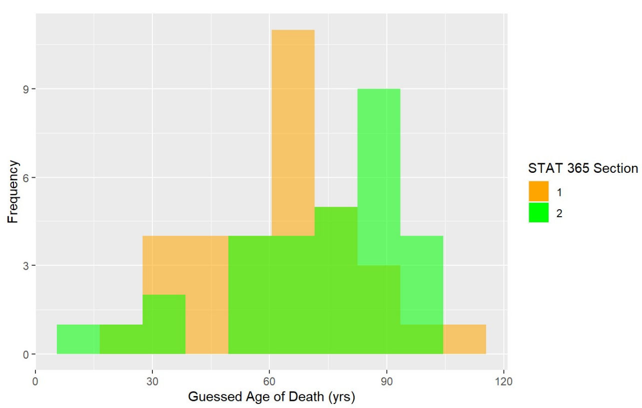


Figure 4.2: Distribution of Guessed Age of Death by STAT 365 Section



As seen in Table 4.1, the sample mean guess for section 2 is about 8.547 years greater than that of section 1. This is a difference of about 0.389 standard deviations, using the STAT 365 sample standard deviation of 21.991.

Table 4.1: Descriptive Statistics by STAT 365 Section

Section	Count	Mean	SD	% >=75
1	34	63.853	20.247	26.471
2	30	72.400	23.323	56.667
Both	49	67.859	21.991	40.625

The sample percentage of guesses greater than 75 years for section 2, 56.667%, is 30.196 percentage points higher than that of section 1, which is 26.471%.

The other secondary question compares the two courses in the data, STAT 365 and STAT 130. When looking at the visualizations in Figures 4.3 and 4.4, it appears that the two courses tend to have similarly distributed guesses.

Figure 4.3: Side-by-side boxplot of Guessed Age of Death by Course

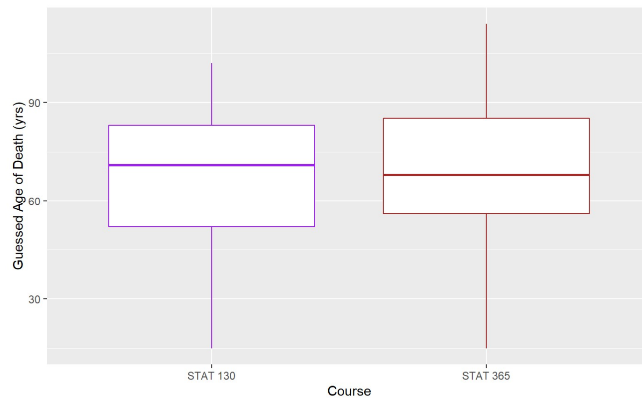
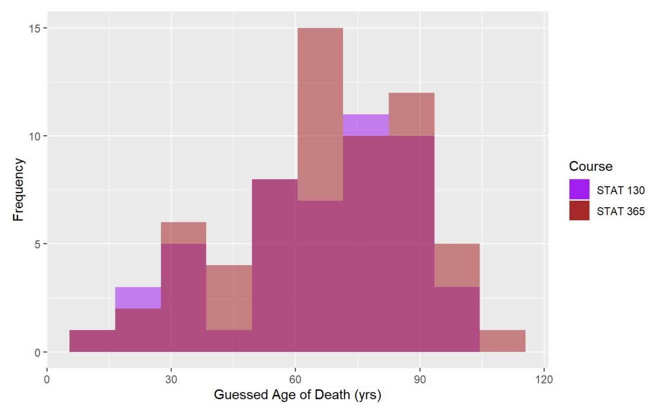


Figure 4.4: Distribution of Guessed Age of Death by Course



As seen in Table 4.2, the sample mean guess for STAT 365 is about 2.594 years greater than that of STAT 130. This is a difference of about 0.118 standard deviations, using the overall sample standard deviation of 21.951.

Table 4.2: Descriptive Statistics by Course

Course	Count	Mean	SD	% >=75
STAT 130	49	65.265	22.039	34.694
STAT 365	64	67.859	21.991	40.625
Both	113	66.735	21.951	38.053

The sample percentage of guesses greater than 75 years for STAT 365, 40.625%, is 5.931 percentage points higher than that of STAT 130, which is 34.694%.

4.2 Secondary inferential findings

In order to answer whether the two sections of STAT 365 differed significantly with regard to average age guess and proportion of guesses over 75, we performed a standard two-sample t-test for the mean age guesses and a two-sample z-test for the proportion of guesses over 75.

Based on the two-sample t-test, we found that that there was no sufficiently strong evidence (p-value=0.122) of a significant difference between the mean guesses of an individual in section 1 versus section 2. However, we did conclude from the two-sample z-test that there is strong evidence (p-value=0.014) a significant difference in expected proportion of guesses over 75 between the two sections.

Additionally, to answer whether the two courses, STAT 365 and STAT 130, differed significantly with regard to average age guess and proportion of guesses over 75, we again performed a standard two-sample t-test for the mean age guesses and a two-sample z-test for the proportion of guesses over 75.

Based on the two-sample t-test and two-sample z-test, we found that that there was no sufficiently strong evidence of either a significant difference between the mean guesses (p-value=0.536) or proportion of guesses over 75 (p-value=0.520) between STAT 365 and STAT 130.

4. Conclusion

From the analysis of the data, we can conclude that providing an age "anchor" does indeed influence the average age at which undergraduate statistics students attending either STAT 365 or STAT 130 believe Nelson Mandela passed away. Additionally, they influenced the average guess in the intended direction. For instance, a small "anchor" of 16 years would decrease the typical guessed age, while a large "anchor" of 160 years would increase the typical guessed age. The expected proportion of guesses over 75 was also greater for individuals given a larger "anchor" than for a smaller "anchor."

Neither STAT 365 section nor course were found to have an influence on average guessed age, and course was not found to have an influence on expected proportion of guesses over 75. However, STAT 365 section appeared to influence the expected proportion of guesses over 75.

5. Study Limitations

These conclusions are only generalizable to the population of statistics students enrolled in STAT 365 and STAT 130 at the time of the experiment, as this demographic comprised the entirety of participants in the study. These groups are not balanced in terms of size, and participants were not vetted on whether or not they had prior knowledge of Mandela's age of death.

Furthermore, participants were not randomly assigned to either course or STAT 365 section. Because of this, the results answering the secondary questions should be viewed as an observational study and should not be seen as evidence of a cause-and-effect relationship between either course or section and mean guess or proportion of guesses above 75.

Finally, STAT 365 section could be confounded with time as the run order of students was not randomized for section. All participants in section 1 took the survey before all the participants in section 2, and section 1 participants were not barred from communicating with section 2 participants. As a result, it may be that section 2 was influenced by section 1, which means the two groups are not independent. This would violate the assumptions of the hypothesis tests used in this analysis.

References

"The Anchoring Effect and How It Can Impact Your Negotiation." *PON Daily Blog*, Harvard Law School, 21 May 2020, https://www.pon.harvard.edu/daily/negotiation-skills-daily/the-drawbacks-of-goals/.

Appendix

Appendix 3.2A – RStudio 2-Sample t-Test and 95% Confidence Interval for Mean Guess, Low Anchor against High Anchor

```
t.test(guess ~ group, data = mandela, var.equal = TRUE)
```

```
     Two Sample t-test

data:  guess by group
t = -6.0418, df = 111, p-value = 2.077e-08
alternative hypothesis: true difference in means between group Even
(Low Anchor) and group Odd (High Anchor) is not equal to 0
95 percent confidence interval:
 -28.93020 -14.64024
sample estimates:
mean in group Even (Low Anchor) mean in group Odd (High Anchor)
                       56.51667                        78.30189
```

Appendix 3.2B – RStudio 2-Sample z-Test for Proportion of Guesses above 75, Low Anchor against High Anchor

```
prop.test(x = c(15, 28), n = c(60, 53),
          alternative = "less",
          correct = FALSE)
```

```
     2-sample test for equality of proportions without continuity
correction

data:  c(15, 28) out of c(60, 53)
X-squared = 9.2464, df = 1, p-value = 0.00118
alternative hypothesis: less
95 percent confidence interval:
 -1.0000000 -0.1327824
sample estimates:
   prop 1    prop 2
0.2500000 0.5283019
```

Appendix 3.2C – RStudio 95% Confidence Interval for Difference in Proportion of Guesses above 75, Low Anchor against High Anchor

```
diffscoreci(15, 60, 28, 53, conf.level = 0.95)
```

```
data:

95 percent confidence interval:
 -0.44240998 -0.09891319
```

Appendix 4.2A – RStudio 2-Sample t-Test for Mean Guess, STAT 365 Section 1 against Section 2

```
t.test(guess ~ section, data = mandela, var.equal = TRUE)
```

```
     Two Sample t-test

data:  guess by section
t = -1.5695, df = 62, p-value = 0.1216
alternative hypothesis: true difference in means between group 1 and
group 2 is not equal to 0
95 percent confidence interval:
 -19.432854   2.338736
sample estimates:
mean in group 1 mean in group 2
       63.85294        72.40000
```

Appendix 4.2B – RStudio 2-Sample z-Test for Proportion of Guesses above 75, STAT 365 Section 1 against Section 2

```
prop.test(x = c(9, 17), n = c(34, 30),
          alternative = "two.sided",
          correct = FALSE)
```

```
     2-sample test for equality of proportions without continuity
correction

data:  c(9, 17) out of c(34, 30)
X-squared = 6.0245, df = 1, p-value = 0.01411
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.53311852 -0.07080305
sample estimates:
   prop 1    prop 2
0.2647059 0.5666667
```

Appendix 4.2C – RStudio 2-Sample t-Test for Mean Guess, STAT 365 against STAT 130

```
t.test(guess ~ course, data = mandela, var.equal = TRUE)
```

```
     Two Sample t-test

data:  guess by course
t = -0.62084, df = 111, p-value = 0.536
alternative hypothesis: true difference in means between group STAT
130 and group STAT 365 is not equal to 0
95 percent confidence interval:
 -10.87376   5.68562
sample estimates:
mean in group STAT 130 mean in group STAT 365
              65.26531               67.85938
```

Appendix 4.2D – RStudio 2-Sample z-Test for Proportion of Guesses above 75, STAT 365 against STAT 130

```
prop.test(x = c(17, 26), n = c(49, 64),
          alternative = "two.sided",
          correct = FALSE)
```

```
     2-sample test for equality of proportions without continuity
correction

data:  c(17, 26) out of c(49, 64)
X-squared = 0.41415, df = 1, p-value = 0.5199
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.2388684  0.1202459
sample estimates:
   prop 1    prop 2 
0.3469388 0.4062500 
```