AP STATISTICS FINAL PROJECT REPORT – SEMESTER 2
EXPLORING THE EFFECTS OF RANDOM NUMBERS ON COUNTING ACCURACY

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2 Introduction

2.1 Overview

Counting numbers is a skill that has been introduced to us from a very young age. It serves as a cornerstone of mathematics and plays a crucial role in various aspects of our daily lives. Whether it's counting objects, tracking quantities, or performing calculations, the ability to count accurately is essential. Therefore, under normal circumstances, it’s expected that every educated individual should have no problem with counting. The question is then, what circumstances could lead to issues with counting?

2.2 Expectations

We expect that by introducing external audio while an individual is counting, such as the playback of random numbers, there will be a potential for errors to occur, which can include stuttering, pausing, or slowing down. The number of errors could be influenced by the presence of auditory stimuli.

2.3 Objective

The objective of this project is to examine the relationship between which factor has a significance influence on counting accuracy while listening to external audio of random numbers. We aim to analyze the potential disruptions or distractions caused by auditory stimuli and their implications for counting performance.

2.4 Confounding Variables

2.4.1 Cognitive Abilities

An individuals’ cognitive abilities, such as working attention span, could influence their counting accuracy.

2.4.2 Prior Numerical Skills and Knowledge

Participants' pre-existing numerical skills and familiarity with counting may impact their accuracy. Some individuals may have stronger counting abilities due to prior exposure to mathematical concepts, or training (including taking higher level math courses).

2.4.3 Environmental Factors

The environment in which participants complete the task, such as noise level or distractions, can affect counting accuracy. It's essential to control these factors to ensure they do not confound the relationship between listening to random numbers and counting accuracy, and thus – we’ve had participants use headphones or other similar devices to minimize the effects of a noisy environment.

2.4.4 Fatigue and Timing Effects

Participants' fatigue or the time of day when the experiment is conducted can impact counting accuracy. It is crucial to consider potential fatigue or timing effects and control for them during data analysis.

2.4.5 Native Language

Different languages have unique counting systems and cultural influences that can potentially impact counting accuracy. To address this, we will include the participants' native language in our analysis. Controlling for native language allows us to isolate the effects of variations of total time and listening to random numbers on counting accuracy, independent of language differences.

3 DATA COLLECTION

3.1 SAMPLE SPACE

The sample space for this study primarily consists of a convenience sample, specifically friends and acquaintances of high school students. Due to the practicality and accessibility of recruiting participants from within existing social networks, this convenience sampling approach was chosen for the study. While convenience sampling offers convenience and ease in participant recruitment, it is important to note that the sample may not be fully representative of the broader population.

Each student in the group, which consisted of two boys and two girls, was assigned to collect data from about 15 individuals, resulting in a total sample size about 60 people. This approach allows each student to have a consistent number of participants to gather data from, contributing to the overall sample size and diversity of the study. By combining the data collected from the 60 individuals and utilizing the diverse perspectives within the group, it allowed our group to collect data quickly and effectively, without introducing too much bias to one gender or age group.

3.2 DEFINITION OF TERMS

Estimated Error – Refers to the specific number that a participant anticipates making a mistake on during the counting task. In other words, it is the participant's self-prediction of the number at which they believe they might encounter difficulties, experience a lapse in accuracy, or encounter any challenges in the counting process.

Errors – Errors represent the numbers in the counting sequence where participants deviated from accuracy, which could include obvious instances of miscounting, slowing down, stuttering, or any other mistakes made during the task.

First Error Time – The amount of time, in seconds, until the first occurrence of an error

First Error — The first number people mess up on.

3.3 THE AUDIO FILE

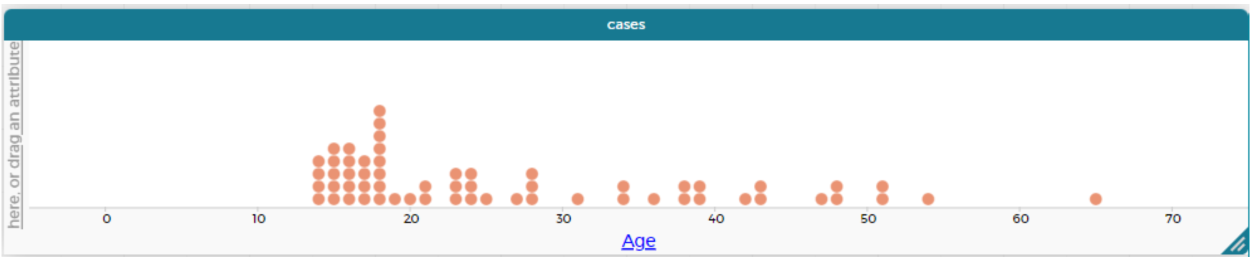
In this study, an approximately 1-minute audio file was utilized, recorded by James, to provide auditory stimuli during the counting task. The audio file was designed to have James recite the numbers 1-10 in increasing order initially, followed by random numbers. The random numbers within the range of 11-100 were generated using a random number generator, ensuring that each number was selected without replacement.

By incorporating this audio file, the study aimed to introduce a controlled and consistent audio distraction for all participants. The initial sequential numbers and subsequent random numbers provided a variation in the counting task, allowing for an examination of potential effects on counting accuracy. The use of a random number generator ensured that the random numbers presented in the audio file were unbiased and independent of any specific pattern or sequence.

4 Data Analysis

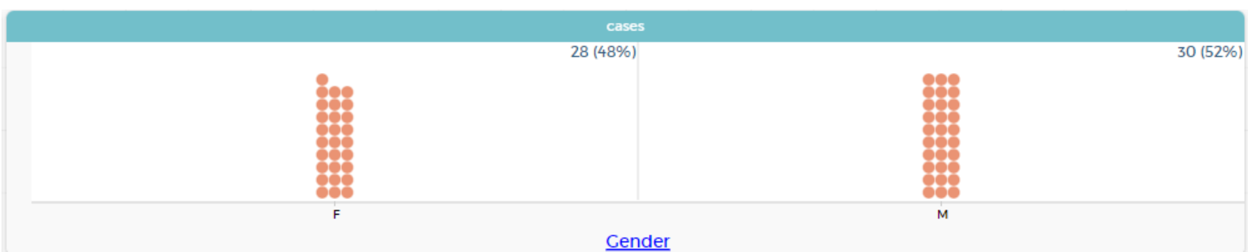
4.1 Data Distribution and Statistics

4.1.1 Age Distribution



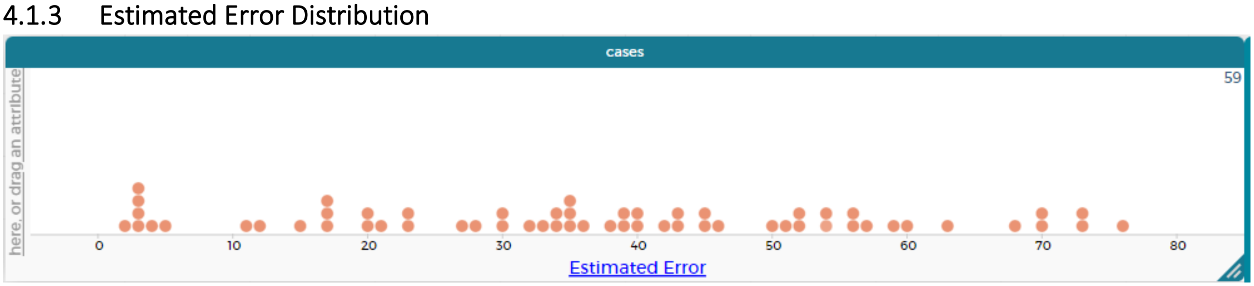
As shown in the dot plot by CODAP, the age is right skew, with most of the ages in the sample between 14-21 years old. There is one outlier who is 65 years old. The data from the random sample had a median of 21 years old, a mean of 26.47 years old, and a moderate standard deviation of 12.71 years.

4.1.2 Gender Distribution



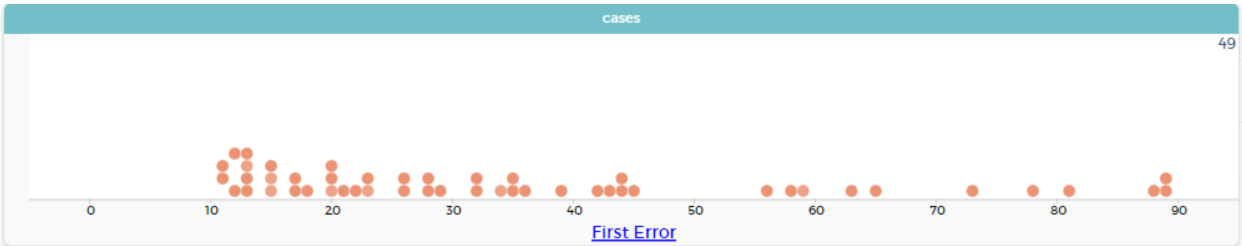
As shown in the chart by CODAP, there are 28 females and 30 males in our study. Females comprise of 48% of the sample, while males comprise of 52% of the sample.

4.1.3 Estimated Error Distribution



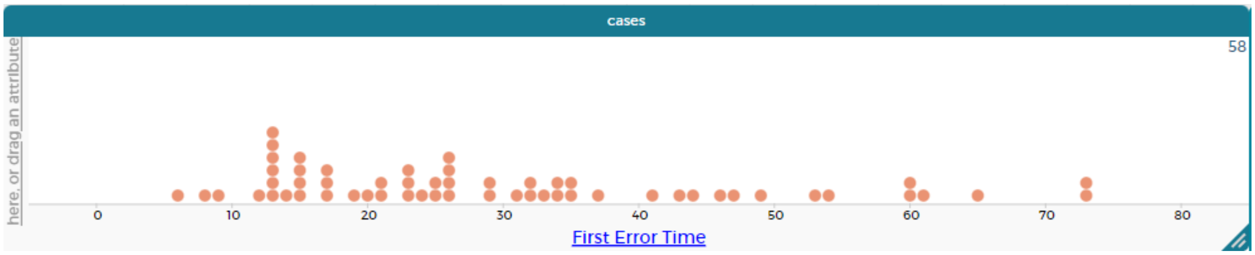
As shown in the dot plot by CODAP, the estimated number participants believed the first error would occur is unimodal with a large spread. The data from the sample has a median of 36, a mean of 36.64, and a large standard deviation of 20.47.

4.1.4 First Error Distribution



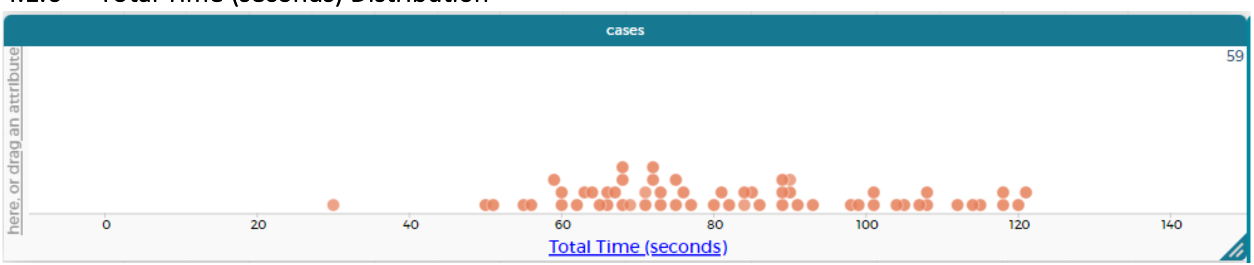
As shown in the dot plot by CODAP, the first error is right skew, with most errors occurring below 50. There are 3 outliers, 88, 89 and 89. The data from the sample has a median of 28, a mean of 35.5, and a large standard deviation of 23.1. It's also notable that there were 4 instances where the first error was at 13.

4.1.5 First Error Time (seconds) Distribution



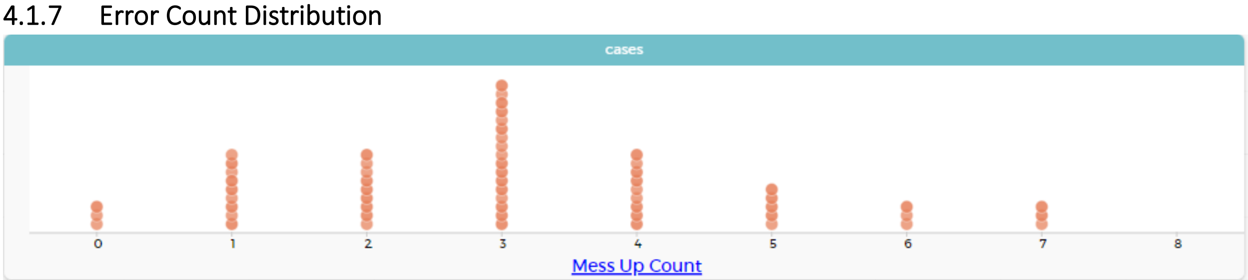
As shown in the dot plot by CODAP, the first error time is right skew, with most of the errors occurring before 40 seconds. There are two outliers at 73 seconds (1 minute 13 seconds). Additionally, the data from the sample has a median of 26 seconds, a mean of 29.75 seconds, and a large standard deviation of 17.02 seconds.

4.1.6 Total Time (seconds) Distribution



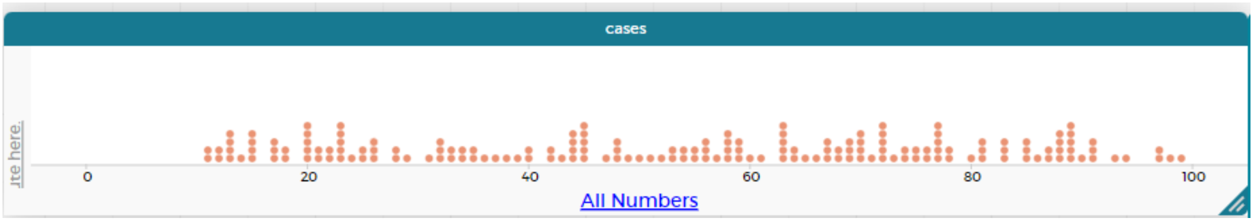
As shown in the dot plot by CODAP, the total time is slightly right skewed, with most of the data between 60 seconds (1 minute) and 93 seconds (1 minute 33 seconds). There are no outliers. Additionally, the data from this sample has a median of 80 seconds (1 minute 20 seconds), a mean of 82.1 seconds (1 minute 22 seconds), and a moderate standard deviation of 20.6 seconds.

4.1.7 Error Count Distribution



As shown in the dot plot by CODAP, the error count is slightly right skew, with the greatest number of errors being 3. There are no outliers. Additionally, the data from this sample has a median of 3 errors, a mean of 3.069 errors, and a moderate standard deviation of 1.756 errors.

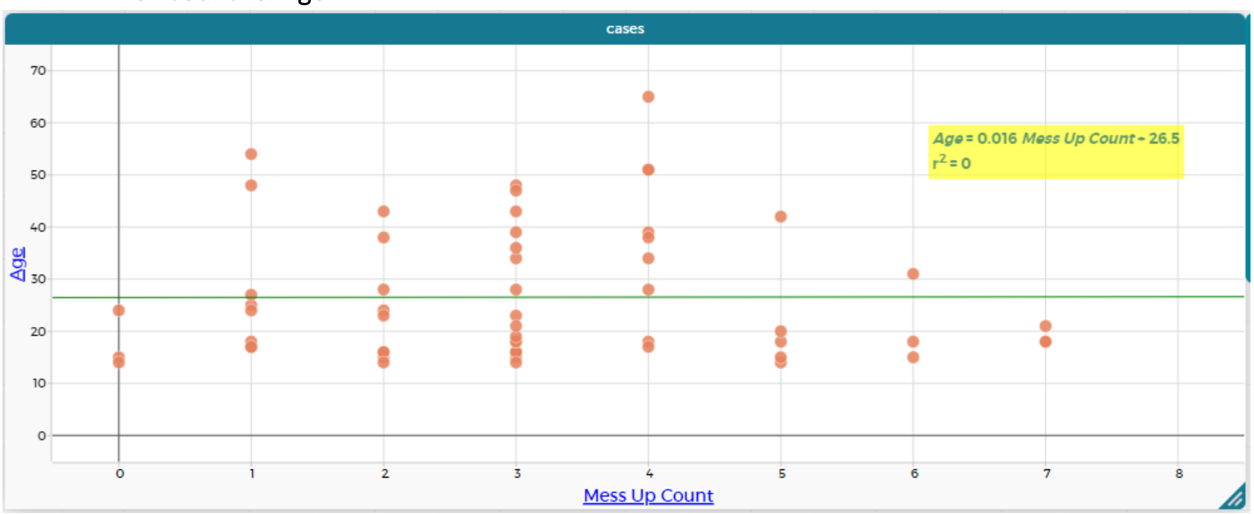
4.1.8 Error Distribution



As shown in the dot plot by CODAP, the errors are almost everywhere, but some could argue that it is slightly bimodal. There are no outliers. Additionally, the data from this sample has a median of 56, mean of 53.7, and large standard deviation of 25.4.

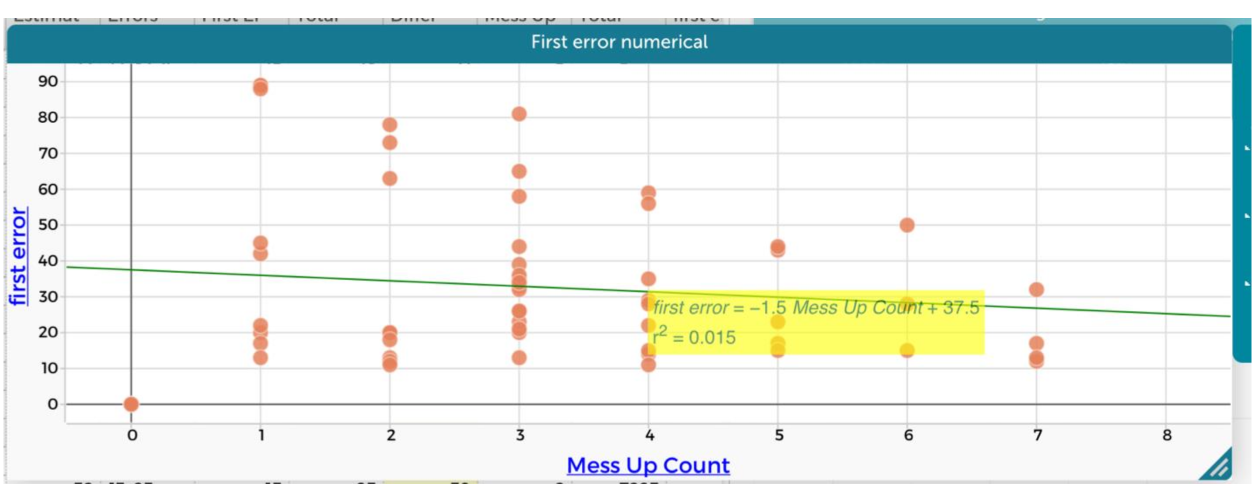
4.2 Linear Regression

4.2.1 Error Count vs. Age



The regression line exhibits a negligible slope, and with an R-squared value of zero, it indicates that none of the data can be explained by the linear regression model. Consequently, it appears that there is no discernible relationship between age and the error count

4.2.2 Error Count vs. First Error



The regression line exhibits a negative slope, and which an R-squared value of 0.015, it indicates that only 1.5 percent of the data can be explained by the linear regression model. Consequently, it appears that there is no discernible relationship between first error and the mess up count.

4.2.3 Error Count vs. First Error Time

The regression line exhibits a negative slope, and which an R-squared value of 0.04, it indicates that only 4 percent of the data can be explained by the linear regression model. Consequently, it appears that there is no discernible relationship between First Error Time and mess up count

4.3 Hypothesis Testing

4.3.1 Hypothesis Test for Difference in Mean of Estimated error and First Error

4.3.1.1 Hypothesis

H0: The difference between the mean of estimated error and mean of first error is zero

Ha: The difference between the mean of estimated error and mean of first error is not zero

4.3.1.2 Conditions

- Samples are dependent (matched-pairs).
- The number of samples is greater than 30 (60 > 30, met)

4.3.1.3 Calculation

$$t = \frac{-3.9 - 0}{\frac{22.6}{\sqrt{60}}} = -1.33669$$

$$p = 0.186$$

4.3.1.4 Conclusion

The obtained p-value of 0.186, exceeding the typical significance levels of 0.05, leads us to fail to reject the null hypothesis (H0). There is **no** convincing evidence that there is difference between the mean of estimated error and mean of first error.

4.4 Chi-Squared Tests

4.4.1 Chi-Squared Test for Independence (Gender and Error Count)

A chi-squared independence test for gender and error count allows us to assess whether there is a significant relationship between these variables. A significant result indicates that there is evidence of a relationship between gender and error count, suggesting that gender may have an impact on counting accuracy.

4.4.1.1 Hypothesis

H0: Gender and error count are independent

HA: Gender and error count are dependent

4.4.1.2 Conditions

- All expected numbers are greater or equal to 5 (met, see table below).
- People are chosen by random (met)

4.4.1.3 Categories and Expected Values

Error Count	Male	Female
[0, 4)	16 (19.322)	32 (18.678)
[4, 8)	14 (10.678)	7 (10.322)

$$X^2 = \Sigma \frac{(O-E)^2}{E} = \frac{(16-19.322)^2}{19.322} + \cdots + \frac{(7-10.322)^2}{10.322} = 3.26 \; df = 1$$

$$p = 0.07$$

4.4.1.4 Results and Conclusion

The obtained p-value of 0.07, exceeding the typical significance levels of 0.05 and 0.01, leads us to fail to reject the null hypothesis (H0). Thus, there is compelling evidence to suggest that gender is not significantly associated with the total number of errors made during counting tasks.

5 Discussion

In the data analysis, various distributions were examined, including age, gender, estimated error, first error, first error time, total time, and error count. The results showed no significant relationship between age and error count, indicating age does not impact counting accuracy. Similarly, there was no significant association between gender and error count, suggesting that gender is not a determining factor in counting accuracy. These findings provide insights into the factors influencing counting performance and contribute to our understanding of the research problem.

Several interesting findings emerged from the analysis. It was observed that most errors occurred either in the smaller numbers or at the larger numbers, with fewer mistakes in the middle. This bimodal pattern suggests a non-uniform distribution of errors, highlighting potential concentration points of difficulty in counting. In particular, the numbers 20, 23, 45, 63, 72, and 89 had the most occurrences of errors. Another notable observation is that individuals who have English as their native language tend to make their first error at a later point compared to those who do not have English as their native language. This finding suggests a potential relationship between native language and the timing of the initial error during the counting task.

6 CONCLUSION

In conclusion, this study found that gender and age were not significantly associated with counting accuracy. However, a notable finding was that individuals with English as their native language tended to make their first error at a later point compared to those with a different native language. Additionally, it’s interesting to see which numbers of people tend to make errors on. Building upon this study, future research could explore additional factors influencing counting accuracy, such as cognitive abilities or task-related variables. This study could also be considered a test to see how well individuals are able to focus and “tune” outside distractions out. If designing a new study to find a relationship, researchers could refine measurement methods, increase sample size, and control for potential confounding variables more effectively.