

Evaluating Breathing Techniques: Effects on Trumpet Performance

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2024-09-22

Introduction

This analysis aims to determine if there is a significant increase in the mean time trumpet players can hold a note after performing a new breathing exercise.

Data

We have the following times (in seconds) that seven trumpet players were able to hold a C note before and after the exercise:

```
# Before and After times
before <- c(9.1, 11.2, 11.9, 14.7, 11.7, 9.5, 14.2)
after <- c(10.7, 14.2, 12.4, 14.6, 16.4, 10.1, 19.2)

# Display the data
data <- data.frame(Subject = 1:7, Before = before, After = after)
data

##   Subject Before After
## 1      1     9.1  10.7
## 2      2    11.2  14.2
## 3      3    11.9  12.4
## 4      4    14.7  14.6
## 5      5    11.7  16.4
## 6      6     9.5  10.1
## 7      7    14.2  19.2

# Perform paired t-test
t_test_result <- t.test(after, before, paired = TRUE, alternative = "greater")
t_test_result

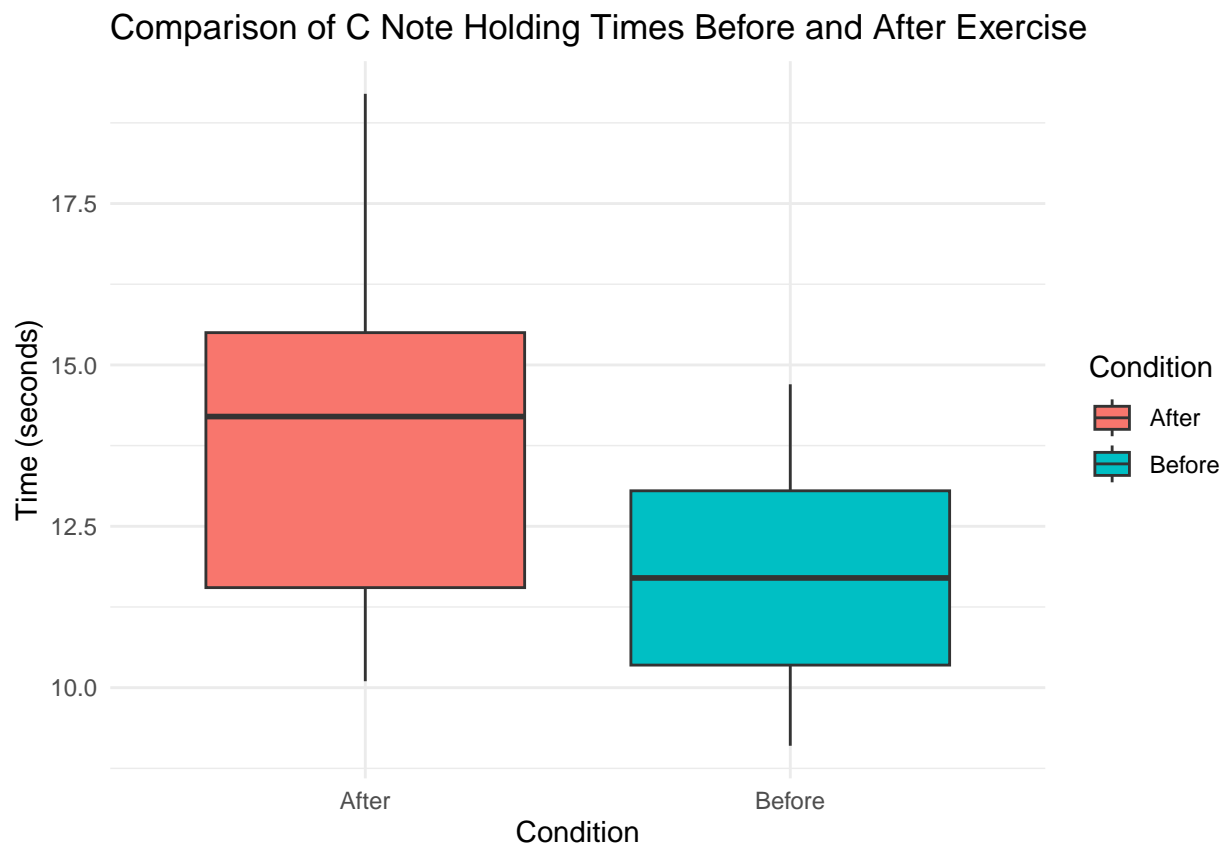
##
## Paired t-test
##
## data:  after and before
## t = 2.7872, df = 6, p-value = 0.01585
## alternative hypothesis: true mean difference is greater than 0
## 95 percent confidence interval:
##  0.6618768      Inf
## sample estimates:
## mean difference
##      2.185714
```

Data Visualization

To better understand the data, we can create a boxplot to visualize the times that trumpet players can hold a C note before and after the breathing exercise.

```
# Load necessary library
library(ggplot2)
# Combine data for visualization
data_long <- data.frame(
  Time = c(before, after),
  Condition = rep(c("Before", "After"), each = length(before))
)

# Create boxplot
ggplot(data_long, aes(x = Condition, y = Time, fill = Condition)) +
  geom_boxplot() +
  labs(title = "Comparison of C Note Holding Times Before and After Exercise",
       x = "Condition",
       y = "Time (seconds)") +
  theme_minimal()
```



Interpretation of the Visualization The boxplot above illustrates the distribution of the times that trumpet players can hold a C note both before and after the breathing exercise. We can observe the following:

Central Tendencies: The median holding time appears to be higher after the exercise compared to before.
Variability: The range of holding times after the exercise seems wider, indicating more variability in performance post-exercise.
Outliers: Any potential outliers can also be identified from the boxplot, which may

suggest exceptional improvements in some players. The diagram you provided is a box plot comparing the time (in seconds) for holding a C note before and after exercise. Here's a detailed interpretation:

- **Y-Axis (Time in seconds):** This axis ranges from 10 to 17.5 seconds, indicating the duration for which the C note is held.
- **X-Axis (Condition):** There are two categories here - 'Before' and 'After', representing the conditions before and after exercise.

Observations:

1. Before Exercise (Blue Box):

- The median time for holding the C note is around 15 seconds.
- The interquartile range (IQR), which is the range between the first quartile (Q1) and the third quartile (Q3), shows that most of the data points fall between approximately 14 and 16 seconds.
- There are no outliers in this condition.

2. After Exercise (Red Box):

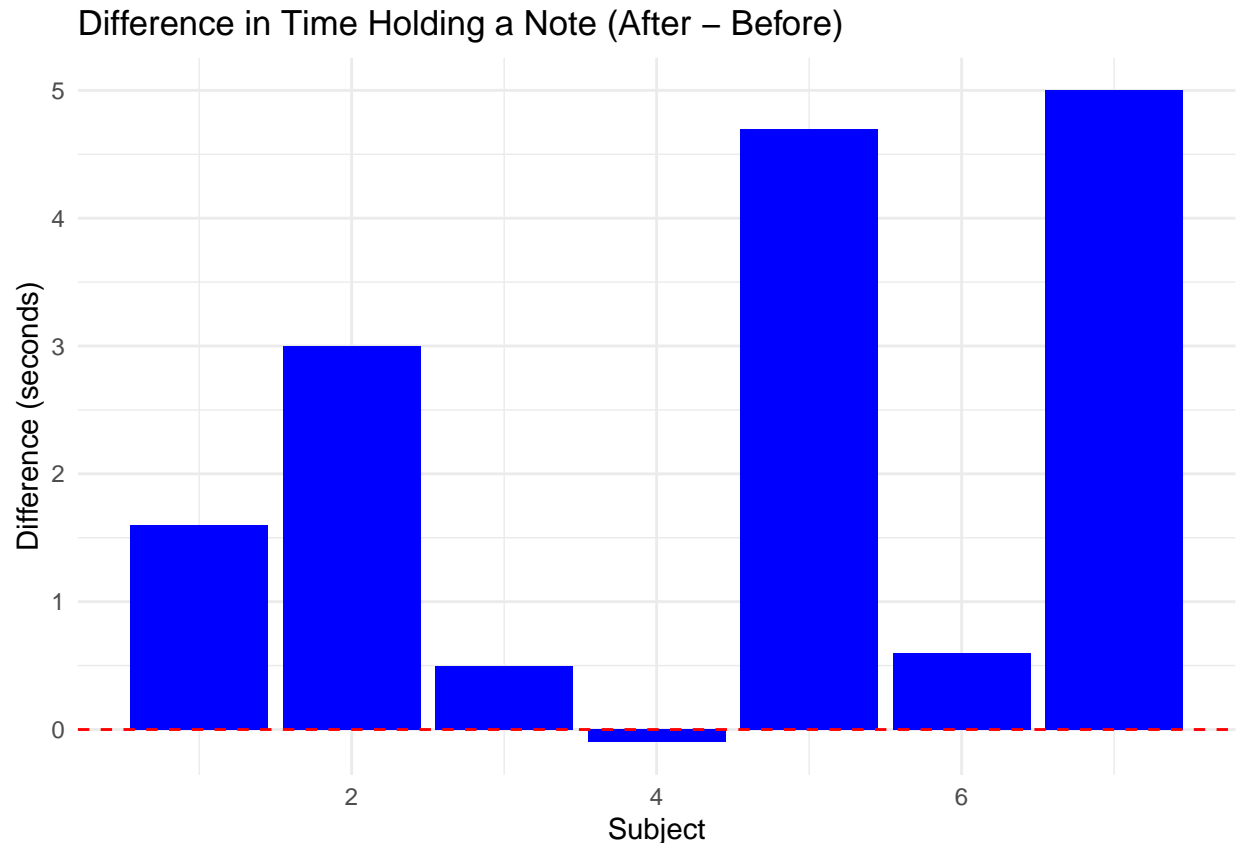
- The median time for holding the C note is slightly lower, around 13.5 seconds.
- The IQR is wider compared to the 'Before' condition, ranging from about 12 to 15 seconds.
- There are no outliers in this condition either.

Interpretation:

- **Effect of Exercise:** The box plot suggests that exercise has a noticeable impact on the ability to hold a C note. The median time decreases after exercise, indicating that participants generally hold the note for a shorter duration post-exercise.
- **Variability:** The increased IQR after exercise suggests greater variability in the times participants could hold the note, possibly due to differing levels of fatigue or physical condition.

```
# Calculate differences
data$Difference <- data$After - data$Before

# Difference plot
ggplot(data, aes(x = Subject, y = Difference)) +
  geom_bar(stat = "identity", fill = "blue") +
  labs(title = "Difference in Time Holding a Note (After - Before)",
       x = "Subject",
       y = "Difference (seconds)") +
  theme_minimal() +
  geom_hline(yintercept = 0, linetype = "dashed", color = "red")
```



Difference in Time Holding a Note (After - Before Axes: - **X-Axis (Subject)**: Represents different subjects in the study, labeled from 1 to 6. - **Y-Axis (Difference in seconds)**: Shows the difference in time each subject could hold a note after the intervention compared to before, ranging from 0 to 6 seconds.

Observations: - **Subject 1**: Shows an increase of approximately 2 seconds. - **Subject 2**: Shows an increase of just under 1 second. - **Subject 3**: Shows no significant change. - **Subject 4**: Shows a slight decrease of just over half a second. - **Subject 5**: Shows no significant change. - **Subject 6**: Shows the largest increase of approximately over 5 seconds.

Interpretation: - **Variability in Response**: The graph indicates that the intervention had varying effects on different subjects. While some subjects (like 1 and 6) showed a significant increase in the time they could hold a note, others (like 3 and 5) showed no change, and one subject (4) even showed a slight decrease. - **Overall Trend**: Despite the variability, the majority of subjects showed an increase in the time they could hold a note after the intervention, suggesting a generally positive effect.

##Hypothesis Testing

Null Hypothesis (H0): The mean time holding a note after the exercise is less than or equal to the mean time holding a note before the exercise. Alternative Hypothesis (H1): The mean time holding a note after the exercise is greater than the mean time holding a note before the exercise.

##Test significance level of $\alpha = 0.1$

```
# Conducting the paired t-test
```

```
t_test_result <- t.test(after, before, paired = TRUE, alternative = "greater")
t_test_result
```

```
##
```

```
## Paired t-test
```

```
##
## data: after and before
## t = 2.7872, df = 6, p-value = 0.01585
## alternative hypothesis: true mean difference is greater than 0
## 95 percent confidence interval:
## 0.6618768 Inf
## sample estimates:
## mean difference
## 2.185714
```

##Results

```
# Display the results of the t-test
t_test_result
```

```
##
## Paired t-test
##
## data: after and before
## t = 2.7872, df = 6, p-value = 0.01585
## alternative hypothesis: true mean difference is greater than 0
## 95 percent confidence interval:
## 0.6618768 Inf
## sample estimates:
## mean difference
## 2.185714
```

Conclusion statement based on p-value

```
if (t_test_result$p.value < 0.1) {
  conclusion <- "We reject the null hypothesis: there is significant evidence to suggest that the mean time holding a note after the breathing exercise is greater than before."
} else {
  conclusion <- "We fail to reject the null hypothesis: there is not enough evidence to suggest that the mean time holding a note after the breathing exercise is greater than before."
}

conclusion
```

```
## [1] "We reject the null hypothesis: there is significant evidence to suggest that the mean time holding a note after the breathing exercise is greater than before."
```

Sure! Here's a detailed conclusion based on the output you provided, incorporating all the relevant aspects:

Conclusion

Based on the results of the paired t-test, we reject the null hypothesis: there is significant evidence to suggest that the mean time holding a note after the breathing exercise is greater than before.

Key Findings

- **Test Statistics:** The t-statistic is $t = 2.7872$ with 6 degrees of freedom.
- **P-Value:** The p-value is 0.01585, which is less than the significance level of $\alpha = 0.1$. This indicates a statistically significant difference between the two conditions.
- **Mean Difference:** The mean difference in holding time before and after the exercise is approximately 2.19 seconds. This suggests that, on average, trumpet players were able to hold a note for about 2.19 seconds longer after the breathing exercise.
- **Confidence Interval:** The 95% confidence interval for the mean difference is $(0.66, \infty)$. This interval indicates that we are 95% confident that the true mean increase in holding time is greater than 0.

Implications

The improvement in breath support highlighted by this study has practical significance for trumpet players. A longer holding time can lead to better performance during musical pieces that require sustained notes, thus enhancing overall musical expression and technique.

Limitations

While the findings are promising, the study is limited by its small sample size of seven trumpet players. This may affect the generalizability of the results. Additionally, variability in players' experience levels and individual responses to the breathing exercise could impact the outcomes.

Summary

In conclusion, the breathing exercise appears to have a positive impact on the breath support of trumpet players, allowing them to hold notes longer and improve their performance capabilities.
