Effect of Music on Task Performance

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Introduction & Background

Cognitive performance can be influenced by the environment.

This study investigates how background music affects memory task performance.

Hypothesis: Listening to music significantly improves memory task performance compared to silence.

Aim: To analyze and compare performance scores under music and silence conditions using a public dataset from Zenodo.

Dataset & Methodology

Dataset:

- Source: "raw-data-memory.xlsx" from the Background Music and Cognitive Task Performance dataset on Zenodo.
- Structure: Rows represent different tests; key columns include "MEANS\n(music)" and "MEANS\n(silence)".

Data Cleaning Process:

- Removed rows with missing or non-numeric values (e.g., "nr", "< 0").
- Conversion of performance scores to numeric format using Pandas.

Methodology:

- Descriptive Analysis: Computed mean and standard deviation for each condition.
- Statistical Analysis: Performed a paired t-test (using scipy.stats.ttest_rel) to compare music vs. silence.
- New features were added to support prediction: score difference and a binary improvement label.

Descriptive Analysis

Calculated Performance Scores:

- Mean (Music): 23.60, SD: 25.65
- Mean (Silence): 22.51, SD: 22.91

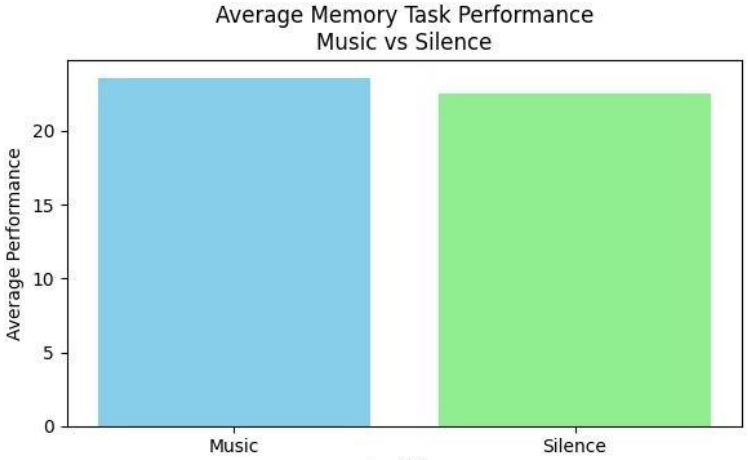
These statistics were computed from the cleaned dataset.

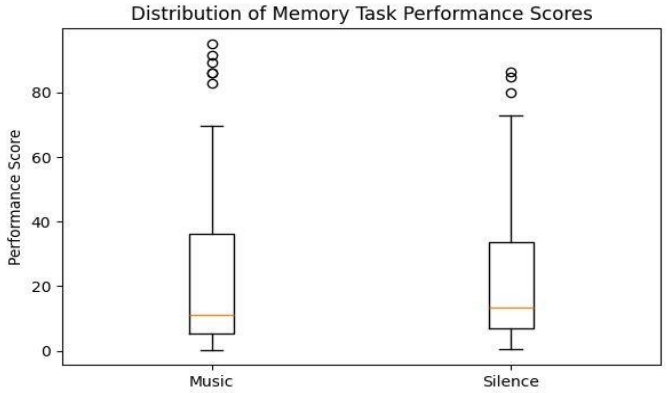
Initial observation suggests a slight improvement under the music condition. However,

- music mean ≈ silence mean.
- High standard deviation; indicating wide range of scores

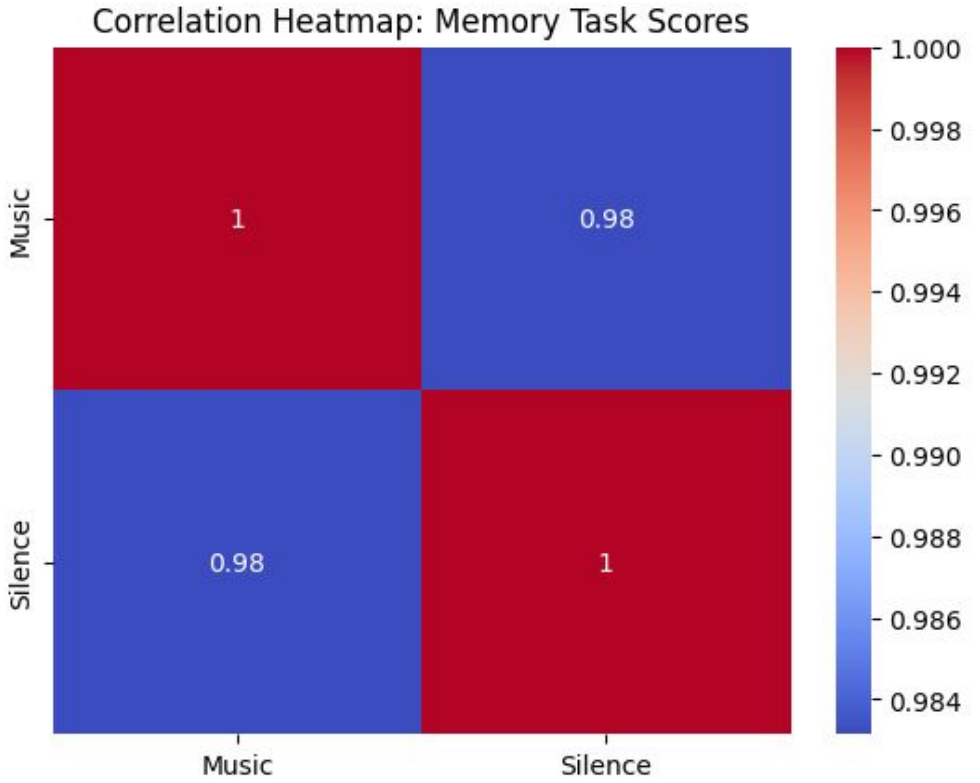
Visualizations

Bar Chart & Box Plot:





Visualizations

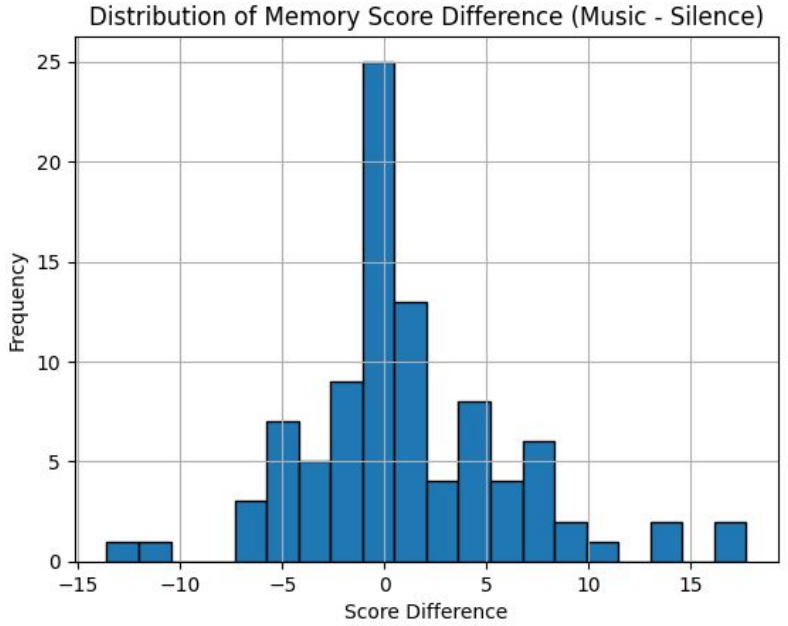


Predictive Modeling

To support predictive modeling, these features were added:

- A difference score (Music - Silence)
- An improved binary label (1 if music > silence)

These features help quantify the effect of music and form the basis for classification.



Statistical Testing (Paired t-test)

Test Details:

- Paired t-test comparing performance between Music and Silence conditions.

Results:

- t-statistic = 2.014
- p-value = 0.047

Interpretation:

- $p < 0.05$ indicates a statistically significant difference
- p-value being close to 0.05 indicates that the effect is small
- Conclusion: Background music leads to a statistically meaningful improvement in memory task performance, though the effect is small.

Logistic Regression: Predicting Improvement

Logistic Regression was used to predict improvement in memory performance based on silence scores

Classification report and confusion matrix:

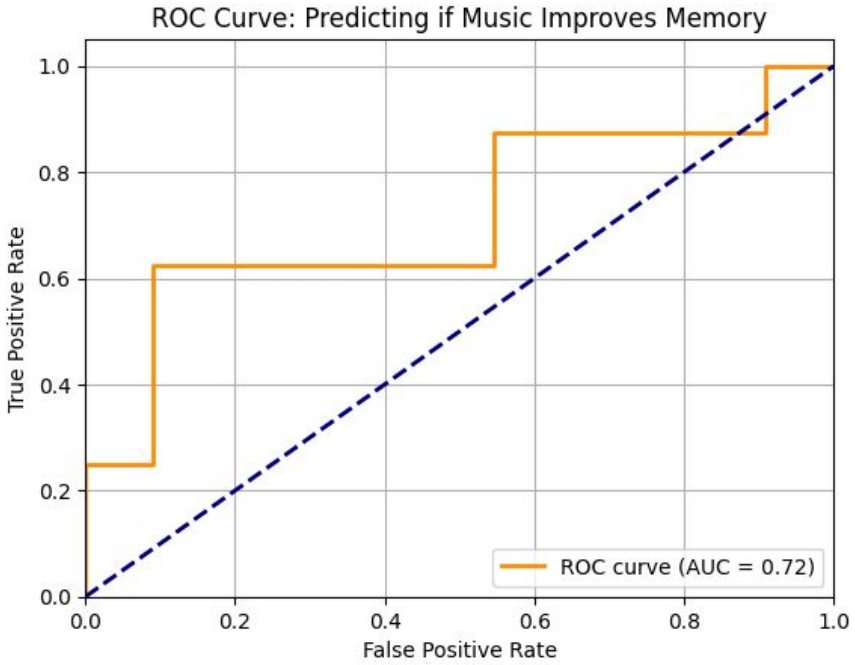
```
Model Evaluation (Predicting if Music Helps):
              precision    recall  f1-score   support

           0       0.77      0.91      0.83        11
           1       0.83      0.62      0.71         8

    accuracy                           0.79        19
   macro avg       0.80      0.77      0.77        19
weighted avg       0.80      0.79      0.78        19

Confusion Matrix:
[[10  1]
 [ 3  5]]
```

Accuracy: ~79%

The model performs better at predicting no improvement than improvement

ROC Curve

The ROC curve measures the model's ability to distinguish between improved and not improved cases.
An AUC of 0.72 was achieved, which indicates fair discriminatory ability. The model performs better than random.



Discussion & Implications

Findings:

- Statistically significant improvement in performance with background music.
- Results support the hypothesis.
- A simple logistic model using silence scores achieved 79% accuracy and an AUC of 0.72.

Implications:

- Potential for using background music to enhance cognitive memory performance in work, education, and other settings.
- Practical applications in designing productive environments.

Limitations:

- Data cleaning removed many rows due to non-numeric/missing values, reducing sample size.
- Variability in test conditions may affect generalizability.
- Effect is modest and strongly correlated with baseline ability