In [98]:
```
import pandas as pd
from scipy import stats
import numpy as np
from scipy.stats import wilcoxon
import seaborn as sns
import matplotlib.pyplot as plt
```

In [100…
```
file_path = '/Users/harriethe/Downloads/Questioneer.xlsx'
df = pd.read_excel(file_path)
df.columns = df.columns.str.strip()
```

In [102…
```
df_new = pd.read_csv('/Users/harriethe/Downloads/Question_new.csv')
```

In [104…
```
# 1. Remove rows where Timepoint is '0'
df_cleaned = df_new[df_new['Timepoint relative to drug administration (in minutes)'

# 2. Replace 'baseline' with 0 in the Timepoint column
df_cleaned['Timepoint relative to drug administration (in minutes)'] = df_cleaned['

df_cleaned = df_cleaned[df_cleaned['Timepoint relative to drug administration (in m
# 3. Replace 'ms' (missing) values with NaN throughout the entire DataFrame
df_cleaned = df_cleaned.replace('ms', np.nan)

df_cleaned['Timepoint relative to drug administration (in minutes)'] = pd.to_numeri

timepoints = df_cleaned['Timepoint relative to drug administration (in minutes)'].u
print(timepoints)
```

```
[  0  30  60 120 180 240 300 360]
/var/folders/fh/_crmyvv94rjbbn8m0gv12w2r0000gn/T/ipykernel_15578/2506174059.py:5: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  df_cleaned['Timepoint relative to drug administration (in minutes)'] = df_cleaned
['Timepoint relative to drug administration (in minutes)'].replace('baseline', 0)
```

In [106…
```
rating_columns = [
    '1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)',
    '2. Now-ness (0 = none to\n10 = strongest imaginable)',
    '3. Letting Go (0 = none to\n10 = strongest imaginable)',
    '4. Equanimity (0 = none to\n10 = strongest imaginable)',
    '5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)',
    '6. Fusion of your personal self into a larger whole (0 = none to\n10 = stronge
    '7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)',
    '8. Timelessness (0 = none to\n10 = strongest imaginable)',
    '9. Ineffability (0 = none to\n10 = strongest imaginable)',
    '10. Feelings of joy (0 = none to\n10 = strongest imaginable)',
    '11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
    '12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)',
    '13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)'
]
```

```
m = len(rating_columns)
```

In [108…

```
df_cleaned.columns = df_cleaned.columns.str.strip()
#print(df_filtered.columns)

df_cleaned[rating_columns] = df_cleaned[rating_columns].apply(pd.to_numeric, errors

# Check if the conversion worked by printing the dtypes
#print(df_filtered[rating_columns].dtypes)
```

Checking NA in df_cleaned

Q4 has 10 missing but it wasn't a reason why

In [110…

```
for timepoint in timepoints:
    df_timepoint = df_cleaned[df_cleaned['Timepoint relative to drug administration
    print(f"Missing values for Timepoint {timepoint} (minutes):")
    print(df_timepoint[rating_columns].isna().sum())
total_missing_values = df_cleaned[rating_columns].isna().sum()
print("Total missing values across all time points for each question:")
print(total_missing_values)
```

```
Missing values for Timepoint 0 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
0
2. Now-ness (0 = none to\n10 = strongest imaginable)
0
3. Letting Go (0 = none to\n10 = strongest imaginable)
0
4. Equanimity (0 = none to\n10 = strongest imaginable)
0
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
0
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    0
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
0
8. Timelessness (0 = none to\n10 = strongest imaginable)
0
9. Ineffability (0 = none to\n10 = strongest imaginable)
0
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
0
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
0
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
0
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
0
dtype: int64
Missing values for Timepoint 30 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
0
2. Now-ness (0 = none to\n10 = strongest imaginable)
0
3. Letting Go (0 = none to\n10 = strongest imaginable)
0
4. Equanimity (0 = none to\n10 = strongest imaginable)
0
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
0
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    0
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
0
8. Timelessness (0 = none to\n10 = strongest imaginable)
0
9. Ineffability (0 = none to\n10 = strongest imaginable)
0
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
0
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
0
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
0
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
0
dtype: int64
```

```
Missing values for Timepoint 60 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
1
2. Now-ness (0 = none to\n10 = strongest imaginable)
1
3. Letting Go (0 = none to\n10 = strongest imaginable)
1
4. Equanimity (0 = none to\n10 = strongest imaginable)
2
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
1
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    2
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
2
8. Timelessness (0 = none to\n10 = strongest imaginable)
3
9. Ineffability (0 = none to\n10 = strongest imaginable)
3
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
3
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
3
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
3
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
3
dtype: int64
Missing values for Timepoint 120 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
2
2. Now-ness (0 = none to\n10 = strongest imaginable)
2
3. Letting Go (0 = none to\n10 = strongest imaginable)
2
4. Equanimity (0 = none to\n10 = strongest imaginable)
3
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
3
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    3
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
3
8. Timelessness (0 = none to\n10 = strongest imaginable)
3
9. Ineffability (0 = none to\n10 = strongest imaginable)
3
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
3
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
4
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
3
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
3
dtype: int64
```

```
Missing values for Timepoint 180 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
1
2. Now-ness (0 = none to\n10 = strongest imaginable)
3
3. Letting Go (0 = none to\n10 = strongest imaginable)
2
4. Equanimity (0 = none to\n10 = strongest imaginable)
2
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
2
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    2
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
2
8. Timelessness (0 = none to\n10 = strongest imaginable)
2
9. Ineffability (0 = none to\n10 = strongest imaginable)
2
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
2
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
3
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
2
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
2
dtype: int64
Missing values for Timepoint 240 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
1
2. Now-ness (0 = none to\n10 = strongest imaginable)
1
3. Letting Go (0 = none to\n10 = strongest imaginable)
1
4. Equanimity (0 = none to\n10 = strongest imaginable)
1
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
1
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    2
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
1
8. Timelessness (0 = none to\n10 = strongest imaginable)
1
9. Ineffability (0 = none to\n10 = strongest imaginable)
2
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
1
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
2
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
2
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
2
dtype: int64
```

```
Missing values for Timepoint 300 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
1
2. Now-ness (0 = none to\n10 = strongest imaginable)
1
3. Letting Go (0 = none to\n10 = strongest imaginable)
3
4. Equanimity (0 = none to\n10 = strongest imaginable)
2
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
3
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    2
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
2
8. Timelessness (0 = none to\n10 = strongest imaginable)
2
9. Ineffability (0 = none to\n10 = strongest imaginable)
2
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
2
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
3
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
3
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
3
dtype: int64
Missing values for Timepoint 360 (minutes):
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
0
2. Now-ness (0 = none to\n10 = strongest imaginable)
0
3. Letting Go (0 = none to\n10 = strongest imaginable)
0
4. Equanimity (0 = none to\n10 = strongest imaginable)
0
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
0
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    0
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
0
8. Timelessness (0 = none to\n10 = strongest imaginable)
0
9. Ineffability (0 = none to\n10 = strongest imaginable)
0
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
0
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
0
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
0
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
0
dtype: int64
```

```
Total missing values across all time points for each question:
1. Overall Psilocybin Effect (0 = none to\n10 = strongest imaginable)
6
2. Now-ness (0 = none to\n10 = strongest imaginable)
8
3. Letting Go (0 = none to\n10 = strongest imaginable)
9
4. Equanimity (0 = none to\n10 = strongest imaginable)
10
5. Pure being and pure awareness (0 = none to\n10 = strongest imaginable)
10
6. Fusion of your personal self into a larger whole (0 = none to\n10 = strongest ima
ginable)    11
7. Sense of reverence or sacredness (0 = none to\n10 = strongest imaginable)
10
8. Timelessness (0 = none to\n10 = strongest imaginable)
11
9. Ineffability (0 = none to\n10 = strongest imaginable)
12
10. Feelings of joy (0 = none to\n10 = strongest imaginable)
11
11. Feelings of peace and tranquility (0 = none to\n10 = strongest imaginable)
15
12. Positive Emotional Valence (0 = none to\n10 = strongest imaginable)
13
13. Negative emotional valence  (0 = none to\n10 = strongest imaginable)
13
dtype: int64
```

Sections for Pair T Test

In [112…

```python
from scipy import stats
paired_results_by_time = {}

for timepoint in timepoints:
    df_timepoint = df_cleaned[df_cleaned['Timepoint relative to drug administration
    placebo_scores = df_timepoint[df_timepoint['Condition (PLA: placebo, EXP: 25 mg
    exp_scores = df_timepoint[df_timepoint['Condition (PLA: placebo, EXP: 25 mg/70
    paired_results_by_time[timepoint] = {}
    for col in rating_columns:
        if len(placebo_scores[col]) == len(exp_scores[col]) and len(placebo_scores[
            t_stat, p_value = stats.ttest_rel(placebo_scores[col], exp_scores[col],
            log_p_value = -np.log10(p_value) if p_value > 0 else None
            paired_results_by_time[timepoint][col] = (t_stat, log_p_value)
        else:
            paired_results_by_time[timepoint][col] = (None, None)

    print(f"Results for Timepoint {timepoint} (minutes):")
    for col, (t_stat, log_p_value) in paired_results_by_time[timepoint].items():
        print(f"{col}: T-statistic = {t_stat}, -log10(P-value) = {log_p_value}")
    print("\n")
```

```
Results for Timepoint 0 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = nan, -log10(P-value) = None
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = 0.18797789509922808, -log10(P-value) = 0.0
6915886514948631
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -0.7056967961720457, -log10(P-value) = 0.3
1112136557311854
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -0.9687189593929654, -log10(P-value) = 0.4
6311943112020176
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = 0.6913837373523726, -log10(P-value) = 0.30
34058432732242
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = 0.657595949221429, -log10(P-value) = 0.285
4227198691093
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = 0.10347288589592778, -log10(P-value) = 0.0
368649478147384
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -0.8154100913168026, -log10(P-value) = 0.3
72181278713321
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = 1.2403473458920846, -log10(P-value) = 0.63
97820977715141
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -0.7096457724119537, -log10(P-value) = 0.3
132602853231982
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -0.26126497213658206, -log10(P-value) = 0.
0987816644558655
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -0.4908806936738159, -log10(P-value) = 0.2
01450339440114
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = 1.698999098923931, -log10(P-value) = 0.979
5454845220463


Results for Timepoint 30 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -3.568797893963764, -log10(P-value) = 2.71
6087991195579
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = 0.6095219666786235, -log10(P-value) = 0.26
039511752616745
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -0.3485075176786614, -log10(P-value) = 0.1
3602268522010522
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 0.12299834568337575, -log10(P-value) = 0.0
4415066298879849
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = 0.13411044519645504, -log10(P-value) = 0.0
```

```
4834410813633313
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = 1.0458250331675942, -log10(P-value) = 0.51
12832578441845
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = 0.14637194260221537, -log10(P-value) = 0.0
53011046420002476
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -0.6218845001217771, -log10(P-value) = 0.2
6676829759103565
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -2.3196933857945083, -log10(P-value) = 1.5
079154030844428
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -0.18458480505051497, -log10(P-value) = 0.
06782387135456634
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = 1.5579423821243894, -log10(P-value) = 0.86
98892996890562
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = 0.4179383795285729, -log10(P-value) = 0.16
7206835658875
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -0.4278625498405581, -log10(P-value) = 0.1
71776498366954


Results for Timepoint 60 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -7.319986682297554, -log10(P-value) = 6.21
4044464489869
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -0.8039020483873397, -log10(P-value) = 0.3
651226811882955
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -0.2756197330161589, -log10(P-value) = 0.1
0467944719314067
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 1.1093162417777198, -log10(P-value) = 0.54
99122508189178
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -1.0062873929698608, -log10(P-value) = 0.4
855562106046149
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -2.7635216651841996, -log10(P-value) = 1.8
928736802685713
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = 0.2802935969389348, -log10(P-value) = 0.10
654439991580514
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -1.2292725943057183, -log10(P-value) = 0.6
276158127944763
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -4.406696305852698, -log10(P-value) = 3.41
38582711872676
10. Feelings of joy (0 = none to
```

```
10 = strongest imaginable): T-statistic = -0.7026008204419223, -log10(P-value) = 0.3
081988904799919
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = 3.1438385661850643, -log10(P-value) = 2.22
76192871497713
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -0.20070964149630047, -log10(P-value) = 0.
07401415095226195
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -1.5312829869775526, -log10(P-value) = 0.8
413483712430532


Results for Timepoint 120 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -10.932119067896782, -log10(P-value) = 8.9
10292199502377
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -5.569933086615312, -log10(P-value) = 4.64
5380271065067
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -2.48305515724224, -log10(P-value) = 1.647
235822971726
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 0.0, -log10(P-value) = -0.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -4.2653445539189185, -log10(P-value) = 3.3
786898918532935
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -6.362252814024701, -log10(P-value) = 5.37
7085410371249
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -3.510319506473832, -log10(P-value) = 2.63
08035673428947
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -6.272727272727273, -log10(P-value) = 5.29
6134616113173
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -7.0141826155279965, -log10(P-value) = 5.9
52634687410637
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -3.1891395762619132, -log10(P-value) = 2.3
16022663667095
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -0.48743450538846206, -log10(P-value) = 0.
1993970671155538
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -1.7331773447985919, -log10(P-value) = 1.0
03209274159585
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -1.0566747075571858, -log10(P-value) = 0.5
172534044798517


Results for Timepoint 180 (minutes):
1. Overall Psilocybin Effect (0 = none to
```

```
10 = strongest imaginable): T-statistic = -16.92254051915307, -log10(P-value) = 12.5
92907183314807
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -9.093305161368113, -log10(P-value) = 7.42
2929175512983
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -7.416493535870903, -log10(P-value) = 6.29
5401266709697
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -6.454972243679028, -log10(P-value) = 5.46
0442996419268
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -8.93519466806411, -log10(P-value) = 7.505
19932433605
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -7.777210863692854, -log10(P-value) = 6.59
4671237184267
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -7.284844920603416, -log10(P-value) = 6.18
4283687266802
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -5.687824834798567, -log10(P-value) = 4.75
63628413523995
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -7.783316947258129, -log10(P-value) = 6.59
96720034188545
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -6.185760537730083, -log10(P-value) = 5.21
7064284971247
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -2.5593176062786935, -log10(P-value) = 1.7
05273979321204
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -5.803639343821998, -log10(P-value) = 4.86
4698246495434
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -0.5784790097963374, -log10(P-value) = 0.2
4432707776025533


Results for Timepoint 240 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -12.261208713114476, -log10(P-value) = 9.7
44874149981774
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -6.167072032845844, -log10(P-value) = 5.20
0017321731256
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -7.377378401994856, -log10(P-value) = 6.26
2492413405327
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -2.559343516304476, -log10(P-value) = 1.71
72648177036187
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -6.307640191571234, -log10(P-value) = 5.32
7757627917003
```

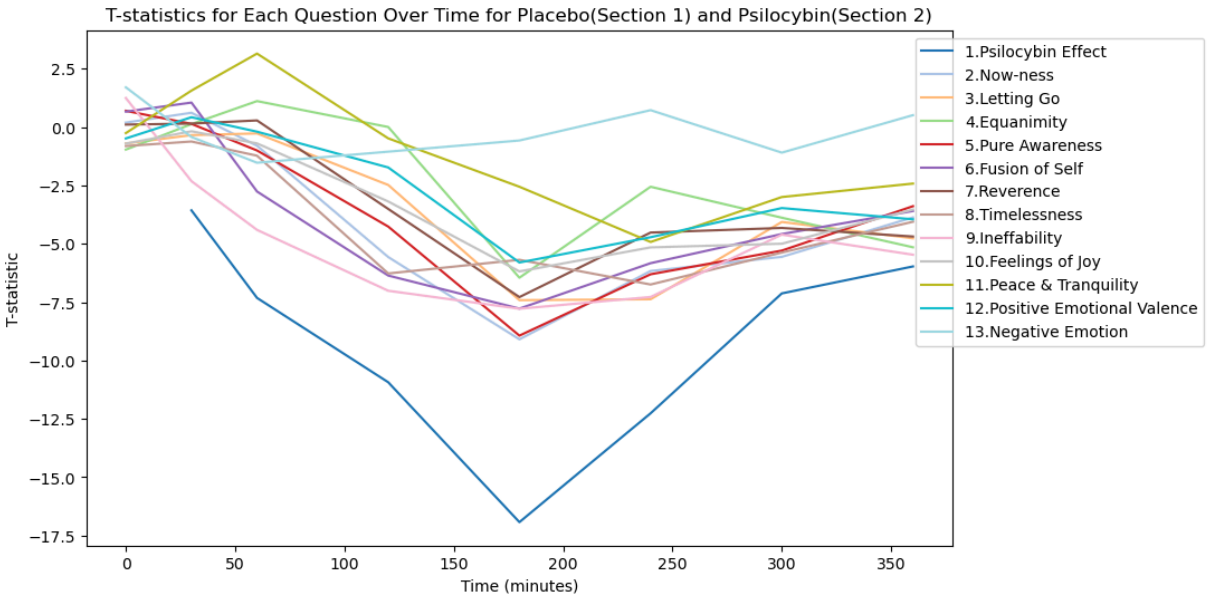
```
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -5.832660825504768, -log10(P-value) = 4.89
1735912331623
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -4.520967182069254, -log10(P-value) = 3.63
1165028852159
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -6.74630238263132, -log10(P-value) = 5.719
133012146268
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -7.279943591298901, -log10(P-value) = 6.18
0127099118932
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -5.156104408169628, -log10(P-value) = 4.25
0529699721511
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -4.924091613757983, -log10(P-value) = 4.02
5913291692642
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -4.720808303895489, -log10(P-value) = 3.82
7480231888625
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = 0.7205037703302525, -log10(P-value) = 0.31
87712053896142


Results for Timepoint 300 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -7.127537641337663, -log10(P-value) = 6.17
9540979204518
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -5.562213147927255, -log10(P-value) = 4.71
7869740699925
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -4.066886812455412, -log10(P-value) = 3.18
20109886911725
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -3.8848299473609478, -log10(P-value) = 3.0
014124919094236
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -5.293714326561026, -log10(P-value) = 4.38
26984524433845
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -4.584506420002511, -log10(P-value) = 3.69
3701172726956
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -4.3233154997720336, -log10(P-value) = 3.4
360524095419147
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -5.378249582661413, -log10(P-value) = 4.46
3472270632864
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -4.61043509420293, -log10(P-value) = 3.719
1903522187917
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -4.99883254853061, -log10(P-value) = 4.098
```

```
502084429593
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -3.0, -log10(P-value) = 2.133020457966206
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -3.4719564436457055, -log10(P-value) = 2.5
930048274403967
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -1.0988733765976275, -log10(P-value) = 0.5
443128903955623


Results for Timepoint 360 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -5.971631046748498, -log10(P-value) = 5.11
2977493089625
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -3.8729833462074166, -log10(P-value) = 3.0
23801009856832
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -4.768316485434158, -log10(P-value) = 3.93
070277823916
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -5.152135733635232, -log10(P-value) = 4.31
4301824039838
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -3.3921747176506836, -log10(P-value) = 2.5
38638422399038
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -3.5976931812503268, -log10(P-value) = 2.7
452224295978698
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -4.690415759823429, -log10(P-value) = 3.85
2290017177736
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -4.0571550015261115, -log10(P-value) = 3.2
107658399508767
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -5.4707703865093915, -log10(P-value) = 4.6
28515703131563
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -3.534578227065181, -log10(P-value) = 2.68
16192749816095
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -2.4230670981304208, -log10(P-value) = 1.6
020146348519788
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -3.952847075210474, -log10(P-value) = 3.10
4846526128196
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = 0.5071831293409736, -log10(P-value) = 0.20
931159411304626
```

In [114…

```
import matplotlib.pyplot as plt
```

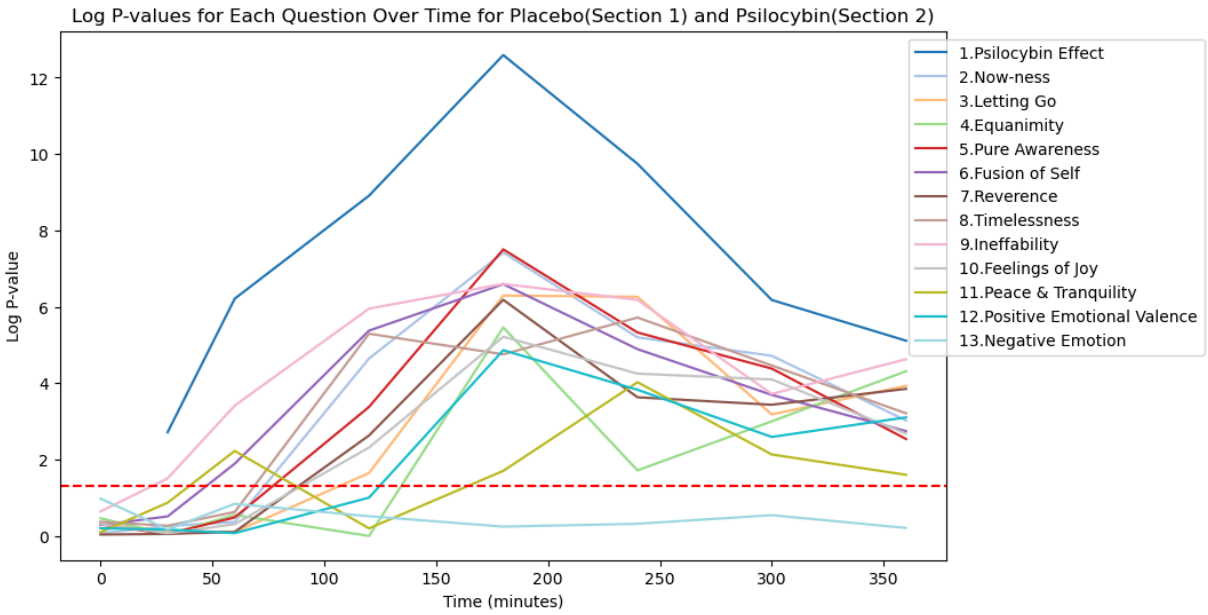
```
shortened_rating_columns = [
    '1.Psilocybin Effect', '2.Now-ness', '3.Letting Go', '4.Equanimity', '5.Pure Aw
    '6.Fusion of Self', '7.Reverence', '8.Timelessness', '9.Ineffability',
    '10.Feelings of Joy', '11.Peace & Tranquility', '12.Positive Emotional Valence'
]

timepoints = list(paired_results_by_time.keys())
t_stats_by_question = {col: [] for col in rating_columns}
for timepoint in timepoints:
    for col in rating_columns:
        t_stat, _ = paired_results_by_time[timepoint][col]
        t_stats_by_question[col].append(t_stat)
plt.figure(figsize=(10, 6))
#for col in rating_columns:
    #plt.plot(timepoints, t_stats_by_question[col], label=col)
cmap = plt.get_cmap('tab20', len(shortened_rating_columns))

for i,(col, short_col) in enumerate(zip(rating_columns, shortened_rating_columns)):
    plt.plot(timepoints, t_stats_by_question[col], label=short_col,color=cmap(i))
plt.xlabel('Time (minutes)')
plt.ylabel('T-statistic')
plt.title('T-statistics for Each Question Over Time for Placebo(Section 1) and Psil
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1))
plt.show()
```



In [118…

```
log_p_values_by_question = {col: [] for col in rating_columns}

for timepoint in timepoints:
    for col in rating_columns:
        _, log_p_value = paired_results_by_time[timepoint][col]
        log_p_values_by_question[col].append(log_p_value)

plt.figure(figsize=(10, 6))
#for col in rating_columns:
    #plt.plot(timepoints, p_values_by_question[col], label=col)
for i,(col, short_col) in enumerate(zip(rating_columns, shortened_rating_columns)):
    plt.plot(timepoints, log_p_values_by_question[col], label=short_col,color=cmap(
```

```
plt.xlabel('Time (minutes)')
plt.ylabel('Log P-value')
plt.title('Log P-values for Each Question Over Time for Placebo(Section 1) and Psil
plt.axhline(y=-np.log10(0.05), color='r', linestyle='--')
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1))
plt.show()
```



This Section is for Wilcoxon

Wilcoxon is not good with NaN

In [120…

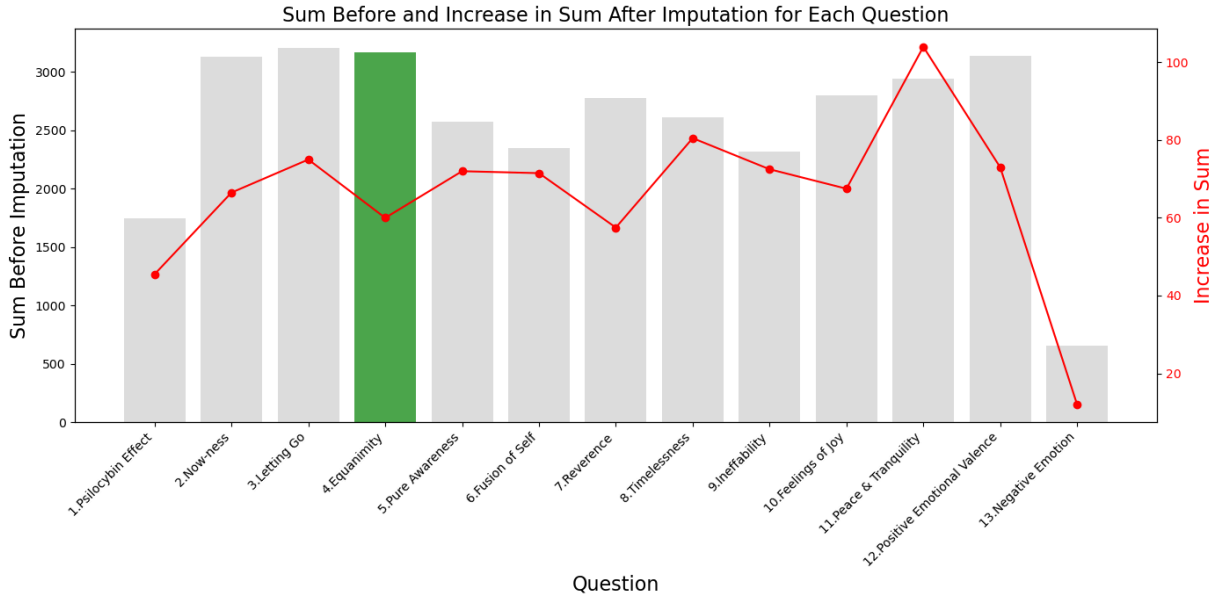
```
df_cleaned_imputed = df_cleaned.copy()

imputation_summary = {col: {'count_before': 0, 'sum_before': 0, 'sum_after': 0, 'im

if all(col in df_cleaned_imputed.columns for col in rating_columns):
    for col in rating_columns:
        missing_before = df_cleaned_imputed[col].isnull()
        imputation_summary[col]['count_before'] = missing_before.sum()
        imputation_summary[col]['sum_before'] = df_cleaned_imputed[col].sum(skipna=
    df_cleaned_imputed[rating_columns] = df_cleaned_imputed[rating_columns].interpo
    for col in rating_columns:
        missing_after = df_cleaned_imputed[col].isnull()
        imputation_summary[col]['sum_after'] = df_cleaned_imputed[col].sum(skipna=T
        imputation_summary[col]['imputed_count'] = imputation_summary[col]['count_b

    print("Imputation Summary:")
    for question, stats in imputation_summary.items():
        count_diff = stats['imputed_count']
        sum_diff = stats['sum_after'] - stats['sum_before']
        print(f"{question}: Imputed Count = {count_diff}, Sum Before = {stats['sum_

else:
    print("Some columns in rating_columns are not found in the DataFrame.")
```

```
Imputation Summary:
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Imputed Count = 6, Sum Before = 1748.0, Sum After = 179
3.5, Increase in Sum = 45.5
2. Now-ness (0 = none to
10 = strongest imaginable): Imputed Count = 8, Sum Before = 3130.0, Sum After = 319
6.5, Increase in Sum = 66.5
3. Letting Go (0 = none to
10 = strongest imaginable): Imputed Count = 9, Sum Before = 3209.0, Sum After = 328
4.0, Increase in Sum = 75.0
4. Equanimity (0 = none to
10 = strongest imaginable): Imputed Count = 10, Sum Before = 3168.0, Sum After = 322
8.0, Increase in Sum = 60.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): Imputed Count = 10, Sum Before = 2573.0, Sum After = 264
5.0, Increase in Sum = 72.0
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Imputed Count = 11, Sum Before = 2352.0, Sum After = 242
3.5, Increase in Sum = 71.5
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Imputed Count = 10, Sum Before = 2780.0, Sum After = 283
7.5, Increase in Sum = 57.5
8. Timelessness (0 = none to
10 = strongest imaginable): Imputed Count = 11, Sum Before = 2612.0, Sum After = 269
2.5, Increase in Sum = 80.5
9. Ineffability (0 = none to
10 = strongest imaginable): Imputed Count = 12, Sum Before = 2320.0, Sum After = 239
2.5, Increase in Sum = 72.5
10. Feelings of joy (0 = none to
10 = strongest imaginable): Imputed Count = 11, Sum Before = 2804.0, Sum After = 287
1.5, Increase in Sum = 67.5
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Imputed Count = 15, Sum Before = 2943.0, Sum After = 304
7.0, Increase in Sum = 104.0
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Imputed Count = 13, Sum Before = 3138.0, Sum After = 321
1.0, Increase in Sum = 73.0
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Imputed Count = 13, Sum Before = 659.0, Sum After = 671.
0, Increase in Sum = 12.0
```

In [122…

```
questions = shortened_rating_columns
sum_before = [imputation_summary[q]['sum_before'] for q in rating_columns]
increase_in_sums = [imputation_summary[q]['sum_after'] - imputation_summary[q]['sum

# Highlight color for the specific question (Q4)
bar_colors = ['lightgray' if q != '4.Equanimity' else 'green' for q in questions]
fig, ax1 = plt.subplots(figsize=(14, 7))
ax1.bar(questions, sum_before, color=bar_colors, alpha=0.7)
ax1.set_xlabel('Question', fontsize=16)
ax1.set_ylabel('Sum Before Imputation', fontsize=16, color='black')
ax1.tick_params(axis='y', labelcolor='black')
ax1.set_xticks(np.arange(len(questions)))
ax1.set_xticklabels(questions, rotation=45, ha='right', fontsize=10)
ax2 = ax1.twinx()
ax2.plot(questions, increase_in_sums, color='red', marker='o', label='Increase in S
```

```
ax2.set_ylabel('Increase in Sum', fontsize=16, color='red')
ax2.tick_params(axis='y', labelcolor='red')
plt.title('Sum Before and Increase in Sum After Imputation for Each Question', font
fig.tight_layout()
plt.show()
```



In [124…

```
from statsmodels.stats.multitest import multipletests
wilcoxon_results_by_time = {}
m = len(rating_columns)

for timepoint in timepoints:
    df_timepoint = df_cleaned_imputed[df_cleaned_imputed['Timepoint relative to dru
    placebo_scores = df_timepoint[df_timepoint['Condition (PLA: placebo, EXP: 25 mg
    exp_scores = df_timepoint[df_timepoint['Condition (PLA: placebo, EXP: 25 mg/70

    wilcoxon_results_by_time[timepoint] = {}
    wilcoxon_p_values = []
    wilcoxon_test_stats = []

    for col in rating_columns:
        try:
            wilcoxon_t_stat, wilcoxon_p_value = wilcoxon(placebo_scores[col], exp_s
            wilcoxon_p_values.append(wilcoxon_p_value)
            wilcoxon_test_stats.append(wilcoxon_t_stat)
        except ValueError:
            wilcoxon_p_values.append(np.nan)  # Use NaN instead of 1
            wilcoxon_test_stats.append(None)

    adjusted_p_values = multipletests(wilcoxon_p_values, alpha=0.05, method='holm')

    for col, wilcoxon_t_stat, adj_p_value in zip(rating_columns, wilcoxon_test_stat
        wilcoxon_results_by_time[timepoint][col] = (wilcoxon_t_stat, adj_p_value)


    print(f"Results for Timepoint {timepoint} (minutes):")
    for col, (wilcoxon_t_stat, adj_p_value) in wilcoxon_results_by_time[timepoint].
```

```
        print(f"{col}: Wilcoxon statistic = {wilcoxon_t_stat}, Bonferroni-Holm adju
    print("\n")
```

```
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
```

```
Results for Timepoint 0 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = None, Bonferroni-Holm adjusted P-va
lue = nan
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 37.5, Bonferroni-Holm adjusted P-va
lue = 1.0
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 74.0, Bonferroni-Holm adjusted P-va
lue = 1.0
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 59.5, Bonferroni-Holm adjusted P-va
lue = 1.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 43.5, Bonferroni-Holm adjusted P-va
lue = 1.0
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 33.5, Bonferroni-Holm adjusted P-va
lue = 1.0
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 74.0, Bonferroni-Holm adjusted P-va
lue = 1.0
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 48.5, Bonferroni-Holm adjusted P-va
lue = 1.0
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 28.0, Bonferroni-Holm adjusted P-va
lue = 1.0
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 57.5, Bonferroni-Holm adjusted P-va
lue = 1.0
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 51.5, Bonferroni-Holm adjusted P-va
lue = 1.0
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 70.0, Bonferroni-Holm adjusted P-va
lue = 1.0
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 19.0, Bonferroni-Holm adjusted P-va
lue = 1.0


Results for Timepoint 30 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 4.0, Bonferroni-Holm adjusted P-val
ue = 0.028358990172091477
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 79.5, Bonferroni-Holm adjusted P-va
lue = 1.0
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 55.0, Bonferroni-Holm adjusted P-va
lue = 1.0
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 42.0, Bonferroni-Holm adjusted P-va
lue = 1.0
5. Pure being and pure awareness (0 = none to
```

```
10 = strongest imaginable): Wilcoxon statistic = 57.0, Bonferroni-Holm adjusted P-va
lue = 1.0
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 37.5, Bonferroni-Holm adjusted P-va
lue = 1.0
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 54.0, Bonferroni-Holm adjusted P-va
lue = 1.0
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 59.0, Bonferroni-Holm adjusted P-va
lue = 1.0
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 31.0, Bonferroni-Holm adjusted P-va
lue = 0.36087616466806216
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 56.0, Bonferroni-Holm adjusted P-va
lue = 1.0
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 35.5, Bonferroni-Holm adjusted P-va
lue = 1.0
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 52.0, Bonferroni-Holm adjusted P-va
lue = 1.0
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 32.5, Bonferroni-Holm adjusted P-va
lue = 1.0


Results for Timepoint 60 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 1.0, Bonferroni-Holm adjusted P-val
ue = 0.0013120104851622628
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 80.5, Bonferroni-Holm adjusted P-va
lue = 1.0
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 71.0, Bonferroni-Holm adjusted P-va
lue = 1.0
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 54.5, Bonferroni-Holm adjusted P-va
lue = 1.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 63.5, Bonferroni-Holm adjusted P-va
lue = 1.0
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 38.0, Bonferroni-Holm adjusted P-va
lue = 0.21323427208107654
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 66.5, Bonferroni-Holm adjusted P-va
lue = 1.0
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 33.5, Bonferroni-Holm adjusted P-va
lue = 1.0
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 3.0, Bonferroni-Holm adjusted P-val
ue = 0.005687671146054502
```

```
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 54.0, Bonferroni-Holm adjusted P-va
lue = 1.0
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 16.0, Bonferroni-Holm adjusted P-va
lue = 0.13215729841338025
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 64.5, Bonferroni-Holm adjusted P-va
lue = 1.0
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 39.5, Bonferroni-Holm adjusted P-va
lue = 1.0
```

```
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
```

```
Results for Timepoint 120 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 1.0, Bonferroni-Holm adjusted P-val
ue = 2.47955322265625e-05
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 5.0, Bonferroni-Holm adjusted P-val
ue = 0.0015854765941606243
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 34.0, Bonferroni-Holm adjusted P-va
lue = 0.06787807954907459
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 110.0, Bonferroni-Holm adjusted P-v
alue = 1.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 23.5, Bonferroni-Holm adjusted P-va
lue = 0.029994623306758113
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 1.0, Bonferroni-Holm adjusted P-val
ue = 0.0010627879976395915
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 17.0, Bonferroni-Holm adjusted P-va
lue = 0.0475915411967716
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 2.5, Bonferroni-Holm adjusted P-val
ue = 0.0012269612294571897
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 3.0, Bonferroni-Holm adjusted P-val
ue = 5.7220458984375e-05
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 26.0, Bonferroni-Holm adjusted P-va
lue = 0.03784279877519212
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 69.5, Bonferroni-Holm adjusted P-va
lue = 1.0
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 67.5, Bonferroni-Holm adjusted P-va
lue = 0.3831977844238281
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 50.0, Bonferroni-Holm adjusted P-va
lue = 1.0


Results for Timepoint 180 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 1.239776611328125e-05
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 2.0, Bonferroni-Holm adjusted P-val
ue = 3.4332275390625e-05
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.0008525028899448955
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 9.0, Bonferroni-Holm adjusted P-val
ue = 0.002449746451882985
5. Pure being and pure awareness (0 = none to
```

```
10 = strongest imaginable): Wilcoxon statistic = 7.0, Bonferroni-Holm adjusted P-val
ue = 0.0001811981201171875
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 4.0, Bonferroni-Holm adjusted P-val
ue = 7.343292236328125e-05
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 11.5, Bonferroni-Holm adjusted P-va
lue = 0.0018498760338581267
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 6.5, Bonferroni-Holm adjusted P-val
ue = 0.0018114691866422824
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.0006857902075055515
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 8.5, Bonferroni-Holm adjusted P-val
ue = 0.0017851659017345447
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 58.5, Bonferroni-Holm adjusted P-va
lue = 0.09198570251464844
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 7.5, Bonferroni-Holm adjusted P-val
ue = 0.0001811981201171875
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 34.0, Bonferroni-Holm adjusted P-va
lue = 0.6920614909359382
```

```
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
```

```
Results for Timepoint 240 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 1.239776611328125e-05
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 2.5, Bonferroni-Holm adjusted P-val
ue = 0.0012178612713498508
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.0012178612713498508
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 24.5, Bonferroni-Holm adjusted P-va
lue = 0.027056656979213917
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.0013252283793901 67
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.0012178612713498508
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 6.5, Bonferroni-Holm adjusted P-val
ue = 0.0016645317420968292
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 3.5, Bonferroni-Holm adjusted P-val
ue = 5.245208740234375e-05
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 2.5, Bonferroni-Holm adjusted P-val
ue = 3.4332275390625e-05
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 7.5, Bonferroni-Holm adjusted P-val
ue = 0.0013252283793901 67
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 17.5, Bonferroni-Holm adjusted P-va
lue = 0.0013252283793901 67
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 19.0, Bonferroni-Holm adjusted P-va
lue = 0.0013252283793901 67
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 33.0, Bonferroni-Holm adjusted P-va
lue = 0.6319081306793233


Results for Timepoint 300 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.0015304919640933027
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 10.5, Bonferroni-Holm adjusted P-va
lue = 0.0005531039428710938
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 15.0, Bonferroni-Holm adjusted P-va
lue = 0.005808853894941151
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 18.5, Bonferroni-Holm adjusted P-va
lue = 0.00769269237845995
5. Pure being and pure awareness (0 = none to
```

```
10 = strongest imaginable): Wilcoxon statistic = 4.0, Bonferroni-Holm adjusted P-val
ue = 0.0015776170615020232
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 10.0, Bonferroni-Holm adjusted P-va
lue = 0.004360536956183665
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 9.5, Bonferroni-Holm adjusted P-val
ue = 0.004360536956183665
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 2.0, Bonferroni-Holm adjusted P-val
ue = 0.0025399141012161616
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 6.5, Bonferroni-Holm adjusted P-val
ue = 0.002902181872178863
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 13.0, Bonferroni-Holm adjusted P-va
lue = 0.004360536956183665
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 28.5, Bonferroni-Holm adjusted P-va
lue = 0.014148260037230914
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 23.5, Bonferroni-Holm adjusted P-va
lue = 0.01125866535217163
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 20.0, Bonferroni-Holm adjusted P-va
lue = 0.23824532313177882


Results for Timepoint 360 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.002426544451741681
2. Now-ness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 8.0, Bonferroni-Holm adjusted P-val
ue = 0.017262930816086715
3. Letting Go (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 16.0, Bonferroni-Holm adjusted P-va
lue = 0.007038000869236241
4. Equanimity (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 3.5, Bonferroni-Holm adjusted P-val
ue = 0.005482245141092957
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 15.0, Bonferroni-Holm adjusted P-va
lue = 0.017262930816086715
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 11.0, Bonferroni-Holm adjusted P-va
lue = 0.017262930816086715
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 0.0, Bonferroni-Holm adjusted P-val
ue = 0.004968295656007677
8. Timelessness (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 10.5, Bonferroni-Holm adjusted P-va
lue = 0.011872612124758989
9. Ineffability (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 1.0, Bonferroni-Holm adjusted P-val
ue = 0.005482245141092957
```

```
10. Feelings of joy (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 19.5, Bonferroni-Holm adjusted P-va
lue = 0.017262930816086715
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 42.5, Bonferroni-Holm adjusted P-va
lue = 0.06557937420241276
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 9.0, Bonferroni-Holm adjusted P-val
ue = 0.009637323611717062
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): Wilcoxon statistic = 23.0, Bonferroni-Holm adjusted P-va
lue = 0.6387290943002656
```

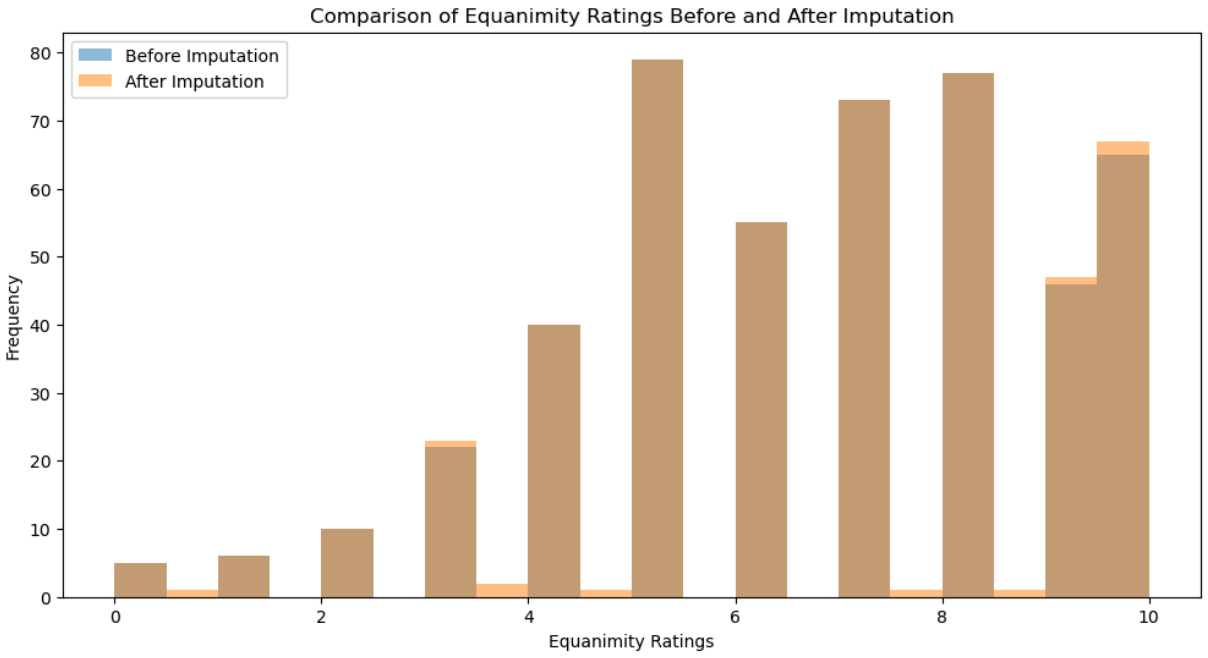
```
/Users/harriethe/anaconda3/lib/python3.11/site-packages/scipy/stats/_morestats.py:34
14: UserWarning: Exact p-value calculation does not work if there are zeros. Switchi
ng to normal approximation.
  warnings.warn("Exact p-value calculation does not work if there are "
```

In [248…

```
plt.figure(figsize=(12, 6))
plt.hist(df_cleaned['4. Equanimity (0 = none to\n10 = strongest imaginable)'], bins
plt.hist(df_cleaned_imputed['4. Equanimity (0 = none to\n10 = strongest imaginable)
plt.xlabel('Equanimity Ratings')
plt.ylabel('Frequency')
plt.title('Comparison of Equanimity Ratings Before and After Imputation')
plt.legend()
plt.show
```

Out[248…

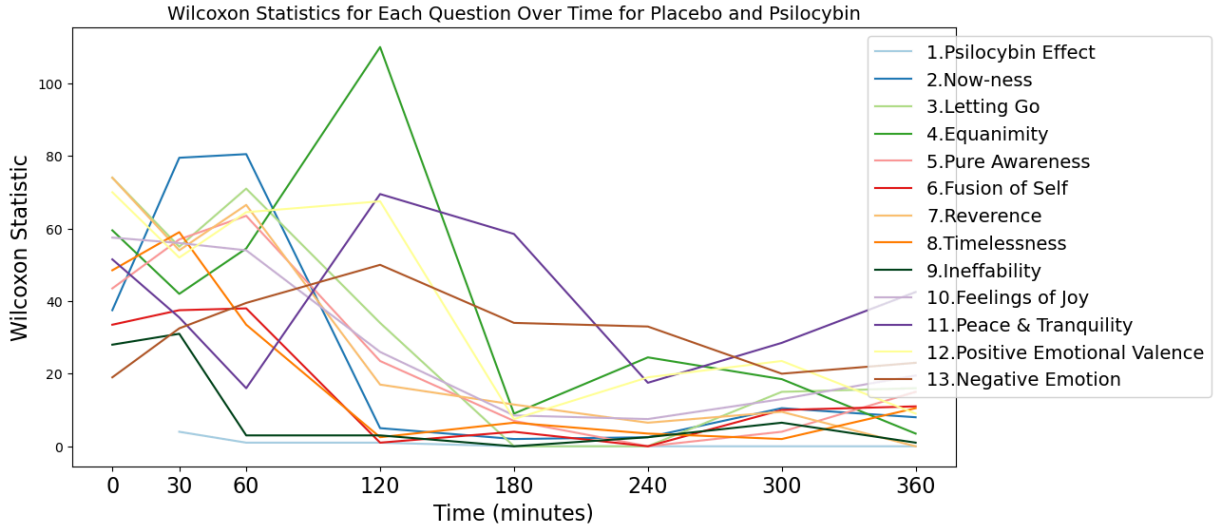
```
<function matplotlib.pyplot.show(close=None, block=None)>
```

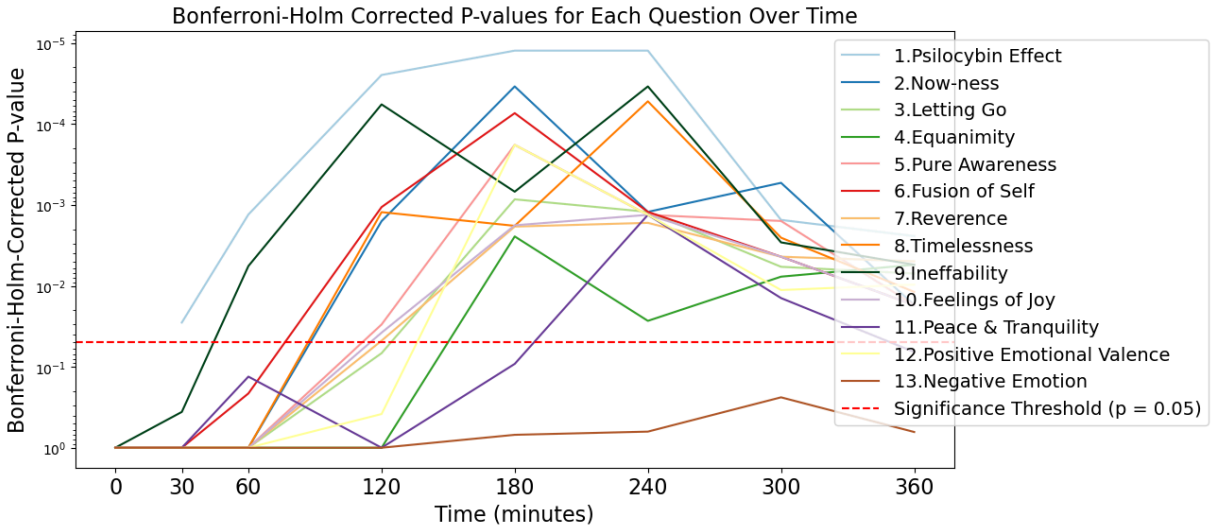


In [132…

```
from statsmodels.stats.multitest import multipletests
import numpy as np
import matplotlib.pyplot as plt

# Assuming wilcoxon_results_by_time has been generated as in your provided code
```

```
specific_timepoints = [0, 30, 60, 120, 180, 240, 300, 360]
custom_colors = [
    "#a6cee3", "#1f78b4", "#b2df8a", "#33a02c", "#fb9a99", "#e31a1c", "#fdbf6f", "#
    "#00441b", "#cab2d6", "#6a3d9a", "#ffff99", "#b15928"
]

# Separate data for plotting
wilcoxon_t_stats_by_question = {col: [] for col in rating_columns}
bonferroni_holm_p_values_by_question = {col: [] for col in rating_columns}

for timepoint in timepoints:
    for col in rating_columns:
        wilcoxon_t_stat, adj_p_value = wilcoxon_results_by_time[timepoint][col]
        wilcoxon_t_stats_by_question[col].append(wilcoxon_t_stat if wilcoxon_t_stat
        bonferroni_holm_p_values_by_question[col].append(adj_p_value if adj_p_value

# Plot Wilcoxon statistics over time
plt.figure(figsize=(12, 6))
for i, (col, short_col) in enumerate(zip(rating_columns, shortened_rating_columns))
    plt.plot(timepoints, wilcoxon_t_stats_by_question[col], label=short_col, color=
plt.xlabel('Time (minutes)', fontsize=16)
plt.ylabel('Wilcoxon Statistic', fontsize=16)
plt.title('Wilcoxon Statistics for Each Question Over Time for Placebo and Psilocyb
plt.xticks(specific_timepoints, fontsize=16)
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1), fontsize=14)
plt.show()

plt.figure(figsize=(12, 6))
for i, (col, short_col) in enumerate(zip(rating_columns, shortened_rating_columns))
    plt.plot(timepoints, bonferroni_holm_p_values_by_question[col], label=short_col
plt.xlabel('Time (minutes)', fontsize=16)
plt.ylabel('Bonferroni-Holm-Corrected P-value', fontsize=16)
plt.yscale('log')
plt.gca().invert_yaxis()
plt.title('Bonferroni-Holm Corrected P-values for Each Question Over Time', fontsiz
plt.xticks(specific_timepoints, fontsize=16)
plt.axhline(y=0.05, color='r', linestyle='--', label='Significance Threshold (p = 0
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1), fontsize=14)
plt.show()
```





Sections for Indepedent T Test

In [314…

```
from statsmodels.stats.multitest import multipletests
from scipy import stats

independent_results_by_time = {}
m = len(rating_columns)

for timepoint in timepoints:
    df_timepoint = df_cleaned_imputed[df_cleaned_imputed['Timepoint relative to dru
    placebo_scores = df_timepoint[(df_timepoint['Condition (PLA: placebo, EXP: 25 m
    psilocybin_scores = df_timepoint[(df_timepoint['Condition (PLA: placebo, EXP: 2
    independent_results_by_time[timepoint] = {}
    p_values = []
    t_stats = []

    for col in rating_columns:
        if len(placebo_scores[col]) > 0 and len(psilocybin_scores[col]) > 0:
            t_stat, p_value = stats.ttest_ind(placebo_scores[col], psilocybin_score
            p_values.append(p_value)
            t_stats.append(t_stat)
        else:
            p_values.append(1)
            t_stats.append(None)
    adjusted_p_values = multipletests(p_values, alpha=0.05, method='holm')[1]
    for col, t_stat, adj_p_value in zip(rating_columns, t_stats, adjusted_p_values)
        tiny_threshold = 1e-14
        log_adj_p_value = -np.log10(max(adj_p_value, tiny_threshold))

        independent_results_by_time[timepoint][col] = (t_stat, log_adj_p_value)

    print(f"Results for Timepoint {timepoint} (minutes):")
    for col, (t_stat, log_adj_p_value) in independent_results_by_time[timepoint].it
        print(f"{col}: T-statistic = {t_stat}, Log Bonferroni-Holm P-value = {log_a
    print("\n")
```

```
Results for Timepoint 0 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = nan, Log Bonferroni-Holm P-value = nan
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -0.010462094021844254, Log Bonferroni-Holm
P-value = -0.0
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = 0.4106802868547341, Log Bonferroni-Holm P-
value = -0.0
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 0.4621971015345972, Log Bonferroni-Holm P-
value = -0.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -0.473218228828803, Log Bonferroni-Holm P-
value = -0.0
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -0.41198550354253083, Log Bonferroni-Holm
P-value = -0.0
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -0.9793048011484835, Log Bonferroni-Holm P
-value = -0.0
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -0.47500000000000026, Log Bonferroni-Holm
P-value = -0.0
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = 0.5550387187548214, Log Bonferroni-Holm P-
value = -0.0
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -0.47946061998807177, Log Bonferroni-Holm
P-value = -0.0
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -0.5434455494020758, Log Bonferroni-Holm P
-value = -0.0
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -0.48424964604039233, Log Bonferroni-Holm
P-value = -0.0
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = 0.4983788459631745, Log Bonferroni-Holm P-
value = -0.0


Results for Timepoint 30 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -2.552540076628362, Log Bonferroni-Holm P-
value = 0.7147695431204234
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = 0.6171130204740658, Log Bonferroni-Holm P-
value = -0.0
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = 0.2738783380405275, Log Bonferroni-Holm P-
value = -0.0
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 0.6579810812815282, Log Bonferroni-Holm P-
value = -0.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -0.5173156617226574, Log Bonferroni-Holm P
```

```
-value = -0.0
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = 0.0276658177100034, Log Bonferroni-Holm P-
value = -0.0
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -0.2931360119622945, Log Bonferroni-Holm P
-value = -0.0
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -0.9024347734055966, Log Bonferroni-Holm P
-value = -0.0
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -0.33768192496148414, Log Bonferroni-Holm
P-value = -0.0
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = 0.39376246564579326, Log Bonferroni-Holm P
-value = -0.0
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = 1.0035091622007186, Log Bonferroni-Holm P-
value = -0.0
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = 0.06512620114237956, Log Bonferroni-Holm P
-value = -0.0
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -1.598275917983452, Log Bonferroni-Holm P-
value = -0.0


Results for Timepoint 60 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -5.609360811795251, Log Bonferroni-Holm P-
value = 4.594839009917543
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -2.0071011576594713, Log Bonferroni-Holm P
-value = 0.38181963655194484
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -0.09475440802297211, Log Bonferroni-Holm
P-value = -0.0
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 1.191249336822786, Log Bonferroni-Holm P-v
alue = 0.016025014353879208
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -2.3743176532001242, Log Bonferroni-Holm P
-value = 0.6890425097446584
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -3.4428667763019623, Log Bonferroni-Holm P
-value = 1.769838059131229
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -1.460443727519181, Log Bonferroni-Holm P-
value = 0.11808078339447114
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -2.5905615557851416, Log Bonferroni-Holm P
-value = 0.8592808680766302
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -2.6199512209740337, Log Bonferroni-Holm P
-value = 0.8592808680766302
10. Feelings of joy (0 = none to
```

```
10 = strongest imaginable): T-statistic = 0.1725465173831758, Log Bonferroni-Holm P-
value = -0.0
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = 1.9569001793369099, Log Bonferroni-Holm P-
value = 0.38181963655194484
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = 1.1571144961609732, Log Bonferroni-Holm P-
value = 0.016025014353879208
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -1.822620655442316, Log Bonferroni-Holm P-
value = 0.3396841459351888


Results for Timepoint 120 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -7.6675498521689684, Log Bonferroni-Holm P
-value = 7.390375093544798
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -4.533249796288661, Log Bonferroni-Holm P-
value = 3.2946257065728477
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -2.082452738874872, Log Bonferroni-Holm P-
value = 0.6567440238858038
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -0.28805412687489096, Log Bonferroni-Holm
P-value = -0.0
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -3.8960314885357628, Log Bonferroni-Holm P
-value = 2.5126441110463875
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -4.81525868672134, Log Bonferroni-Holm P-v
alue = 3.627024246133427
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -3.048626322549102, Log Bonferroni-Holm P-
value = 1.601581405693394
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -5.111229536492285, Log Bonferroni-Holm P-
value = 3.986636684762618
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -5.31993569543655, Log Bonferroni-Holm P-v
alue = 4.2334214234092835
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -3.6393916092686887, Log Bonferroni-Holm P
-value = 2.2465012874975345
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -1.3932846575526983, Log Bonferroni-Holm P
-value = 0.1633450341461047
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -1.0377096689857654, Log Bonferroni-Holm P
-value = 0.03720893776562642
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -0.6710040081666133, Log Bonferroni-Holm P
-value = -0.0


Results for Timepoint 180 (minutes):
```

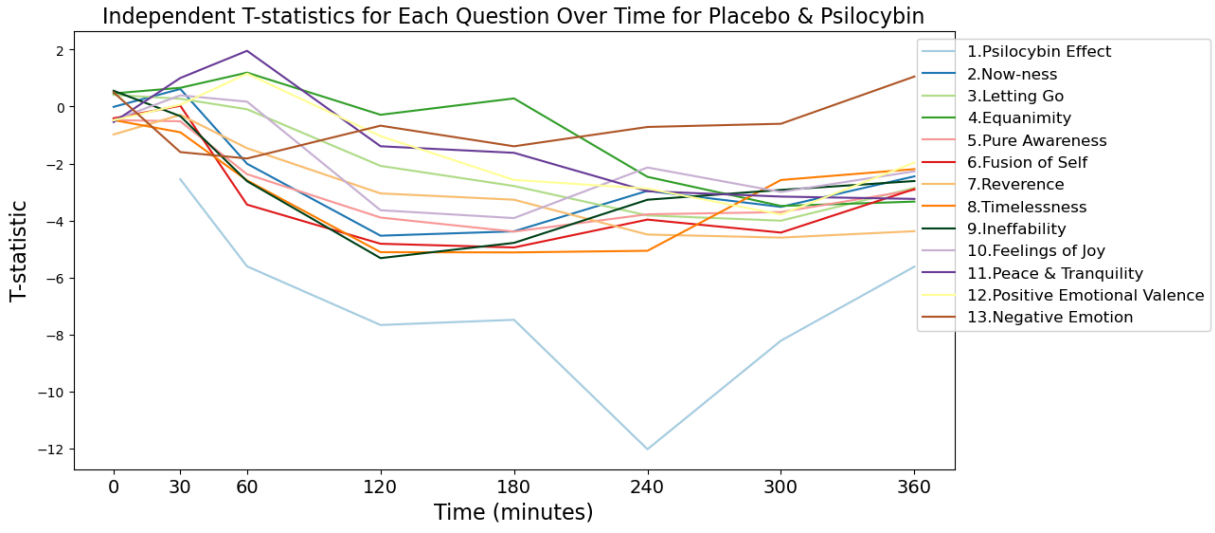
```
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -7.484703545940707, Log Bonferroni-Holm P-
value = 7.14688383448475
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -4.380088228751307, Log Bonferroni-Holm P-
value = 3.103865414410549
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -2.788705138031388, Log Bonferroni-Holm P-
value = 1.386010831582846
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = 0.2851662223104158, Log Bonferroni-Holm P-
value = 0.10954246035136854
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -4.389570847510182, Log Bonferroni-Holm P-
value = 3.103865414410549
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -4.945296223379279, Log Bonferroni-Holm P-
value = 3.761378466451604
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -3.269957506369274, Log Bonferroni-Holm P-
value = 1.8620026262703524
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -5.119977253616796, Log Bonferroni-Holm P-
value = 3.9607503211333164
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -4.784389888206902, Log Bonferroni-Holm P-
value = 3.585420362339976
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -3.914839157704937, Log Bonferroni-Holm P-
value = 2.5946862513710958
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -1.623515184990318, Log Bonferroni-Holm P-
value = 0.47077297201454554
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -2.574670477256183, Log Bonferroni-Holm P-
value = 1.2501692026217888
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -1.394483717203298, Log Bonferroni-Holm P-
value = 0.4652855168990003


Results for Timepoint 240 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -12.029107670838291, Log Bonferroni-Holm P
-value = 12.686156850693381
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -2.9579553749169363, Log Bonferroni-Holm P
-value = 1.5135296632882906
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -3.820768804014625, Log Bonferroni-Holm P-
value = 2.3656385888518483
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -2.467065289170506, Log Bonferroni-Holm P-
value = 1.2617714166070764
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -3.781557596063955, Log Bonferroni-Holm P-
```

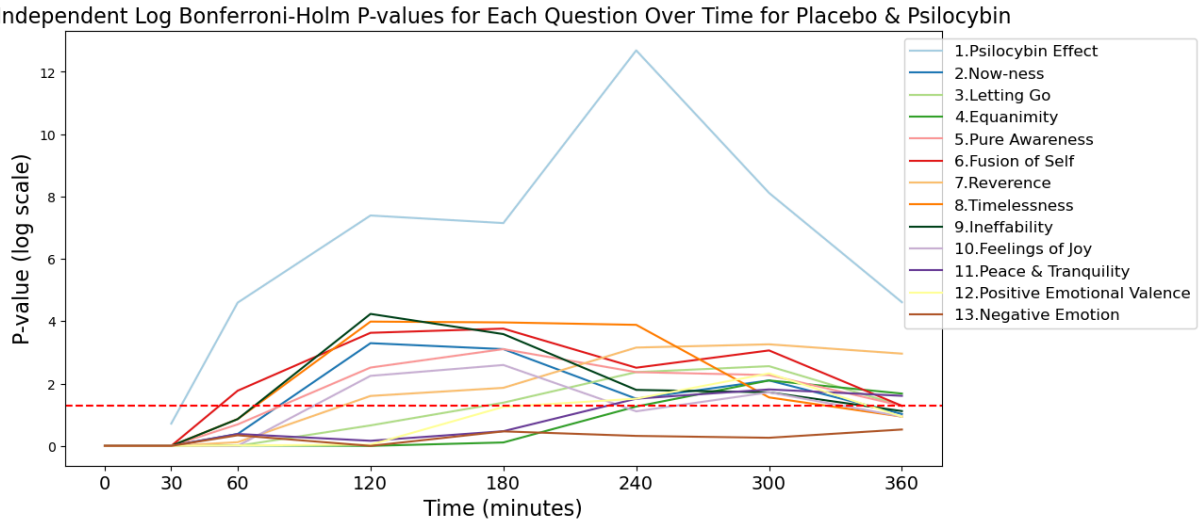
```
value = 2.3656385888518483
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -3.967631988926796, Log Bonferroni-Holm P-
value = 2.507493494162403
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -4.492936147654533, Log Bonferroni-Holm P-
value = 3.1538082660416884
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -5.062558286368434, Log Bonferroni-Holm P-
value = 3.88267225684168
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -3.270829991554526, Log Bonferroni-Holm P-
value = 1.7960982810514077
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -2.139075208020157, Log Bonferroni-Holm P-
value = 1.1088399382082297
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -2.9721264724327194, Log Bonferroni-Holm P
-value = 1.5135296632882906
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -2.879945114034409, Log Bonferroni-Holm P-
value = 1.5135296632882906
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -0.7157812286555142, Log Bonferroni-Holm P
-value = 0.320116213269788


Results for Timepoint 300 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -8.217294912362242, Log Bonferroni-Holm P-
value = 8.113618090970649
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -3.52079741079654, Log Bonferroni-Holm P-v
alue = 2.0994853454789166
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -4.005862419730912, Log Bonferroni-Holm P-
value = 2.5567058534341567
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -3.4883766099348574, Log Bonferroni-Holm P
-value = 2.0994853454789166
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -3.705201476169394, Log Bonferroni-Holm P-
value = 2.2708755431395478
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -4.423390065930259, Log Bonferroni-Holm P-
value = 3.0614858434137986
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -4.599261838267847, Log Bonferroni-Holm P-
value = 3.2577913651340533
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -2.578093165289796, Log Bonferroni-Holm P-
value = 1.5548456759996339
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -2.9261274469652157, Log Bonferroni-Holm P
-value = 1.7183328267543516
10. Feelings of joy (0 = none to
```

```
10 = strongest imaginable): T-statistic = -2.997172053272729, Log Bonferroni-Holm P-
value = 1.7183328267543516
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -3.160093088646672, Log Bonferroni-Holm P-
value = 1.8108949432266985
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -3.789154452194632, Log Bonferroni-Holm P-
value = 2.3255659935815203
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -0.6042066489369918, Log Bonferroni-Holm P
-value = 0.2601928865129403


Results for Timepoint 360 (minutes):
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -5.61962115183335, Log Bonferroni-Holm P-v
alue = 4.608905271121201
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -2.4501332397753726, Log Bonferroni-Holm P
-value = 1.0223226504584313
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -2.855177677501452, Log Bonferroni-Holm P-
value = 1.2849491265095712
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -3.3357291090473784, Log Bonferroni-Holm P
-value = 1.6776775177916259
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -2.926078476401547, Log Bonferroni-Holm P-
value = 1.2849491265095712
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -2.8967465012584706, Log Bonferroni-Holm P
-value = 1.2849491265095712
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -4.374638829163784, Log Bonferroni-Holm P-
value = 2.9591861797961654
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -2.195887879822549, Log Bonferroni-Holm P-
value = 0.9385479215488532
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -2.613822899356994, Log Bonferroni-Holm P-
value = 1.1159402387649762
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -2.272482913726537, Log Bonferroni-Holm P-
value = 0.9385479215488532
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -3.2414033023014923, Log Bonferroni-Holm P
-value = 1.606103877455944
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -1.9674107033687713, Log Bonferroni-Holm P
-value = 0.9385479215488532
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = 1.0539774830183923, Log Bonferroni-Holm P-
value = 0.5249844354740643
```

In [316…

```
t_stats_by_question_independent = {col: [] for col in rating_columns}
log_p_value_by_question_independent = {col: [] for col in rating_columns}

for timepoint in timepoints:
    for col in rating_columns:
        t_stat, log_bonferroni_holm_p_value = independent_results_by_time[timepoint
        t_stats_by_question_independent[col].append(t_stat if t_stat is not None el
        log_p_value_by_question_independent[col].append(log_bonferroni_holm_p_value

plt.figure(figsize=(12, 6))
for i, (col, short_col) in enumerate(zip(rating_columns, shortened_rating_columns))
    plt.plot(timepoints, t_stats_by_question_independent[col], label=short_col, col
plt.xlabel('Time (minutes)', fontsize=16)
plt.ylabel('T-statistic', fontsize=16)
plt.title('Independent T-statistics for Each Question Over Time for Placebo & Psilo
plt.xticks(specific_timepoints, fontsize=14)
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1), fontsize=12)
plt.show()

plt.figure(figsize=(12, 6))
for i, (col, short_col) in enumerate(zip(rating_columns, shortened_rating_columns))
    plt.plot(timepoints, log_p_value_by_question_independent[col], label=short_col,
plt.xlabel('Time (minutes)', fontsize=16)
plt.ylabel('P-value (log scale)', fontsize=16)
plt.title('Independent Log Bonferroni-Holm P-values for Each Question Over Time for
plt.xticks(specific_timepoints, fontsize=14)
plt.axhline(y=-np.log10(0.05), color='r', linestyle='--')
plt.legend(loc='upper right', bbox_to_anchor=(1.3, 1), fontsize=12)
plt.show()
```





Heatmap comparing Wilcoxon and Independent T-statstic

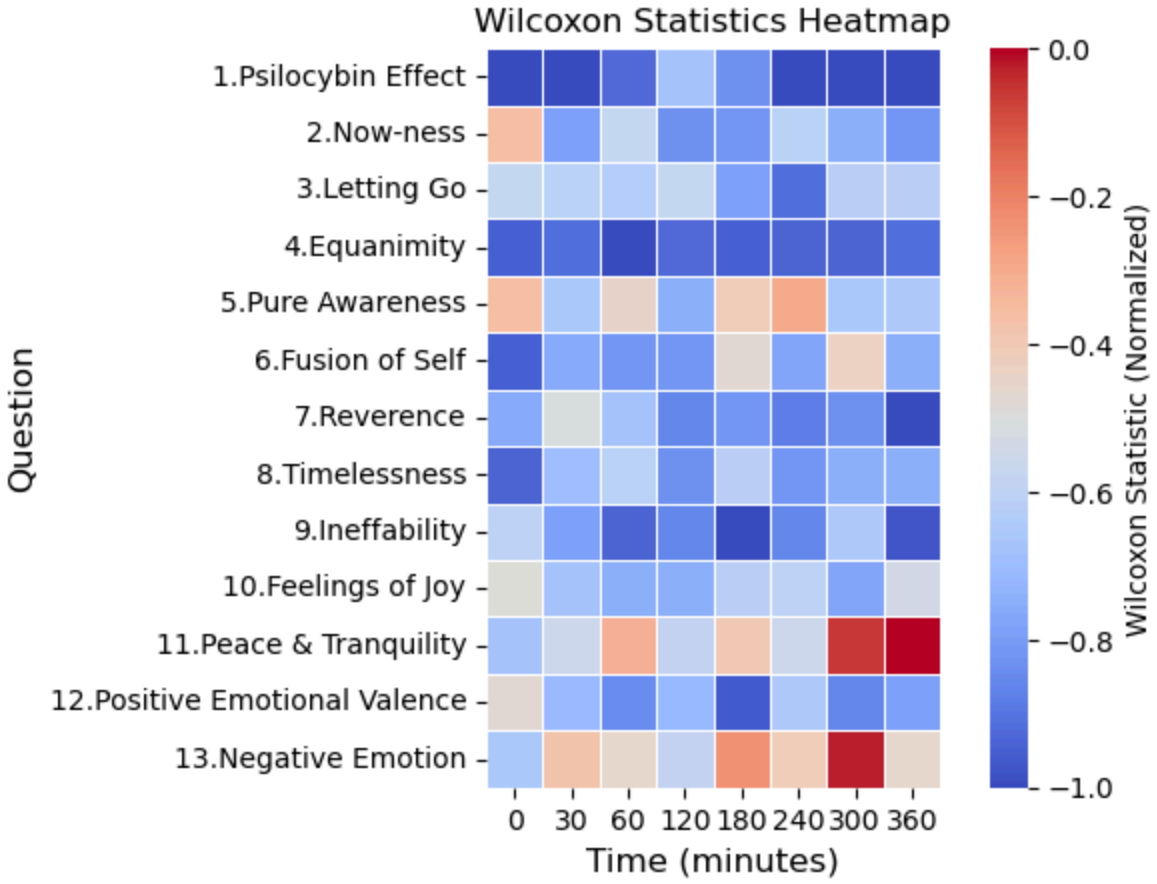
In [95]:
```
t_stats_df = pd.DataFrame(t_stats_by_question_independent, index=timepoints).T
wilcoxon_stats_df = pd.DataFrame(t_stats_by_question, index=timepoints).T

t_stats_df_normalized = (t_stats_df - t_stats_df.min().min()) / (t_stats_df.max().m
wilcoxon_stats_df_normalized = (wilcoxon_stats_df - wilcoxon_stats_df.min().min())

plt.figure(figsize=(14, 8))
plt.subplot(1, 2, 1)
sns.heatmap(t_stats_df_normalized, cmap='coolwarm', annot=False, cbar_kws={'label':
            yticklabels=shortened_rating_columns, linewidths=0.5, linecolor='white'
plt.title('T-Statistics Heatmap')
plt.xlabel('Time (minutes)', fontsize=12)
plt.ylabel('Question', fontsize=12)
plt.xticks(fontsize=10)
plt.yticks(fontsize=10)
plt.subplot(1, 2, 2)
sns.heatmap(wilcoxon_stats_df_normalized, cmap='coolwarm', annot=False, cbar_kws={'
            yticklabels=shortened_rating_columns, linewidths=0.5, linecolor='white'
plt.title('Wilcoxon Statistics Heatmap')
plt.xlabel('Time (minutes)', fontsize=12)
plt.ylabel('Question', fontsize=12)
plt.xticks(fontsize=10)
plt.yticks(fontsize=10)
plt.show()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[95], line 1
----> 1 t_stats_df = pd.DataFrame(t_stats_by_question_independent, index=timepoint
s).T
      2 wilcoxon_stats_df = pd.DataFrame(t_stats_by_question, index=timepoints).T
      4 t_stats_df_normalized = (t_stats_df - t_stats_df.min().min()) / (t_stats_df.
max().max() - t_stats_df.min().min())

NameError: name 't_stats_by_question_independent' is not defined
```

In [99]:
```
# Check and print raw Wilcoxon statistics data
print("Raw Wilcoxon Results (before normalization):")
print(wilcoxon_stats_df)

# Ensure normalization consistency by printing min/max values
print("Wilcoxon Statistics Min:", wilcoxon_stats_df.min().min())
print("Wilcoxon Statistics Max:", wilcoxon_stats_df.max().max())

wilcoxon_stats_df = pd.DataFrame(t_stats_by_question, index=timepoints).T
print(wilcoxon_stats_df)
# Apply normalization
wilcoxon_stats_df_normalized = (wilcoxon_stats_df - wilcoxon_stats_df.min().min())

sns.heatmap(wilcoxon_stats_df_normalized, cmap='coolwarm', annot=False, cbar_kws={'
            yticklabels=shortened_rating_columns, linewidths=0.5, linecolor='white'
plt.title('Wilcoxon Statistics Heatmap')
plt.xlabel('Time (minutes)', fontsize=12)
plt.ylabel('Question', fontsize=12)
plt.xticks(fontsize=10)
plt.yticks(fontsize=10)
plt.show()
```

```
Raw Wilcoxon Results (before normalization):
                                                    0     30    60    120  \
1. Overall Psilocybin Effect (0 = none to\n10 =...   0.0   0.0   3.0  14.0
2. Now-ness (0 = none to\n10 = strongest imagin...  27.0   9.0  18.0   7.0
3. Letting Go (0 = none to\n10 = strongest imag...  18.0  16.5  15.5  18.0
4. Equanimity (0 = none to\n10 = strongest imag...   2.0   3.5   0.0   3.0
5. Pure being and pure awareness (0 = none to\n...  27.0  14.5  23.5  10.5
6. Fusion of your personal self into a larger w...   2.0  10.0   7.5   8.0
7. Sense of reverence or sacredness (0 = none t...  10.0  21.0  13.5   6.0
8. Timelessness (0 = none to\n10 = strongest im...   2.5  13.0  16.5   7.0
9. Ineffability (0 = none to\n10 = strongest im...  17.0   9.0   2.5   6.0
10. Feelings of joy (0 = none to\n10 = stronges...  21.5  14.0  10.5  11.0
11. Feelings of peace and tranquility (0 = none...  13.5  19.0  29.0  17.5
12. Positive Emotional Valence (0 = none to\n10...  22.0  12.5   6.5  12.0
13. Negative emotional valence  (0 = none to\n1...  14.5  26.5  23.0  17.5

                                                   180   240   300   360
1. Overall Psilocybin Effect (0 = none to\n10 =...   7.0   0.0   0.0   0.0
2. Now-ness (0 = none to\n10 = strongest imagin...   8.0  16.5  10.5   8.0
3. Letting Go (0 = none to\n10 = strongest imag...   9.0   3.5  16.0  16.0
4. Equanimity (0 = none to\n10 = strongest imag...   2.0   2.5   2.5   3.5
5. Pure being and pure awareness (0 = none to\n...  25.0  30.0  14.5  15.0
6. Fusion of your personal self into a larger w...  22.0   9.5  24.0  11.0
7. Sense of reverence or sacredness (0 = none t...   7.5   5.0   7.0   0.0
8. Timelessness (0 = none to\n10 = strongest im...  16.0   8.0  10.5  10.5
9. Ineffability (0 = none to\n10 = strongest im...   0.0   6.0  15.0   1.0
10. Feelings of joy (0 = none to\n10 = stronges...  16.0  17.0   9.5  19.5
11. Feelings of peace and tranquility (0 = none...  25.5  19.0  40.0  42.5
12. Positive Emotional Valence (0 = none to\n10...   1.5  15.0   6.0   9.0
13. Negative emotional valence  (0 = none to\n1...  32.5  25.0  41.5  23.0
Wilcoxon Statistics Min: 0.0
Wilcoxon Statistics Max: 42.5
                                                    0     30    60    120  \
1. Overall Psilocybin Effect (0 = none to\n10 =...   0.0   0.0   3.0  14.0
2. Now-ness (0 = none to\n10 = strongest imagin...  27.0   9.0  18.0   7.0
3. Letting Go (0 = none to\n10 = strongest imag...  18.0  16.5  15.5  18.0
4. Equanimity (0 = none to\n10 = strongest imag...   2.0   3.5   0.0   3.0
5. Pure being and pure awareness (0 = none to\n...  27.0  14.5  23.5  10.5
6. Fusion of your personal self into a larger w...   2.0  10.0   7.5   8.0
7. Sense of reverence or sacredness (0 = none t...  10.0  21.0  13.5   6.0
8. Timelessness (0 = none to\n10 = strongest im...   2.5  13.0  16.5   7.0
9. Ineffability (0 = none to\n10 = strongest im...  17.0   9.0   2.5   6.0
10. Feelings of joy (0 = none to\n10 = stronges...  21.5  14.0  10.5  11.0
11. Feelings of peace and tranquility (0 = none...  13.5  19.0  29.0  17.5
12. Positive Emotional Valence (0 = none to\n10...  22.0  12.5   6.5  12.0
13. Negative emotional valence  (0 = none to\n1...  14.5  26.5  23.0  17.5

                                                   180   240   300   360
1. Overall Psilocybin Effect (0 = none to\n10 =...   7.0   0.0   0.0   0.0
2. Now-ness (0 = none to\n10 = strongest imagin...   8.0  16.5  10.5   8.0
3. Letting Go (0 = none to\n10 = strongest imag...   9.0   3.5  16.0  16.0
4. Equanimity (0 = none to\n10 = strongest imag...   2.0   2.5   2.5   3.5
5. Pure being and pure awareness (0 = none to\n...  25.0  30.0  14.5  15.0
6. Fusion of your personal self into a larger w...  22.0   9.5  24.0  11.0
7. Sense of reverence or sacredness (0 = none t...   7.5   5.0   7.0   0.0
8. Timelessness (0 = none to\n10 = strongest im...  16.0   8.0  10.5  10.5
```

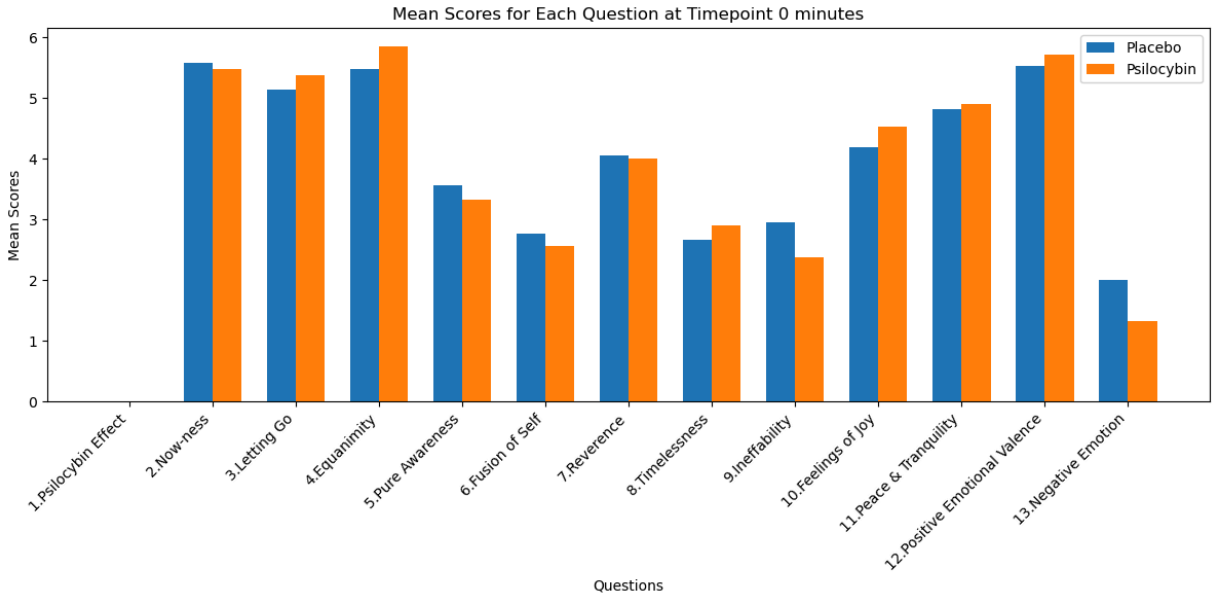
```
9. Ineffability (0 = none to\n10 = strongest im...   0.0   6.0  15.0   1.0
10. Feelings of joy (0 = none to\n10 = stronges...  16.0  17.0   9.5  19.5
11. Feelings of peace and tranquility (0 = none...  25.5  19.0  40.0  42.5
12. Positive Emotional Valence (0 = none to\n10...   1.5  15.0   6.0   9.0
13. Negative emotional valence  (0 = none to\n1...  32.5  25.0  41.5  23.0
```

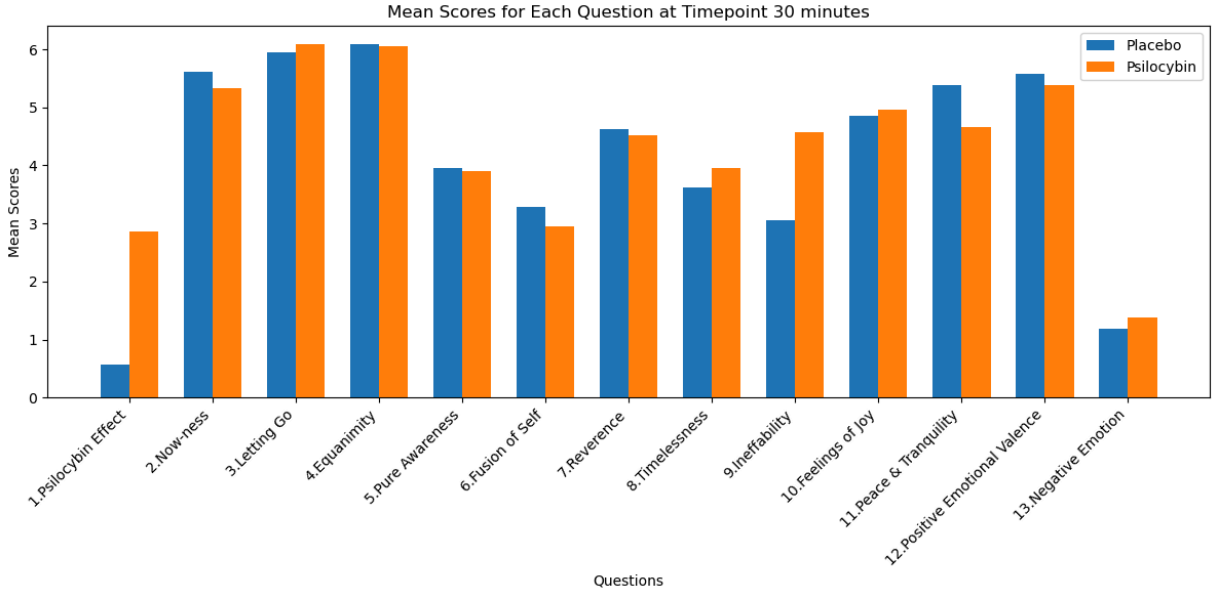


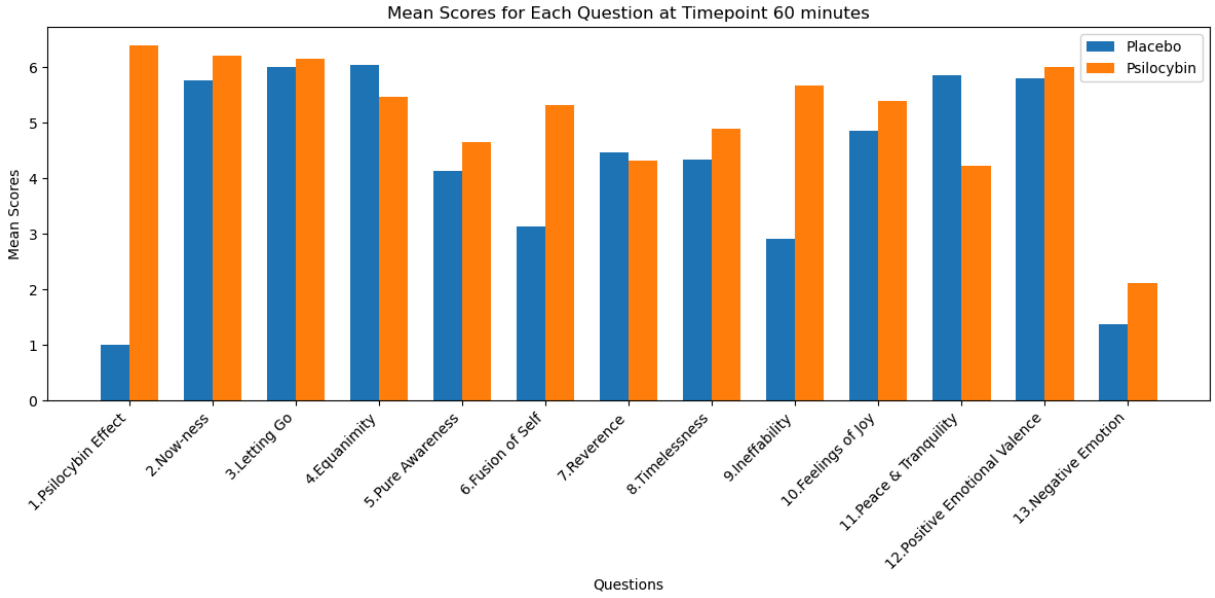
Data Exploration

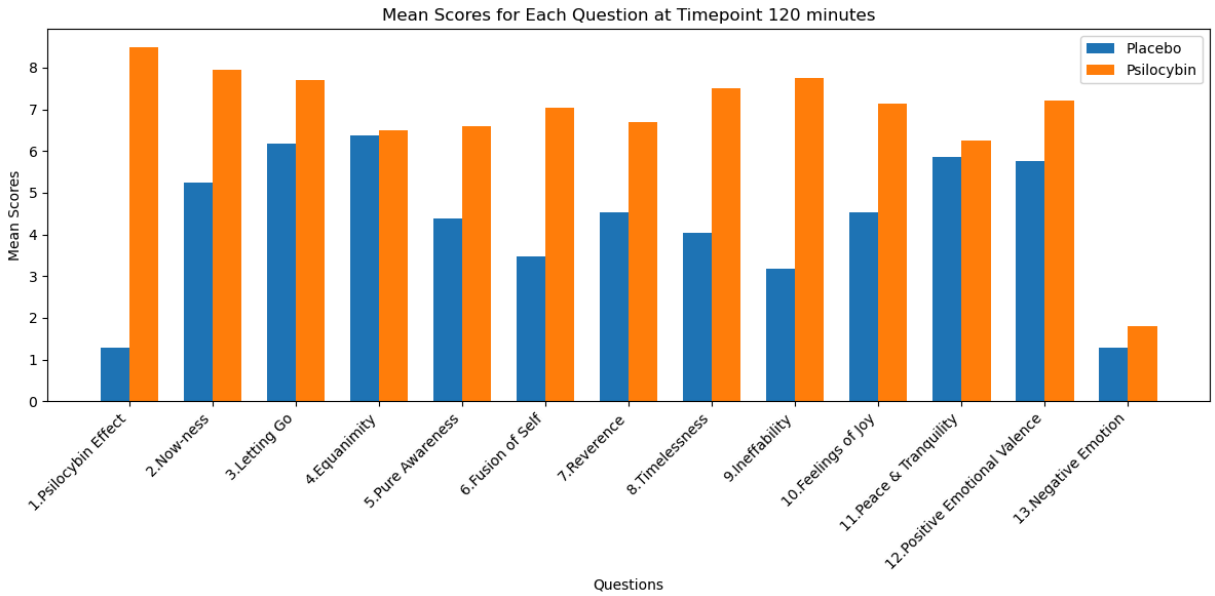
In [33]:
```
for timepoint in timepoints:
    # Filter data for the current timepoint and section 1
    df_timepoint = df_cleaned[df_cleaned['Timepoint relative to drug administration

    df_placebo = df_timepoint[(df_timepoint['Condition (PLA: placebo, EXP: 25 mg/70
    df_exp = df_timepoint[(df_timepoint['Condition (PLA: placebo, EXP: 25 mg/70 kg

    placebo_means = df_placebo[rating_columns].mean()
    exp_means = df_exp[rating_columns].mean()

    # Create a bar plot
    x = np.arange(len(rating_columns))  # the label locations
    width = 0.35  # the width of the bars

    fig, ax = plt.subplots(figsize=(12, 6))

    # Bar plot for placebo and psilocybin
    ax.bar(x - width/2, placebo_means, width, label='Placebo')
    ax.bar(x + width/2, exp_means, width, label='Psilocybin')
```

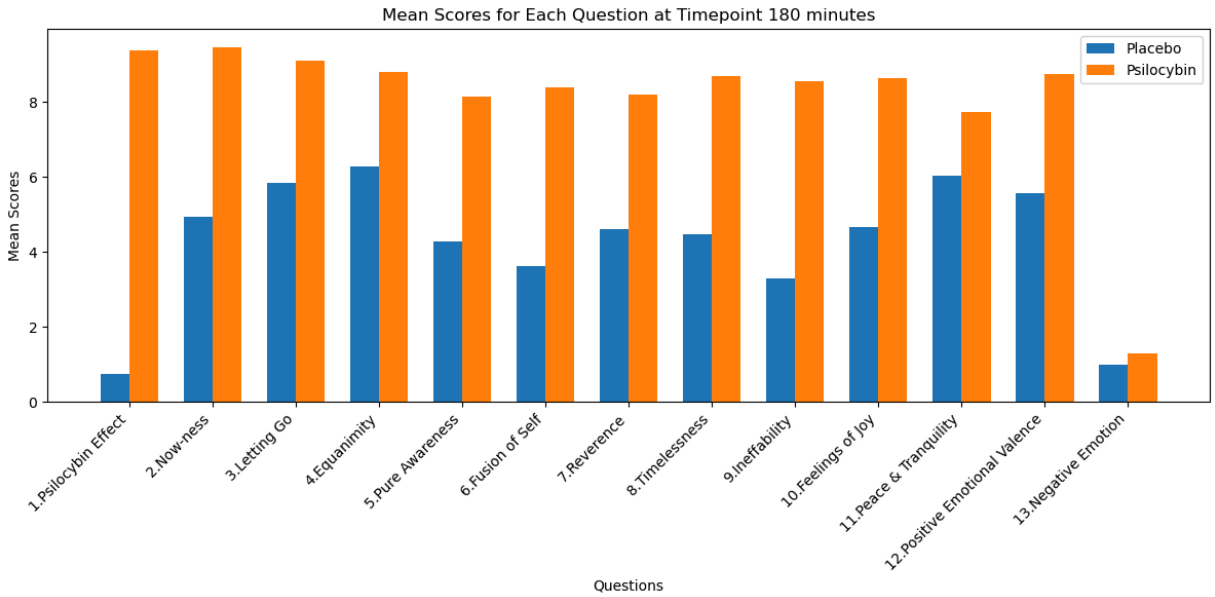
```
    # Add labels, title, and custom x-axis tick labels
    ax.set_xlabel('Questions')
    ax.set_ylabel('Mean Scores')
    ax.set_title(f'Mean Scores for Each Question at Timepoint {timepoint} minutes')
    ax.set_xticks(x)
    ax.set_xticklabels(shortened_rating_columns, rotation=45, ha='right')
    ax.legend()

    fig.tight_layout()
    plt.show()
```

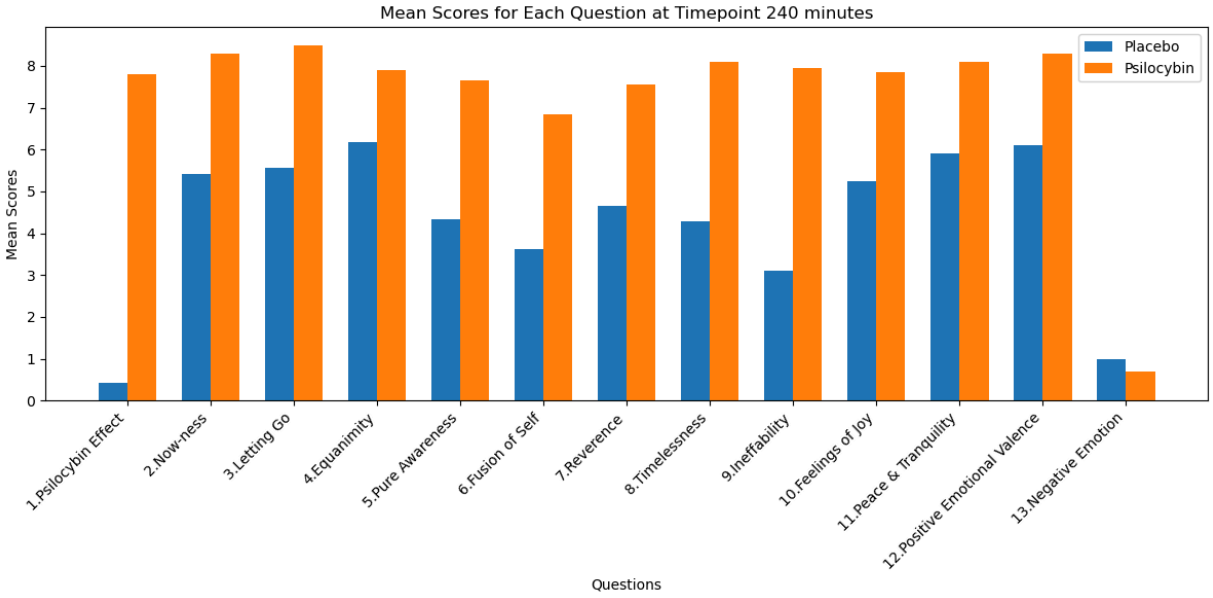


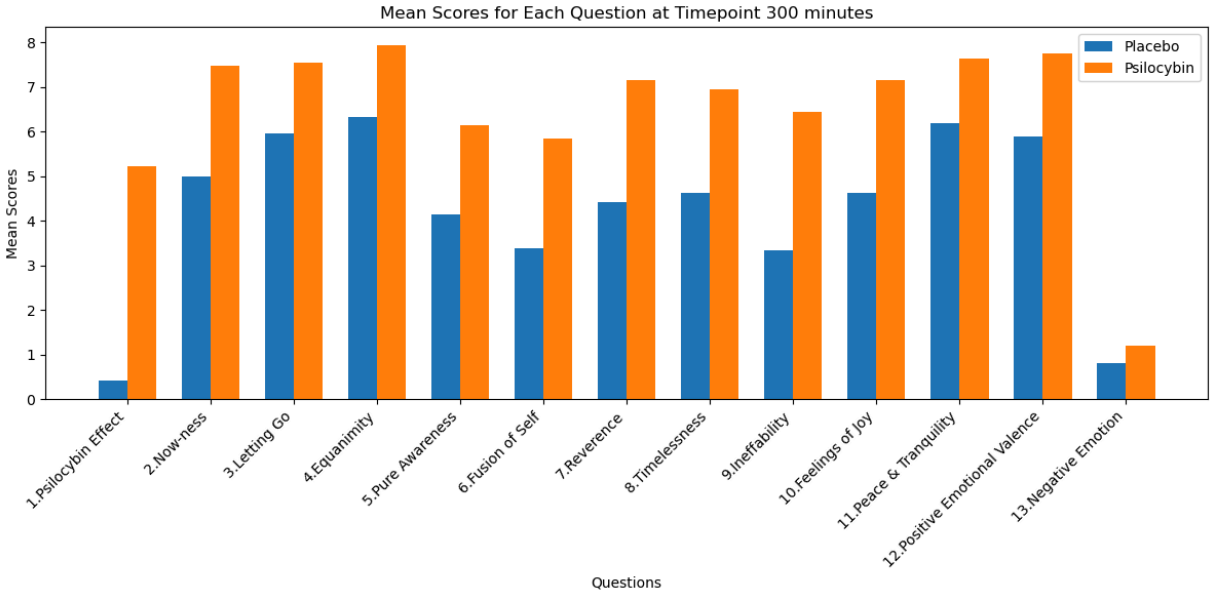


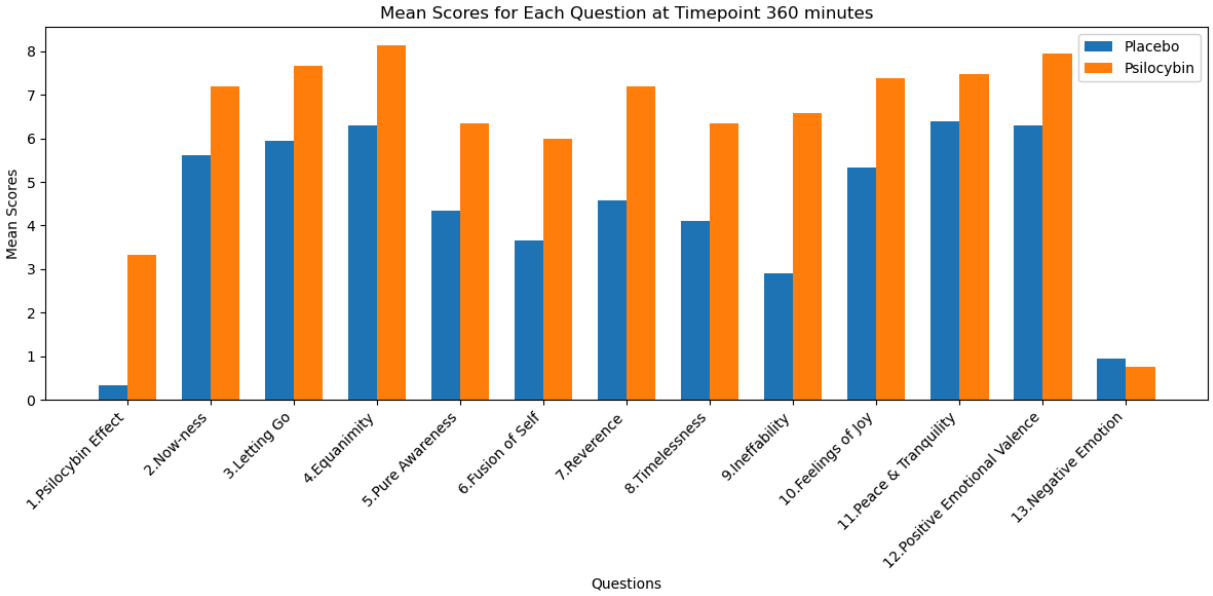

Mean Scores for Each Question at Timepoint 60 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions


Mean Scores for Each Question at Timepoint 120 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions

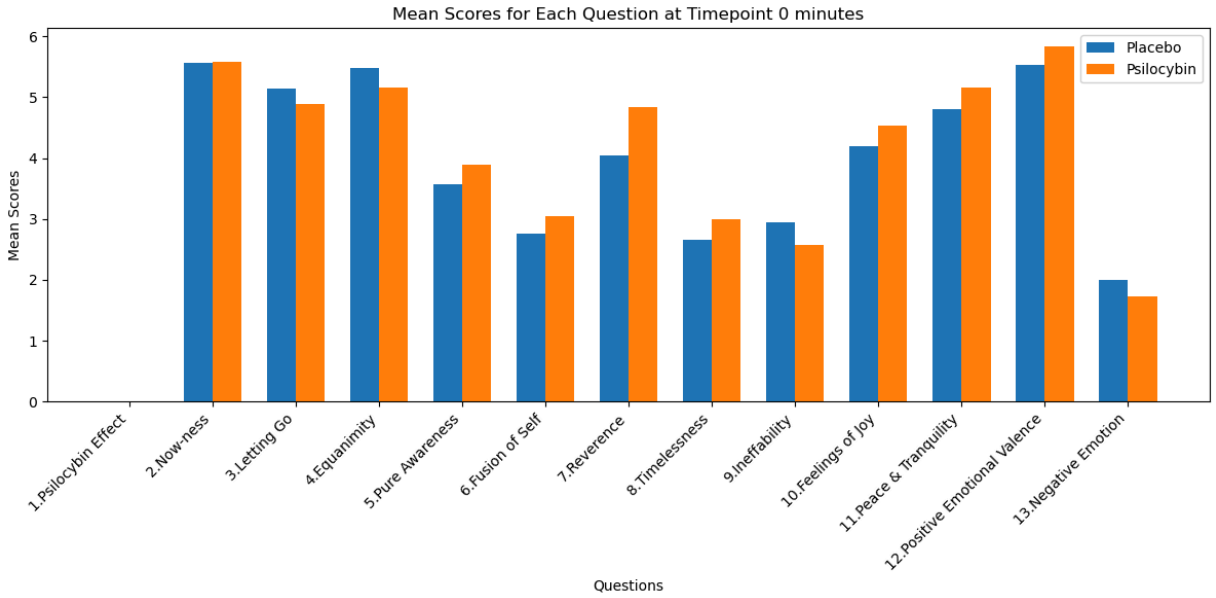

Mean Scores for Each Question at Timepoint 180 minutes
Placebo
Psilocybin
Mean Scores
0
2
4
6
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions

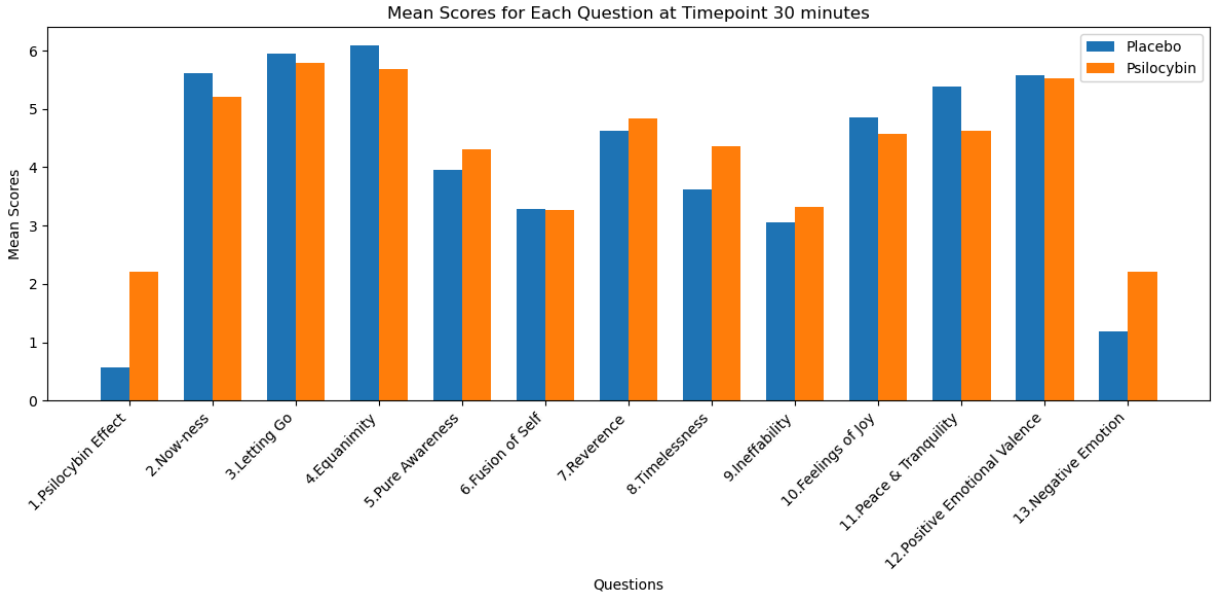

Mean Scores for Each Question at Timepoint 240 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions

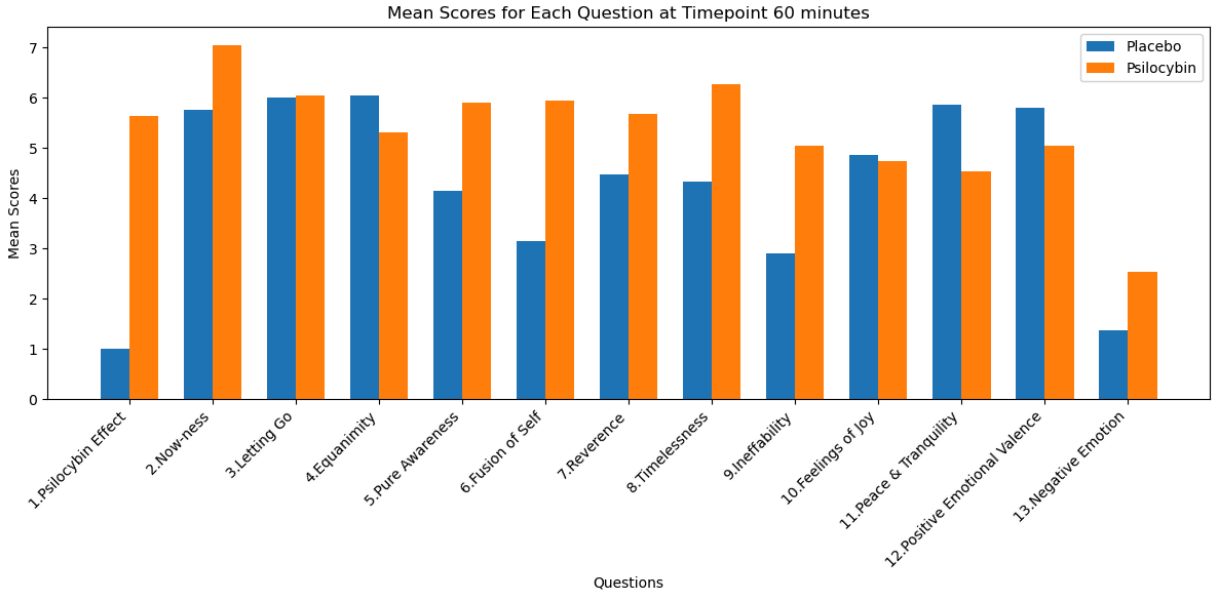

Mean Scores for Each Question at Timepoint 300 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions

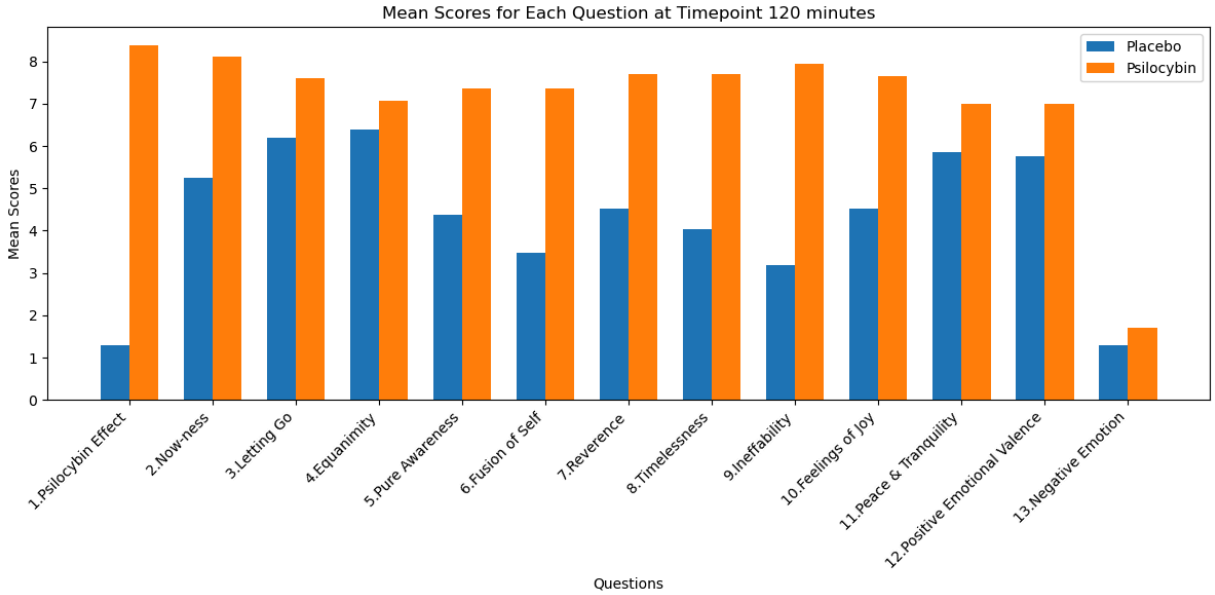

Mean Scores for Each Question at Timepoint 360 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions

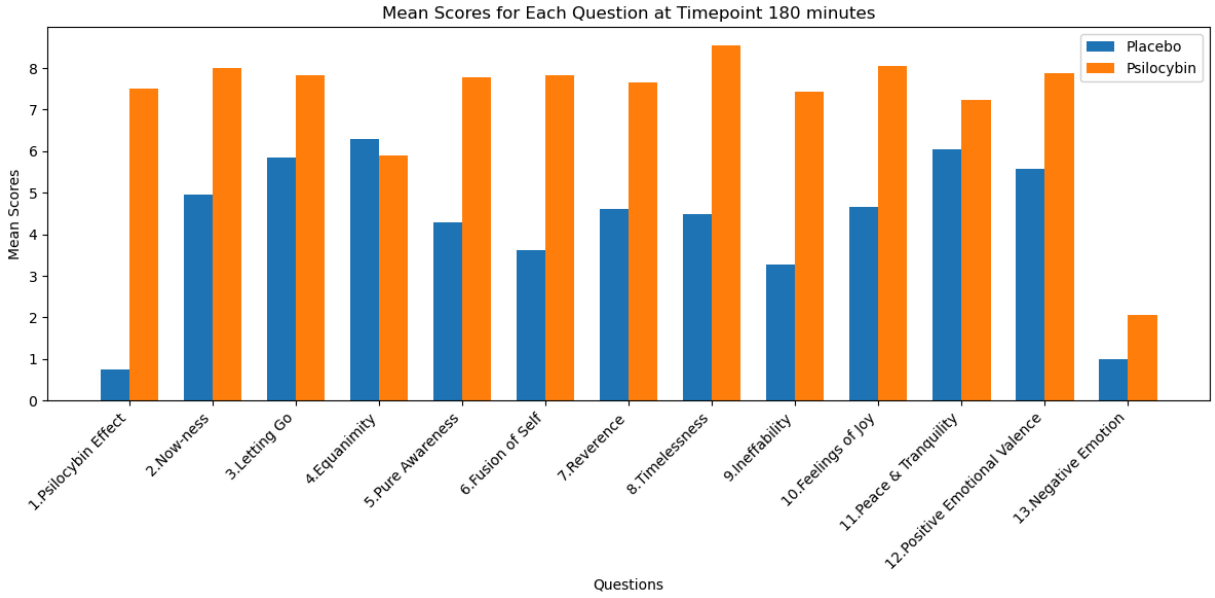
In [34]:
```
for timepoint in timepoints:
    df_timepoint = df_cleaned[df_cleaned['Timepoint relative to drug administration
    df_placebo = df_timepoint[(df_timepoint['Condition (PLA: placebo, EXP: 25 mg/70
    df_psilocybin = df_timepoint[(df_timepoint['Condition (PLA: placebo, EXP: 25 mg

    placebo_means = df_placebo[rating_columns].mean()
    psilocybin_means = df_psilocybin[rating_columns].mean()

    x = np.arange(len(rating_columns))
    width = 0.35

    fig, ax = plt.subplots(figsize=(12, 6))

    ax.bar(x - width/2, placebo_means, width, label='Placebo')
    ax.bar(x + width/2, psilocybin_means, width, label='Psilocybin')

    ax.set_xlabel('Questions')
    ax.set_ylabel('Mean Scores')
    ax.set_title(f'Mean Scores for Each Question at Timepoint {timepoint} minutes')
    ax.set_xticks(x)
    ax.set_xticklabels(shortened_rating_columns, rotation=45, ha='right')
    ax.legend()

    fig.tight_layout()
    plt.show()
```

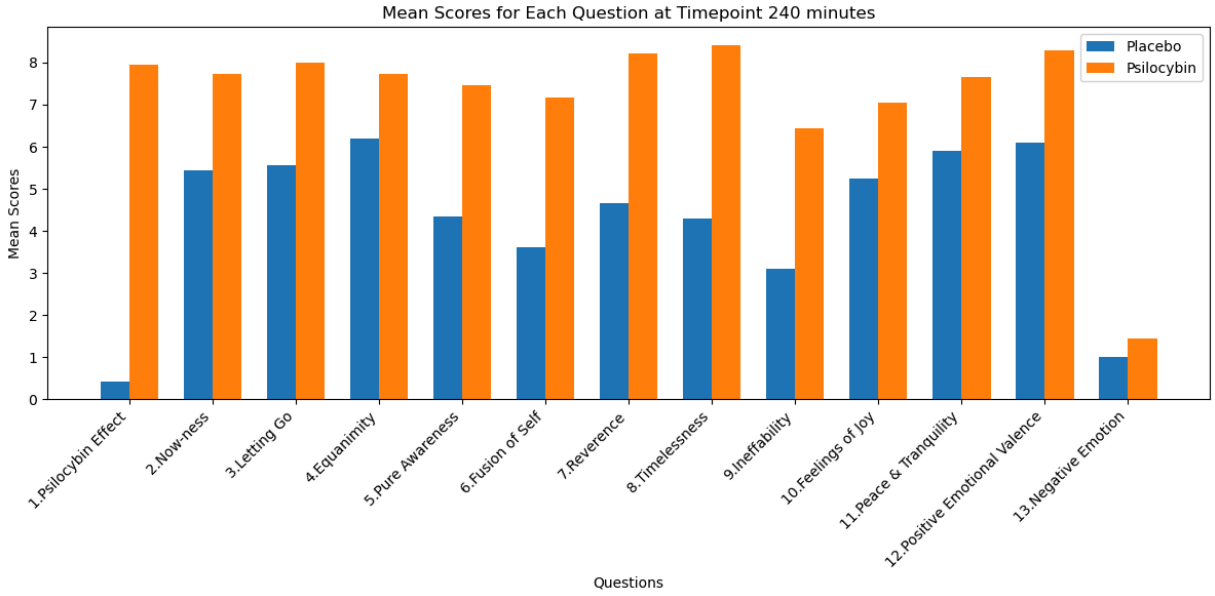


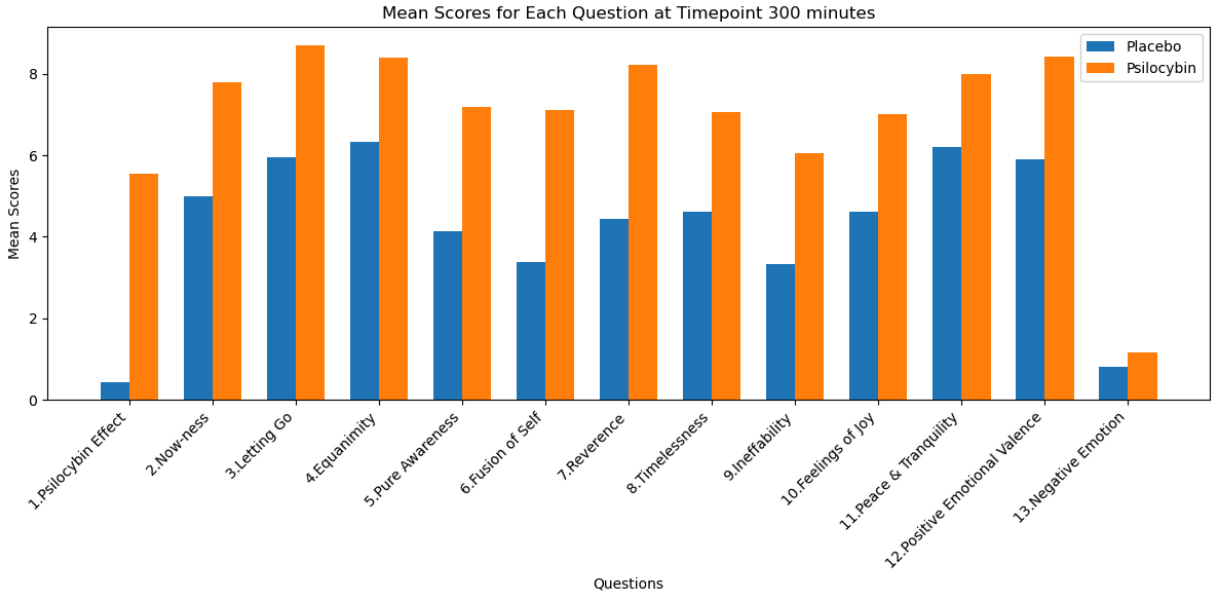

Mean Scores for Each Question at Timepoint 30 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions

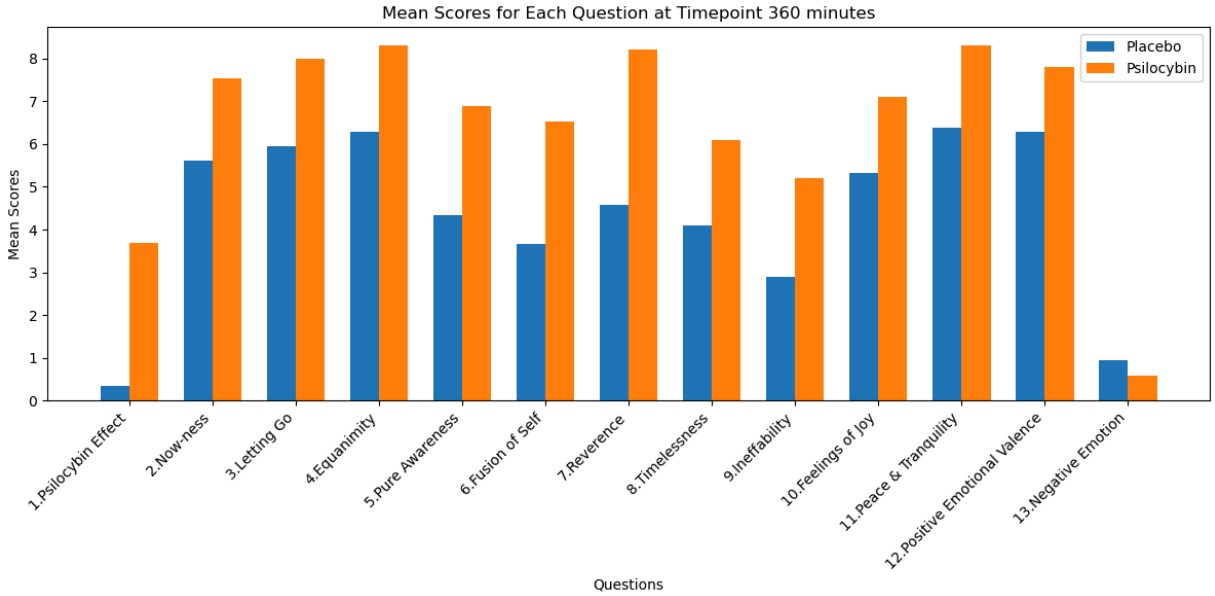

Mean Scores for Each Question at Timepoint 60 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions


Mean Scores for Each Question at Timepoint 120 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions


Mean Scores for Each Question at Timepoint 180 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions


Mean Scores for Each Question at Timepoint 240 minutes
Placebo
Psilocybin
Mean Scores
0
1
2
3
4
5
6
7
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions


Mean Scores for Each Question at Timepoint 300 minutes
Placebo
Psilocybin
Mean Scores
0
2
4
6
8
1.Psilocybin Effect
2.Now-ness
3.Letting Go
4.Equanimity
5.Pure Awareness
6.Fusion of Self
7.Reverence
8.Timelessness
9.Ineffability
10.Feelings of Joy
11.Peace & Tranquility
12.Positive Emotional Valence
13.Negative Emotion
Questions



In [36]:
```
df[rating_columns] = df[rating_columns].apply(pd.to_numeric, errors='coerce')
```

In [39]:
```
session_1 = df[df['Session (1, 2)'] == 1]
session_2 = df[df['Session (1, 2)'] == 2]
crossover_participants = session_1[(session_1['Condition (PLA: placebo, EXP: 25 mg/
```

In [41]:
```
results_paired = {}
for col in rating_columns:
    placebo_scores = session_1[session_1['Volunteer number'].isin(crossover_partici
    psilocybin_scores = session_2[session_2['Volunteer number'].isin(crossover_part
        # Perform paired t-test
    t_stat, p_value = stats.ttest_rel(placebo_scores, psilocybin_scores, nan_policy
    results_paired[col] = (t_stat, p_value)

for col, (t_stat, p_value) in results_paired.items():
    print(f"{col}: T-statistic = {t_stat}, P-value = {p_value}")
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[41], line 6
      4     psilocybin_scores = session_2[session_2['Volunteer number'].isin(crossov
er_participants['Volunteer number'])][col]
      5         # Perform paired t-test
----> 6     t_stat, p_value = stats.ttest_rel(placebo_scores, psilocybin_scores, nan
_policy='omit')
      7     results_paired[col] = (t_stat, p_value)
      9 for col, (t_stat, p_value) in results_paired.items():

File ~/anaconda3/lib/python3.11/site-packages/scipy/stats/_axis_nan_policy.py:502, i
n _axis_nan_policy_factory.<locals>.axis_nan_policy_decorator.<locals>.axis_nan_poli
cy_wrapper(***failed resolving arguments***)
    500 if sentinel:
    501     samples = _remove_sentinel(samples, paired, sentinel)
--> 502 res = hypotest_fun_out(*samples, **kwds)
    503 res = result_to_tuple(res)
    504 res = _add_reduced_axes(res, reduced_axes, keepdims)

File ~/anaconda3/lib/python3.11/site-packages/scipy/stats/_stats_py.py:7133, in ttes
t_rel(a, b, axis, nan_policy, alternative)
   7131 nb = _get_len(b, axis, "second argument")
   7132 if na != nb:
-> 7133     raise ValueError('unequal length arrays')
   7135 if na == 0 or nb == 0:
   7136     # _axis_nan_policy decorator ensures this only happens with 1d input
   7137     return TtestResult(np.nan, np.nan, df=np.nan, alternative=np.nan,
   7138                        standard_error=np.nan, estimate=np.nan)

ValueError: unequal length arrays
```

For the participants who received placebo in session 1 and were crossed over to psilocybin in session 2, a paired t-test was performed for each subjective rating variable. This test was performed to determine if there was a significant difference in responses before and after the crossover from placebo to psilocybin. The results indicated significant differences between conditions for most variables, such as "Overall Psilocybin Effect", "Now-ness", "Letting Go", and others, with extremely low p-values, implying strong statistical significance.

In [43]:
```
psilocybin_only = session_1[session_1['Condition (PLA: placebo, EXP: 25 mg/70 kg ps
placebo_only = session_1[session_1['Condition (PLA: placebo, EXP: 25 mg/70 kg psilo
#for col in rating_columns:
   #print(f"{col}: {placebo_only[col].isna().sum()} missing values in placebo group
   #print(f"{col}: {psilocybin_only[col].isna().sum()} missing values in psilocybin
placebo_only_cleaned = placebo_only.dropna(subset=rating_columns)
psilocybin_only_cleaned = psilocybin_only.dropna(subset=rating_columns)
#print(placebo_only.shape)
#print(placebo_only_cleaned.shape)
```

In [45]:
```
results_independent = {}
for col in rating_columns:
    placebo_scores = placebo_only[col]
    psilocybin_scores = psilocybin_only[col]
```

```
    # Perform the two-sample t-test
    t_stat, p_value = stats.ttest_ind(placebo_scores, psilocybin_scores, nan_policy
    results_independent[col] = (t_stat, p_value)

for col, (t_stat, p_value) in results_independent.items():
    print(f"{col}: T-statistic = {t_stat}, P-value = {p_value}")
```

```
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -15.429444401377932, P-value = 1.829968648
04383e-41
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -5.807565754223764, P-value = 1.4086530819
80698e-08
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -3.4222356395405535, P-value = 0.000693751
208854987
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -1.0788089163713, P-value = 0.281407435099
00423
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -7.920759406904275, P-value = 3.1062213986
7374e-14
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -8.695702299863871, P-value = 1.3220305417
83588e-16
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -8.321093126288845, P-value = 1.9135481802
495092e-15
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -8.060714853347394, P-value = 1.1795072006
004211e-14
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -7.908199881368684, P-value = 3.3842408781
00939e-14
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -4.6455268571770985, P-value = 4.790566385
977174e-06
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -1.6738433562308155, P-value = 0.095049691
3112998
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -2.4437250220681954, P-value = 0.015026933
942036944
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -2.5920627906530083, P-value = 0.009937648
347856558
```

In [47]:
```
for col in rating_columns:
    placebo_scores = placebo_only_cleaned[col]
    psilocybin_scores = psilocybin_only_cleaned[col]
    t_stat, p_value = stats.ttest_ind(placebo_scores, psilocybin_scores, nan_policy
    results_independent[col] = (t_stat, p_value)

for col, (t_stat, p_value) in results_independent.items():
    print(f"{col}: T-statistic = {t_stat}, P-value = {p_value}")
```

```
1. Overall Psilocybin Effect (0 = none to
10 = strongest imaginable): T-statistic = -15.121591921917284, P-value = 3.919616204
202543e-40
2. Now-ness (0 = none to
10 = strongest imaginable): T-statistic = -5.7045505543911155, P-value = 2.480418165
038184e-08
3. Letting Go (0 = none to
10 = strongest imaginable): T-statistic = -3.2329655931459844, P-value = 0.001341274
6126078713
4. Equanimity (0 = none to
10 = strongest imaginable): T-statistic = -0.9192942150934472, P-value = 0.358573016
22430715
5. Pure being and pure awareness (0 = none to
10 = strongest imaginable): T-statistic = -7.7813754952725285, P-value = 8.100984271
662408e-14
6. Fusion of your personal self into a larger whole (0 = none to
10 = strongest imaginable): T-statistic = -8.56778916092202, P-value = 3.38738317066
0452e-16
7. Sense of reverence or sacredness (0 = none to
10 = strongest imaginable): T-statistic = -8.094743032561867, P-value = 9.5203136536
51218e-15
8. Timelessness (0 = none to
10 = strongest imaginable): T-statistic = -7.865891329449438, P-value = 4.5725851794
23882e-14
9. Ineffability (0 = none to
10 = strongest imaginable): T-statistic = -8.026053821879076, P-value = 1.5295534870
23367e-14
10. Feelings of joy (0 = none to
10 = strongest imaginable): T-statistic = -4.899774759162811, P-value = 1.4679740926
42273e-06
11. Feelings of peace and tranquility (0 = none to
10 = strongest imaginable): T-statistic = -1.6597118800429018, P-value = 0.097865550
58434498
12. Positive Emotional Valence (0 = none to
10 = strongest imaginable): T-statistic = -2.3868296782583407, P-value = 0.017523356
844877214
13. Negative emotional valence  (0 = none to
10 = strongest imaginable): T-statistic = -2.440220296377513, P-value = 0.0151724200
3345195
```

an independent t-test for participants who received either psilocybin or placebo in session 1, comparing these two groups. This test was first conducted with missing data and later with cleaned data (remove NaN).For the cleaned data, you found significant differences between the psilocybin and placebo groups across several variables, including "Overall Psilocybin Effect", "Letting Go", "Sense of reverence or sacredness", and others, with p-values showing strong statistical significance (e.g., p-values < 0.001)

Both the paired and independent t-tests indicated that psilocybin had a statistically significant effect on participants' subjective experiences when compared to placebo.

Trying Lazy Predict

In [95]:
```
!pip install opendatasets --upgrade --quiet
!pip3 install lazypredict
!pip3 install graphviz
```

```
Requirement already satisfied: lazypredict in /Users/harriethe/anaconda3/lib/python
3.11/site-packages (0.2.12)
Requirement already satisfied: click in /Users/harriethe/anaconda3/lib/python3.11/si
te-packages (from lazypredict) (8.0.4)
Requirement already satisfied: scikit-learn in /Users/harriethe/anaconda3/lib/python
3.11/site-packages (from lazypredict) (1.5.2)
Requirement already satisfied: pandas in /Users/harriethe/anaconda3/lib/python3.11/s
ite-packages (from lazypredict) (1.5.3)
Requirement already satisfied: tqdm in /Users/harriethe/anaconda3/lib/python3.11/sit
e-packages (from lazypredict) (4.65.0)
Requirement already satisfied: joblib in /Users/harriethe/anaconda3/lib/python3.11/s
ite-packages (from lazypredict) (1.2.0)
Requirement already satisfied: lightgbm in /Users/harriethe/anaconda3/lib/python3.1
1/site-packages (from lazypredict) (4.5.0)
Requirement already satisfied: xgboost in /Users/harriethe/anaconda3/lib/python3.11/
site-packages (from lazypredict) (2.1.1)
Requirement already satisfied: numpy>=1.17.0 in /Users/harriethe/anaconda3/lib/pytho
n3.11/site-packages (from lightgbm->lazypredict) (1.24.3)
Requirement already satisfied: scipy in /Users/harriethe/anaconda3/lib/python3.11/si
te-packages (from lightgbm->lazypredict) (1.10.1)
Requirement already satisfied: python-dateutil>=2.8.1 in /Users/harriethe/anaconda3/
lib/python3.11/site-packages (from pandas->lazypredict) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /Users/harriethe/anaconda3/lib/python
3.11/site-packages (from pandas->lazypredict) (2022.7)
Requirement already satisfied: threadpoolctl>=3.1.0 in /Users/harriethe/anaconda3/li
b/python3.11/site-packages (from scikit-learn->lazypredict) (3.5.0)
Requirement already satisfied: six>=1.5 in /Users/harriethe/anaconda3/lib/python3.1
1/site-packages (from python-dateutil>=2.8.1->pandas->lazypredict) (1.16.0)
Requirement already satisfied: graphviz in /Users/harriethe/anaconda3/lib/python3.1
1/site-packages (0.20.3)
```

In [103…
```
import os
import numpy as np
import pandas as pd
import opendatasets as od
import lazypredict
from lazypredict.Supervised import LazyClassifier
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier # for Random Forest Classifier
from sklearn.metrics import accuracy_score, confusion_matrix, precision_score, reca
from sklearn.tree import export_graphviz
from IPython.display import Image
import graphviz
```

In [112…
```
X = df[rating_columns]
y = df['Condition (PLA: placebo, EXP: 25 mg/70 kg psilocybi)']
```

In [114…
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y = le.fit_transform(y)
```

```
# Split the data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_sta

# Initialize LazyClassifier
clf = LazyClassifier(verbose=0, ignore_warnings=True, custom_metric=None)

# Fit and predict
models, predictions = clf.fit(X_train, X_test, y_train, y_test)

# View results
print(models)
```

```
100%|██████████| 31/31 [00:03<00:00, 10.29it/s]
```

```
[LightGBM] [Info] Auto-choosing row-wise multi-threading, the overhead of testing wa
s 0.000488 seconds.
You can set `force_row_wise=true` to remove the overhead.
And if memory is not enough, you can set `force_col_wise=true`.
[LightGBM] [Info] Total Bins 183
[LightGBM] [Info] Number of data points in the train set: 488, number of used featur
es: 8
[LightGBM] [Info] Start training from score -1.025529
[LightGBM] [Info] Start training from score -1.042821
[LightGBM] [Info] Start training from score -1.241556
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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                               Accuracy  Balanced Accuracy ROC AUC  F1 Score  \
Model
LGBMClassifier                     0.50               0.52    None      0.49
NuSVC                              0.49               0.52    None      0.46
LogisticRegression                 0.49               0.52    None      0.46
CalibratedClassifierCV             0.48               0.51    None      0.42
LabelSpreading                     0.50               0.50    None      0.49
RidgeClassifier                    0.47               0.50    None      0.40
RandomForestClassifier             0.48               0.50    None      0.46
LinearSVC                          0.47               0.50    None      0.41
SVC                                0.47               0.50    None      0.41
RidgeClassifierCV                  0.46               0.50    None      0.38
LabelPropagation                   0.49               0.50    None      0.48
KNeighborsClassifier               0.47               0.49    None      0.44
ExtraTreesClassifier               0.48               0.49    None      0.46
LinearDiscriminantAnalysis         0.46               0.49    None      0.41
XGBClassifier                      0.48               0.49    None      0.47
BaggingClassifier                  0.45               0.47    None      0.43
AdaBoostClassifier                 0.47               0.47    None      0.46
PassiveAggressiveClassifier        0.45               0.45    None      0.45
QuadraticDiscriminantAnalysis      0.45               0.45    None      0.42
SGDClassifier                      0.43               0.44    None      0.40
ExtraTreeClassifier                0.42               0.43    None      0.40
Perceptron                         0.43               0.42    None      0.43
GaussianNB                         0.42               0.42    None      0.40
DecisionTreeClassifier             0.40               0.41    None      0.40
```

```
NearestCentroid                0.40          0.40     None      0.37
BernoulliNB                    0.37          0.37     None      0.35
DummyClassifier                0.29          0.33     None      0.13
```

Model	Time Taken
LGBMClassifier	0.18
NuSVC	0.06
LogisticRegression	0.03
CalibratedClassifierCV	0.11
LabelSpreading	0.04
RidgeClassifier	0.02
RandomForestClassifier	0.25
LinearSVC	0.02
SVC	0.04
RidgeClassifierCV	0.02
LabelPropagation	0.04
KNeighborsClassifier	0.03
ExtraTreesClassifier	0.22
LinearDiscriminantAnalysis	0.04
XGBClassifier	1.36
BaggingClassifier	0.06
AdaBoostClassifier	0.25
PassiveAggressiveClassifier	0.03
QuadraticDiscriminantAnalysis	0.02
SGDClassifier	0.02
ExtraTreeClassifier	0.02
Perceptron	0.02
GaussianNB	0.02
DecisionTreeClassifier	0.02
NearestCentroid	0.02
BernoulliNB	0.02
DummyClassifier	0.02

Some Random PCA I done

In [116…
```
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt
```

In [146…
```
from sklearn.impute import SimpleImputer
imputer = SimpleImputer(strategy='mean')
X_imputed = imputer.fit_transform(df[rating_columns])
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X_imputed)
```

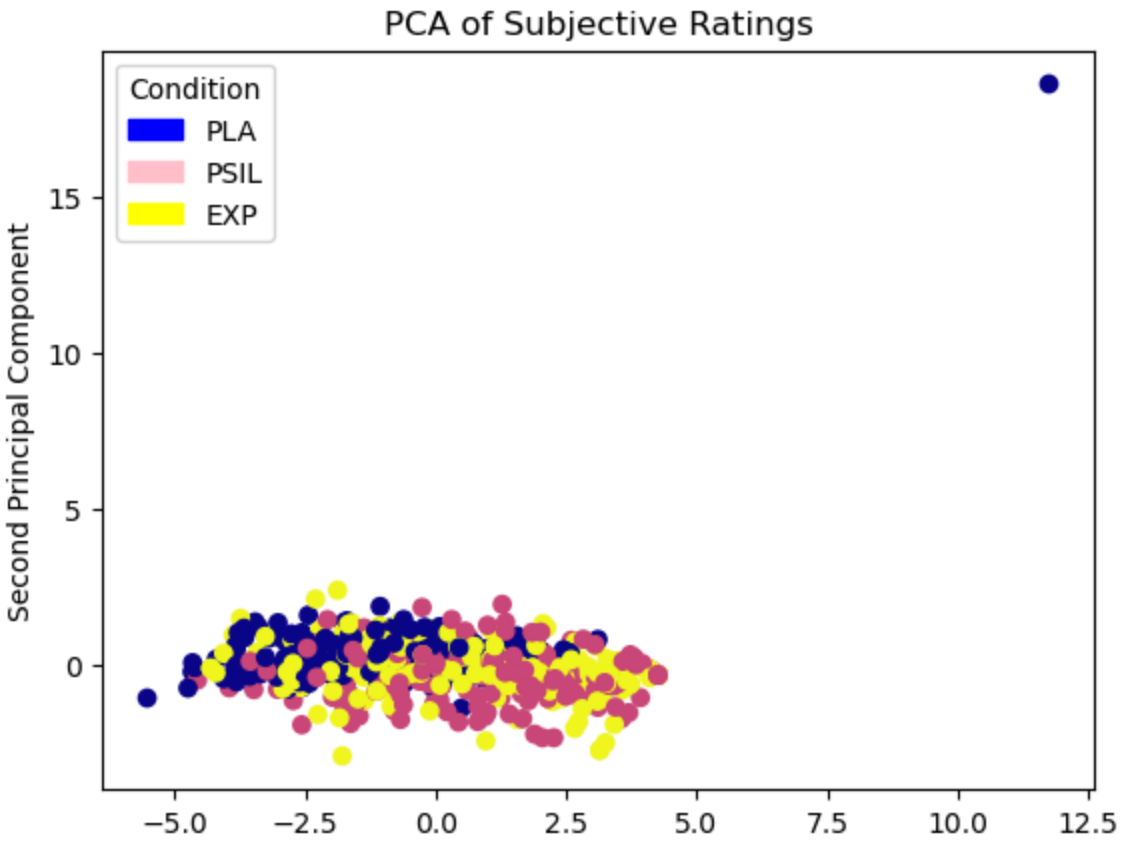
In [172…
```
pca = PCA(n_components=X_scaled.shape[1])
X_pca = pca.fit_transform(X_scaled)
explained_variance = pca.explained_variance_ratio_
print("Explained Variance Ratio:", explained_variance)
print("Total Variance Explained by 2 components:", sum(explained_variance))
```

```
Explained Variance Ratio: [0.62776203 0.14278614 0.0789812  0.04592319 0.03807703 0.
02993752
 0.01986962 0.01666328]
Total Variance Explained by 2 components: 0.9999999999999999
```

In [206…

```
import matplotlib.patches as mpatches
df['Condition_encoded'] = df['Condition (PLA: placebo, EXP: 25 mg/70 kg psilocybi)'

# Use the encoded values for the 'c' argument
plt.scatter(X_pca[:, 0], X_pca[:, 1], c=df['Condition_encoded'], cmap='plasma')
plt.ylabel('Second Principal Component')
plt.title('PCA of Subjective Ratings')
legend_handles = [mpatches.Patch(color='blue', label='PLA'),
                  mpatches.Patch(color='pink', label='PSIL'),
                  mpatches.Patch(color='yellow', label='EXP')]
plt.legend(handles=legend_handles, title='Condition')
plt.show()
```



In [208…

```
from sklearn.decomposition import FastICA
ica = FastICA(n_components=X_scaled.shape[1], random_state=42)
X_ica = ica.fit_transform(X_scaled)
```

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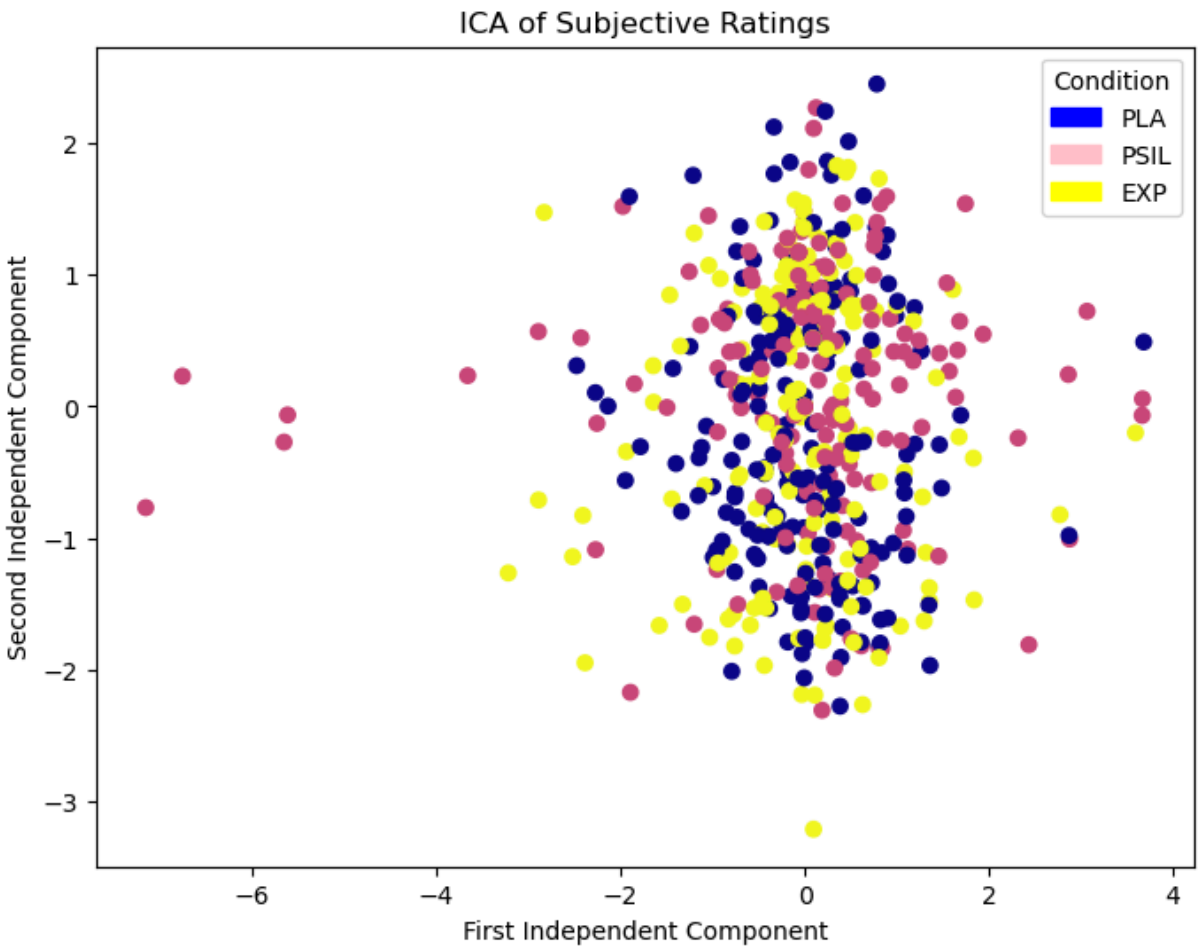
```
plt.figure(figsize=(8, 6))
plt.scatter(X_ica[:, 0], X_ica[:, 1], c=df['Condition_encoded'], cmap='plasma')
plt.xlabel('First Independent Component')
plt.ylabel('Second Independent Component')
plt.title('ICA of Subjective Ratings')
#plt.colorbar(label='Condition (PLA, PSIL, EXP)')
nd_handles = [mpatches.Patch(color='blue', label='PLA'),
```

```
                   mpatches.Patch(color='pink', label='PSIL'),
                   mpatches.Patch(color='yellow', label='EXP')]
plt.legend(handles=legend_handles, title='Condition')
plt.show()
```



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