BRSM Homework Assignment

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from scipy import stats
import pandas as pd
import numpy as np
import statsmodels.api as sm
from statsmodels.formula.api import ols
from statsmodels.stats.multicomp import pairwise_tukeyhsd
from statsmodels.stats.anova import AnovaRM

# Load the Excel file
file_path = "ANOVA practice data.xlsx"
xls = pd.ExcelFile(file_path)

# Load memory scores
memory_scores_df = pd.read_excel(xls, sheet_name="memory scores",
skiprows=1, usecols="A:C")
memory_scores_df.columns = ["Regular Children", "Children with
Autism", "Children with Epilepsy"]
memory_scores_clean = memory_scores_df.dropna()

# One-Way ANOVA for memory scores
anova_memory = stats.f_oneway(memory_scores_clean["Regular Children"],

                              memory_scores_clean["Children with
Autism"],
                              memory_scores_clean["Children with
Epilepsy"])

print(f"Memory Scores ANOVA p-value: {anova_memory.pvalue}")

# Post hoc analysis (Tukey's HSD) if significant
if anova_memory.pvalue < 0.05:
    memory_melted = memory_scores_clean.melt(var_name="Group",
value_name="Score")
    tukey_memory = pairwise_tukeyhsd(memory_melted["Score"],
memory_melted["Group"])
    print(tukey_memory)

# Load driving ability scores
driving_scores_df = pd.read_excel(xls, sheet_name="driving ability",
skiprows=1, usecols="A:C")
driving_scores_df.columns = ["1 Night Deprivation", "2 Nights
Deprivation", "3 Nights Deprivation"]
driving_scores_clean = driving_scores_df.dropna()
```

```python
# One-Way ANOVA (Condition 2: Different People)
anova_one_way = stats.f_oneway(driving_scores_clean["1 Night
Deprivation"],
                               driving_scores_clean["2 Nights
Deprivation"],
                               driving_scores_clean["3 Nights
Deprivation"])

print(f"Driving Ability One-Way ANOVA p-value:
{anova_one_way.pvalue}")

# Post hoc analysis (Tukey's HSD) if significant
if anova_one_way.pvalue < 0.05:
    driving_melted = driving_scores_clean.melt(var_name="Condition",
value_name="Score")
    tukey_driving = pairwise_tukeyhsd(driving_melted["Score"],
driving_melted["Condition"])
    print(tukey_driving)

# Repeated Measures ANOVA (Condition 1: Same People)
num_subjects = driving_scores_clean.shape[0]
driving_melted["Subject"] = np.tile(np.arange(num_subjects), 3)

anova_rm = AnovaRM(driving_melted, depvar="Score", subject="Subject",
within=["Condition"]).fit()
print(anova_rm.anova_table)

# Effect Size Calculation (η² for One-Way ANOVA)
SS_between = anova_one_way.statistic * (driving_scores_clean.shape[0]
- 3)
SS_total = sum([sum((driving_scores_clean[col] -
driving_scores_clean[col].mean())**2) for col in
driving_scores_clean.columns])
eta_squared = SS_between / SS_total
print(f"Effect Size (η²): {eta_squared}")
```

```
Memory Scores ANOVA p-value: 4.831350364781915e-08
                Multiple Comparison of Means - Tukey HSD, FWER=0.05

=============================================================================
==============
        group1                 group2         meandiff p-adj   lower
upper  reject
-----------------------------------------------------------------------------
--------------
  Children with Autism Children with Epilepsy  14.3889    0.0  8.2842
20.4935   True
  Children with Autism       Regular Children  15.7778    0.0  9.6731
21.8824   True
Children with Epilepsy       Regular Children   1.3889 0.8473 -4.7158
```

```
7.4935  False
------------------------------------------------------------------------
--------------
Driving Ability One-Way ANOVA p-value: 1.1305349928649485e-23
              Multiple Comparison of Means - Tukey HSD, FWER=0.05

========================================================================
==========
       group1                group2        meandiff p-adj  lower
upper  reject
------------------------------------------------------------------------
----------
 1 Night Deprivation 2 Nights Deprivation     -3.7   0.0  -5.2977 -
2.1023   True
 1 Night Deprivation 3 Nights Deprivation    -11.4   0.0 -12.9977 -
9.8023   True
2 Nights Deprivation 3 Nights Deprivation     -7.7   0.0  -9.2977 -
6.1023   True
------------------------------------------------------------------------
----------
              F Value  Num DF  Den DF        Pr > F
Condition  178.017544     2.0    38.0  5.020250e-20
Effect Size (η²): 10.383841192049713
```

ANOVA Analysis: Memory Scores & Sleep Deprivation Impact on Driving Ability

Q1: Do Children with Neurodevelopmental Disorders Have Lower Memory Scores?

ANOVA Result:

- **p-value = 4.83×10^{-8} (Very Significant)**
- Since **p < 0.05**, we conclude that **memory scores significantly differ** among the groups.

Tukey HSD Post-Hoc Analysis:

Comparison	Mean Difference	p-value	Significant?
Children with Autism vs. Children with Epilepsy	**14.39**	**0.0**	Yes
Children with Autism vs. Regular Children	**15.78**	**0.0**	Yes

Comparison	Mean Difference	p-value	Significant?
Children with Epilepsy vs. Regular Children	**1.39**	**0.8473**	No

Interpretation:

- **Children with Autism have significantly lower memory scores** than both Regular Children and Children with Epilepsy.
- **No significant difference** between Regular Children and Children with Epilepsy.
- **Conclusion:** Neurodevelopmental disorders, especially autism, **impact memory scores significantly**.

Q2: What Extent of Sleep Deprivation Affects Driving Ability?

Condition 1 (Same People in All 3 Groups – Repeated Measures ANOVA)

- **F = 178.02, p-value = 5.02×10^{-20} (Extremely Significant)**
- Since **p < 0.05**, sleep deprivation **significantly affects driving ability**.

Condition 2 (Different People in All 3 Groups – One-Way ANOVA)

- **p-value = 1.13×10^{-23} (Extremely Significant)**
- Since **p < 0.05**, driving ability **differs significantly** across sleep deprivation levels.

Tukey HSD Post-Hoc Analysis:

Comparison	Mean Difference	p-value	Significant?
1 Night vs. 2 Nights Deprivation	**-3.7**	**0.0**	Yes
1 Night vs. 3 Nights Deprivation	**-11.4**	**0.0**	Yes
2 Nights vs. 3 Nights Deprivation	**-7.7**	**0.0**	Yes

Effect Size (η^2) = 10.38 (Very High)

- A very high **η^2** value suggests that **sleep deprivation strongly impacts driving ability**.

Interpretation:

- **Driving ability worsens significantly with increased sleep deprivation.**
- **Even 1 extra night of sleep loss causes a significant performance drop.**
- **3 Nights of Deprivation leads to the worst performance.**

Final Conclusion

1. **Children with Autism have significantly lower memory scores** than other groups.
2. **Sleep deprivation has a severe impact on driving ability**, with performance dropping significantly for **every additional night of deprivation**.
3. **Effect size ($\eta^2 = 10.38$) confirms that sleep loss has a very strong impact on driving ability.**
4. **Both within-subjects (Repeated Measures ANOVA) and between-subjects (One-Way ANOVA) confirm these findings.**