**The Relationship Between Superpowers and Intelligence in Avengers: A Statistical Analysis**

Tamar Gazit

Department of Psychiatry, Dalhousie University

PSYO 6003: Fundamentals of Applied Statistics and Research Design

Dr. Sandra Meier

February 16, 2025

**The Relationship Between Superpowers and Intelligence in Avengers: A Statistical Analysis**

This study examines whether Avengers with superpowers have higher intelligence (IQ) than those without. Given that superpowers may be associated with enhanced cognitive abilities, such as problem-solving and strategic thinking, it was hypothesized that superpowered Avengers would have higher IQ scores.

To test this hypothesis, an independent samples t-test compared IQ scores between superpowered and non-superpowered Avengers. A power analysis was conducted to ensure adequate sample size, and an equivalence test assessed whether IQ differences between groups were statistically negligible. Additionally, battlefield performance was analyzed by comparing combat effectiveness, kills, and injuries across locations. The study also examined variability in these measures to determine which was the least reliable.

**Methods, Results, and Discussion**

**Data Availability**

All data and analysis scripts used in this study are publicly available at the following GitHub repository: <https://github.com/tamargazit/Assignment1_Tamar.git>. This repository contains the cleaned dataset, statistical analysis scrips, and the final report to ensure transparency and reproducibility.

**Dataset**

The dataset initially included 814 Avengers. After removing missing data, the final sample consisted of 812 Avengers, of whom 780 did not have superpowers and 32 had superpowers. The key variables analyzed were IQ (dependent variable), superpower status (independent variable), combat effectiveness (sum of agility, speed, strength, and willpower), kill count, and number of injuries.

**IQ and Superpowers**

An independent samples t-test was conducted to compare IQ scores between Avengers with and without superpowers. Before conducting the analysis, two approaches were considered for estimating the required sample size: First, an a priori power analysis to determine the minimum sample size needed to detect a meaningful effect (Biau et al., 2008). This method would ensure adequate statistical power. Second, a literature-based approach was considered, using past research on cognitive differences in expert populations versus non-expert populations to estimate a reasonable effect size (Ericsson & Charness, 1994). The power analysis was chosen because it directly applies to hypothesis testing and compensates for the lack of empirical research on Avengers.

A power analysis was conducted using Cohen’s d = 0.5 (moderate effect size; Cohen, 1988), α = 0.05 (to maintain a 5% Type I error rate), and power = 0.80 (80% chance of determining a true effect; Cohen, 1988), determining that at least 64 participants per group (128 total) were required. However, only 32 Avengers with superpowers were available, making the study underpowered to detect a moderate effect with confidence.

The independent samples t-test yielded a statistically significant difference in IQ scores *t*(810) = 4.25, *p* < .001, indicating that Avengers with superpowers had higher IQ scores than Avengers without superpowers. The effect size was Cohen’s d = 0.30, with a 95% confidence interval of [0.16, 0.44], suggesting a small to moderate effect. While these findings provide some support for the hypothesis that superpowered Avengers have higher IQs, the small effect size suggests that the difference may not be practically meaningful (Ferguson, 2009). Moreover, the relatively wide confidence interval suggests some uncertainty in the precise magnitude of the effect. Thus, while the results confirm a statistical difference, the hypothesis that superpowers confer a meaningful advantage in intelligence remains inconclusive.

**Equivalence Testing**

Since the study was underpowered to detect a moderate effect, an equivalence test (TOST) was conducted to determine whether the IQ difference was small enough to be considered negligible (Lakens et al., 2018). The equivalence margin was set at d = ±0.2, following standard conventions for small effects in psychological research (Cohen, 1988). A power analysis was conducted using α = 0.05 (to maintain a 5% Type I error rate) and power = 0.80 (to ensure an 80% chance of correctly detecting equivalence), determining that at least 429 participants per group (858 total) were required. Because only 32 Avengers with superpowers were available, the study was underpowered for equivalence testing. As a result, even if the observed IQ difference were small, the data do not allow us to confidently conclude that superpowers have no meaningful effect on IQ.

**Battlefield Comparisons**

The dataset was subsetted to include only Avengers without superpowers who died, and combat effectiveness, kills, and injuries were analyzed by battlefield location. The subsetted dataset was saved in both CSV and SPSS formats.

Avengers on the North battlefield had slightly higher combat effectiveness scores (*M* = 499.78, *SD* = 174.07, Min = 130.68, Max = 897.06) than those on the South battlefield (*M* = 491.68, *SD* = 189.53, Min = 67.25, Max = 946.89). However, kills were higher in the South battlefield (*M* = 4.75, *SD* = 14.99, Min = 0, Max = 79) compared to the North battlefield (*M* = 1.71, *SD* = 4.57, Min = 0, Max = 34). Conversely, injuries were more frequent in the North battlefield (*M* = 4.60, *SD* = 0.68, Min = 2, Max = 5) compared to the South battlefield (M = 4.43, SD = 0.88, Min = 2, Max = 5). These results suggest that, while Avengers on the North battlefield were more effective in combat, they also sustained slightly more injuries than those in the South. The greater injury rate may reflect different tactical strategies, but further analysis would be required to determine the underlying cause.

Based on the standard deviation values in the overall subsetted sample, kills was the most erroneous variable in the mean model. The high standard deviation for kills (*SD* = 8.81) compared to combat effectiveness (*SD* = 177.56) and injuries (*SD* = 0.74) suggests that kills had the greatest individual variability and was the least reliable as a central tendency measure. This large variability indicates that some Avengers had exceptionally high kill counts, while others had few or none, making the mean a less stable representation of overall battlefield performance.

**Conclusion**

This study highlights the importance of sample size considerations and variability in interpreting statistical findings. While the observed IQ difference between superpowered and non-superpowered Avengers was statistically significant, its small effect size raises questions about its practical significance. The study’s power limitations also prevented definitive conclusions about whether superpowers meaningfully impact intelligence. Battlefield comparisons revealed differences in combat effectiveness and injuries, but variability in kills suggests that some measures may be less reliable indicators of performance. These findings underscore the need for robust study designs, adequate sample sizes, and careful selection of outcome variables to ensure meaningful and interpretable conclusions in psychiatric research.

**References**

Biau, D. J., Kernéis, S., & Porcher, R. (2008). Statistics in brief: the importance of sample size in

the planning and interpretation of medical research. *Clinical Orthopaedics and Related*

*Research*, *466*(9), 2282–2288. https://doi.org/10.1007/s11999-008-0346-9

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). L. Erlbaum

Associates.

Ferguson, C. J. (2009). An effect size primer: A guide for clinicians and researchers. Professional

Psychology: Research and Practice, 40(5), 532–538. https://doi.org/10.1037/a0015808

Ericsson, K. A., & Charness, N. (1994). Expert performance: Its structure and

acquisition. American Psychologist, 49(8), 725–747. https://doi.org/10.1037/0003-066X.49.8.725

Lakens, D., Scheel, A. M., & Isager, P. M. (2018). Equivalence testing for psychological

research: A tutorial. Advances in Methods and Practices in Psychological Science, 1(2),

259–269. https://doi.org/10.1177/2515245918770963