Assignment #1

By

Pierre-Olivier Couture

Dr. Sandra Meier

PSYR 6003 Fundamentals of Applied Statistics

Dalhousie University

16 Feb 2025

**Methods**

An observational, cross-sectional study was conducted in a sample of *N* = 814 Avengers to examine the relationship between superpower status and their IQ. Incomplete cases or those with invalid data were excluded to ensure the validity of the results. The survey collected data about the respondent's superpowers as a categorical variable of "yes" or "no" with the dependent variable IQ being measured by a standardized short form of the Wechsler Adult Intelligence Scale (Donnell et al., 2005). A composite variable called "Combat Effectiveness" was created, which summed up agility, speed, strength, and willpower. An *a priori* power analysis was conducted in R using the *pwr.t.test* function to determine the sample size required to detect a small effect size (Cohen's *d* = .2) with an independent samples t-test (Champely, 2020; R Core Team, 2023). A small effect size (Cohen's *d* = 0.2) was chosen based on the smallest effect size of interest (SESOI)—the smallest effect size considered relevant for the study. An alpha level of .05 and a statistical power of 0.8 were used and indicated that 394 participants were required per group (i.e., a total sample size of 788 participants) would be required to achieve sufficient power to detect the expected effect size. Beyond the power analysis, no additional justification for the sample size was available as no prior research compared the IQ of Avengers with and without superpowers. Because this is an exploratory study, there was no established precedent or heuristic to determine an ideal sample size beyond standard power considerations. It is hypothesized that Avengers with superpowers will have a higher IQ than those without superpowers. Results will be interpreted in the context of superhero cognitive abilities and potential training implications for non-superpowered Avengers.

**Results**

A total of *N* = 814 Avengers started the survey, and *n* = 2 participants were removed from the analysis for providing invalid data or not completing all the questions, leaving our final participant total as *N* = 812.

**Battlefield Comparison**

The sample had a mean combat effectiveness of *M* = 615.02 (*SD* = 160.77), ranging from 67.25 to 1587.85. The North battlefield had a mean of *M* = 610.74 (*SD* = 156.14), ranging from 130.68 to 990.91, while the South battlefield had a higher mean (*M* = 619.30, *SD* = 165.34), with a range from 67.25 to 1587.85.

The mean number of injuries in the overall sample was *M* = 3.49 (*SD* = 1.26), ranging from 0 to 5. The North battlefield had a mean of *M* = 3.80 (*SD*=1.20), ranging from 0 to 5 injuries, while the South battlefield had a mean of *M* = 3.18 (*SD*=1.25), within the same 0 to 5 range.

The overall sample had a mean of *M* = 3.83 (*SD*=10.79), ranging from 0 to 176 kills. The South battlefield had a higher mean number of kills (*M* = 4.43, *SD* = 9.58) compared to the North battlefield (*M* = 3.23, *SD* = 11.85), with a broader range from 0 to 79 kills in the South, compared to 0 to 34 kills in the North.

**Superpower and IQ**

An independent samples t-test was executed to see if superpower status affected IQ. The t-test results calculated were significant, t(YES + NO - 2) = 4.25, p < .05. The group who did not have a superpower had *n* = 780 participants while the group with superpowers only had *n* = 32 participants. The effect size, as measured by Cohen's d, was *d* = 0.30 with a 95% confidence interval from 0.16 to 0.44. Based on Cohen (1988), this is categorized as a small effect size, and the calculated Cohen's d can be interpreted as precise as both ends of the 95% confidence intervals are within the small effect size qualitative label.

To ensure that the study has enough power to confirm whether there truly is no difference between the groups (zero effect), a power analysis was performed using equivalence bounds of -0.2 and 0.2, which are appropriate for the smallest effect size of significance, which is what we sought to examine. The power analysis revealed that a sample size of *n =* 429 participants per group (or *N* = 858 in total) would be required to achieve 80% power with a Cronbach's alpha value of .05. This ensures that the study would be adequately powered to confirm whether a meaningful difference exists between the groups if one truly exists.

**Conclusion**

This study's findings shed light on the most effective battlefield for Avengers and the effect of superpowers (or lack thereof) on IQ. From the analysis, it was determined that the South battlefield had greater combat effectiveness (*M* = 619.30, *SD* = 165.34) than the North battlefield (*M* = 610.74, *SD* = 156.14); thus, we conclude that the South battlefield was more effective in combat. This is further supported by the South battlefield having a higher mean "kills" score (*M* = 4.43, *SD* = 9.58), which is superior to the North battlefield (*M* = 3.23, *SD* = 11.85). Along these lines, the North battlefield had a higher mean number of injuries (*M* = 3.80, *SD* = 1.20) than the South battlefield (*M* = 3.18, *SD* = 1.25). The conclusion is that the South battlefield was more hostile to the enemy, scoring higher on average number of kills and broader range in kills; thus, we conclude that the South battlefield was the most effective in combat.

Among the three variables examined—combat effectiveness, kills, and injuries—it was determined that 'kills' was the most erroneous due to its large range from 0 to 176 and its large standard deviation of 10.79.

Our secondary data analysis aimed to explore the relationship between superpowers and IQ in this same sample of Avengers. The hypothesis that Avengers with superpowers would have a higher average IQ than those without was supported, with a small but significant effect size (Cohen's *d* = 0.30, 95% CI [0.16, 0.44], p < .05). A power analysis confirmed that the study had sufficient statistical power to detect meaningful differences between the two groups which ensures the reliability of the findings. These results are the first to examine the link between an Avenger's superpowers (or lack thereof) and their IQ, and this may have implications for future Avengers training to help better select those with and without superpowers.

**References**

Champely, S. (2020). pwr: Basic functions for power analysis (R package version 1.3-0). <https://CRAN.R-project.org/package=pwr>

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Routledge. <https://doi.org/10.4324/9780203771587>

Donnell, A. J., Pliskin, N., Holdnack, J., Axelrod, B., & Randolph, C. (2005). Rapidly administered short forms of the Wechsler Adult Intelligence Scale—3rd edition. *Archives of Clinical Neuropsychology*, 22(4), 917–924. <https://doi.org/10.1016/j.acn.2007.06.007>

R Core Team. (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing. <https://www.R-project.org/>