Studying the Impact of Virtual Reality on Sports: An Experimental Study

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Research Question Does practicing throwing darts in a virtual reality setting cause an increase in performance (score) of throwing darts in real life?

Hypothesis Participants who practice throwing darts in virtual reality will perform better in subsequent real-world dart-throwing tests than participants who do not receive virtual reality-based training.

Introduction A rapidly developing technology, virtual reality (VR) has become more and more common in a variety of industries, including entertainment, education, and healthcare. Researchers have recently begun investigating VR's potential for improving athletic ability. Darts, a game that demands a high degree of accuracy and precision, is one such activity that has caught the interest of researchers.

We wanted to find out how VR affected the accuracy of dart throwing, so we conducted this research to find that out. We were particularly interested in determining whether a more immersive and realistic training setting could help a person throw darts more accurately. To accomplish this, we carried out an experimental study in which participants completed a series of dart-throwing tasks after being randomly assigned to either a VR or non-VR group.

We hope that this study will add to the increasing body of knowledge on the potential of VR in sports performance development. Our results may be useful to athletes, coaches, and trainers who are searching for cutting-edge approaches to enhance performance in a variety of sports, including archery.

Methodology

Procedure For our experiment, we acquired a dartboard(international standard) and dart software that emulated a real-life setting on our Virtual Reality Equipment. The treatment group was subjected to the VR practice session, where they threw three darts in the virtual setting and then threw three darts on the actual dartboard. The control group only threw darts on the real dartboard with no VR exposure. Both treatment and control were conducted in the same setting and environment and conducted simultaneously to make sure no other variables could hamper the experiment. The participants were asked to aim

Participants were instructed to aim for the bulls eye, and points were given according to how closely they came to hitting the target's center. Participants who hit the bulls eye directly got the highest score because it was worth the most points. Using the bullseye as a gauge of accuracy made it possible to compare each participant's success in the experiment on a consistent basis.

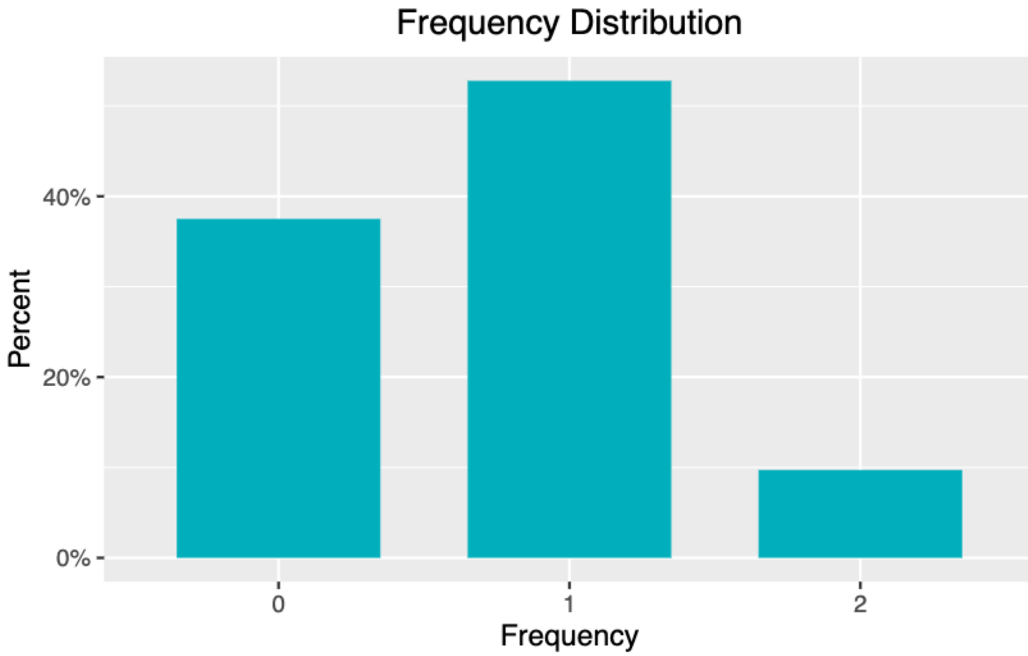
```
dataset <- fread('DART.csv')
colnames(dataset)[6] <- "frequency"
colnames(dataset)[7] <- "head_tail"
colnames(dataset)[8] <- "test"
colnames(dataset)[9] <- "throw1"
colnames(dataset)[10] <- "throw2"
colnames(dataset)[11] <- "throw3"

for (col in c("Degree", "Gender", "Age", "frequency", "head_tail")) {
  dataset[[col]] <- as.factor(dataset[[col]])
}

dataset$total_score <- dataset$throw1 + dataset$throw2 + dataset$throw3
dataset$accuracy <- dataset$total_score / 30
dataset$accuracy <- round(dataset$accuracy, 5)
data_treatment <- dataset[test == 1]
data_control <- dataset[test == 0]

ggplot(dataset, aes(x=frequency)) +
  geom_bar(aes(y = (..count..)/sum(..count..)), width = 0.7, fill = "#00AFBB") +
  scale_y_continuous(labels = scales::percent_format()) +
  ggtitle("Frequency Distribution") +
  xlab("Frequency") +
  ylab("Percent") +
  theme(plot.title = element_text(hjust = 0.5))
```

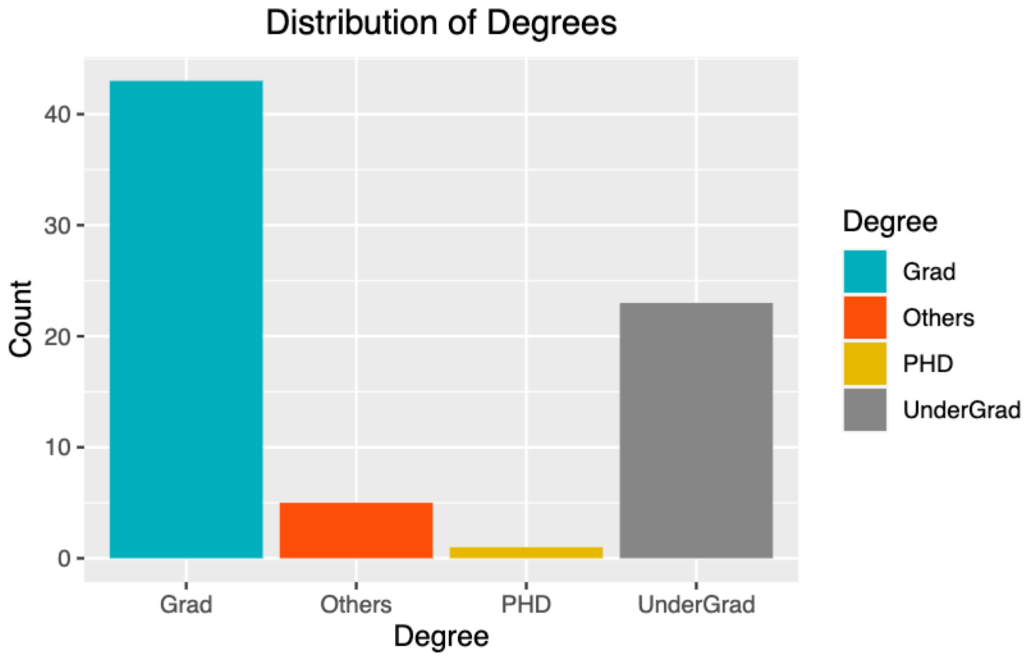
```
Warning: The dot-dot notation (`..count..`) was deprecated in ggplot2 3.4.0.
i Please use `after_stat(count)` instead.
```



From the participants (0=Never Player,1=PlayedOften 2=RegularPlayers), The above graph shows most of the participants have played darts few times before (Value 1)

```
library(ggplot2)

ggplot(data = dataset, aes(x = Degree, fill = Degree)) +
  geom_bar() +
  ggtitle("Distribution of Degrees") +
  xlab("Degree") +
  ylab("Count") +
  scale_fill_manual(values = c("#00AFBB",
                                        "#FC4E07",
                                        "#E7B800",
                                        "#868686", "#FF7F0F", "#8DA0CB")) +
  theme(plot.title = element_text(hjust = 0.5))
```



Above graph shows us the varied departments, that are participant were from. This represents good variance between Grad, PHD, UnderGrad & Others.

The points scored were computed as follows: If the dart landed between the double ring and the triple ring, it was deemed as one point. If the dart landed between the triple ring and the bull's eye, it was considered as three points. If the dart landed on the bull's eye, it was counted as ten points. If the dart landed outside the double ring, it was considered as zero points.

Participants The participants in this research were chosen and assigned to the treatment and control group at random from a large group of students and faculty in a busy common area at Questrom. Along with faculty employees, the sample included undergraduate, graduate, and PhD pupils. The degree of dart playing proficiency among the participants ranged from beginner to expert.

We classified a beginner to be a person who had never played darts before, intermediate to be someone who plays darts a few times in a month and an expert to be someone who practices darts very frequently.

Randomization Simple and complete

We conducted our experiment in person and randomized on an individual level. In order to decide which participants would be in treatment or control we used simple randomization. We used a fair coin and tossed it for each participant. Tails was assigned to Treatment and Heads was assigned to control. Even though we did not intend to enforce complete randomization, we had an equal split of participants between treatment and control group. Therefore we had 50% in treatment and 50% in control.

Randomization check The p-value is a probability value that is used in hypothesis testing to determine whether the observed results of a study are statistically significant, or whether they could have occurred by chance alone.

```r
#Randomization Check
prop.test(dataset[test == 1, .N], 72, 0.5)
```

```
	1-sample proportions test without continuity correction

data:  dataset[test == 1, .N] out of 72, null probability 0.5
X-squared = 0, df = 1, p-value = 1
alternative hypothesis: true p is not equal to 0.5
95 percent confidence interval:
 0.3874709 0.6125291
sample estimates:
  p
0.5
```

We can see that, the p-value > 0.05, we fail to reject the null hypothesis. This means that we do not have sufficient evidence to conclude that the true proportion is different from 0.5. The 95 % CI for the true proportion is (0.3874709, 0.6125291). This means that, we can be 95 percent confident that the true proportion falls within this interval. The sample estimate of the proportion is 0.5, which is exactly the null hypothesis value. Hence, the randomization was done properly.

In the context of our study, comparing the treatment group and a control group, a p-value would typically be calculated to assess whether there is a significant difference between the two groups in terms of the outcome being measured. .

We ran a p test and got a value of 1. Since 50% of the participants were in the control group and 50% were in the treatment group, we received a complete randomization which suggests that there is no significant difference between the treatment and control groups

Data Analysis We can use the available data to conduct various regression analyses to examine the performance of our participants in different ways in the dart experiment. We can begin with a simple regression analysis to investigate the impact of being in the treatment group (using the virtual reality technology) on the dart-throwing score. By running the regression, we can obtain insights into the main effect we are researching and determine the significance of the treatment on the participants' performance.

```r
model_reg <- lm(accuracy ~ test, data = dataset)
summary(model_reg)
```

```
Call:
lm(formula = accuracy ~ test, data = dataset)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.17870 -0.05463 -0.02130  0.05463  0.25463 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
```

```
(Intercept)  0.15463    0.01581   9.783 9.87e-15 ***
test         0.02407    0.02235   1.077    0.285
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09484 on 70 degrees of freedom
Multiple R-squared:  0.0163,    Adjusted R-squared:  0.002247
F-statistic:  1.16 on 1 and 70 DF,  p-value: 0.2852
```

From above we see that the test has a coefficient of 0.024 which indicates that there is a +ve coorelation between test and accuracy. However the results are not statistically significant. This is mainly because the data set is quite small and there is comparatively high variance in the dataset.

```r
model_reg <- lm(accuracy ~ test + frequency + Gender + Degree , data = dataset)
summary(model_reg)
```

```
Call:
lm(formula = accuracy ~ test + frequency + Gender + Degree, data = dataset)

Residuals:
      Min        1Q    Median        3Q       Max
-0.188973 -0.064184 -0.001149  0.051239  0.277812

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      0.1422762  0.0256387   5.549 5.88e-07 ***
test             0.0132414  0.0240538   0.550    0.584
frequency1      -0.0064747  0.0259003  -0.250    0.803
frequency2      -0.0319734  0.0434511  -0.736    0.465
GenderM          0.0330484  0.0250365   1.320    0.192
DegreeOthers     0.0467808  0.0479029   0.977    0.332
DegreePHD        0.1509572  0.1000999   1.508    0.136
DegreeUnderGrad  0.0004066  0.0265816   0.015    0.988
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09587 on 64 degrees of freedom
Multiple R-squared:  0.08097,   Adjusted R-squared:  -0.01955
F-statistic: 0.8055 on 7 and 64 DF,  p-value: 0.5858
```

From the above, we add covariats to the previous regression model & we see, the coefficient for test goes down to 0.0132, however the results are still not statistical significant, since there is no increase in dataset.

```r
model_reg <- lm(throw2 ~ test, data = dataset)
summary(model_reg)
```

```
Call:
lm(formula = throw2 ~ test, data = dataset)

Residuals:
    Min      1Q  Median      3Q     Max 
-2.1111 -1.1111 -0.3889  0.8889  1.6111 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   1.3889     0.1993   6.968 1.43e-09 ***
test          0.7222     0.2819   2.562   0.0126 *  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.196 on 70 degrees of freedom
Multiple R-squared:  0.08574,   Adjusted R-squared:  0.07268 
F-statistic: 6.565 on 1 and 70 DF,  p-value: 0.01256
```

Here we see, the coefficient of test is 0.7222 & is statistically significant. However in this case this seems to be one of the cases where we a statistically significant p value just by chance, reason being the variance of the data is still the same & the values for throw 1 & throw 3 are still statistically not significant.

Limitation Sample Size: Because the sample size was only 72 it might not be representative of the entire population and it may be too small to draw meaningful conclusions or make generalizations.

Self-reported dart-throwing experience may not be accurate: The subjects were asked to self-report their knowledge of throwing darts. Individuals' perceptions of their own skill level or practice habits might not always be correct. Someone who considers themselves to be a regular player may only play once a month. This variation in self-reported experience may have an influence on the findings and make it more difficult to draw definitive conclusions about how the VR system affects dart throwing performance.

Equipment limitations: The VR equipment used in the experiment may not accurately simulate the weight and feel of a real dart, which could affect participants' performance in the virtual and real settings.

Conclusion In the experiment, we wanted to see the potential benefits of using virtual reality technology to improve dart-throwing skills.