What Type of Interpersonal Competition Is Most Effective Among Overlake High School Students?

By Kristin Lacy and Toby Sinclair

Introduction:

Competition. America thrives on it, but how are we best motivated, what makes us compete at the highest level? Is it the will to be better than our close friends, or to just be the best? This is the question core to our experiment: Will competing against a close friend or will beating a fastest time push someone to do a maze faster?

Research showing that competition can improve motivation dates all the way back to 1898, when psychologist Norman Triplett discovered that a cyclist will ride faster when there is another cyclist present. Gavin J. Kilduff argues that "how we behave in competition situations depends on our relationship and history of interaction with our opponent" (Driven to Win: Rivalry, Motivation, and Performance. Social Psychological and Personality Science). This experiment was done to compare rival and nonrival competition among the adult population and whether the presence of rivalry was associated with increased motivation and performance. We are curious if just simply having someone you know or, having an impersonal entity to beat will produce significantly different results.

Statistical Question:

Is there a significant difference between personal and impersonal competition among ninth to eleventh grade Overlake Highschool students?

Methods/Data Collection:

To collect data, we approached volunteers and asked if they wanted to participate in our experiment (see script for phrasing). The volunteers we approached were sitting next to each other. If the volunteers said yes, we used a coin flipping simulator to flip a coin. *Note that with them sitting together the assumption was made that the volunteers knew each other. This was done so if they were assigned to Treatment Two there would be an element of personal*

competition. We took volunteers from a range of different locations on the campus in order to diversify our pool of volunteers to make sure that we got ninth to eleventh high school students from a variety of demographics. If the coin lands on heads they were assigned to treatment one. If the coin landed on tails they were assigned to treatment two.

- Treatment 1: Each volunteer is split up out of the line of sight of the other and is told the current fastest time is eighteen seconds (see appendix), they are told they will be timed and to say when they are finished.
- Treatment 2: Volunteers are put back to back and told to compete against each other, they are told that they will be timed, to continue even if the other finishes, and to say when they are finished.

The "Current fastest" time of eighteen seconds for Treatment One was chosen after a test group of three people did the maze. The lowest score was chosen and one second was subtracted from the time. This one second subtraction was done to make the time both feasible and competitive. The maze used was a 16 x 16 orthogonal maze designed by a maze generating website, and each volunteer had the same maze. This maze size was chosen because it seemed challenging but also seemed as though it could be done in a reasonable amount of time to ask of the volunteers.

Randomization of treatments was the only source of randomization used in the experiment. The time it took to complete the maze was recorded using iPhone stopwatches. Regarding Treatment One, the same statistician moved away from the area each time, and let the volunteers decide which volunteer went out of line sight of the other. Regarding Treatment Two, whichever volunteer was closer to a statistician was the volunteer the statistician timed. Once each maze was completed, their times where recorded in seconds. Every volunteer only did the maze once,

had not seen another person do the maze, and the purpose of the experiment had not been explained to them previously.

Math:

Treatment 1: Each volunteer is split up (out of the line of vision and hearing) and competes against the time of eighteen seconds.

Treatment 2: Volunteers are put back to back and compete against each other.

Two Sample t-test for $\mu_{\text{Treatment 1}}-\mu_{\text{Treatment 2}}$ at $\alpha = .05$

$$H_o = \mu_{\text{Treatment 1}} - \mu_{\text{Treatment 2}} = 0$$

$$Ha = \mu_{\text{Treatment 1}} - \mu_{\text{Treatment 2}} \neq 0$$

Conditions

- Random assignment

Random assignment to treatments was done with the method of using a coin flipping application if heads, the volunteers were assigned to treatment one, and on tails the volunteers were assigned to treatment two. Treatment was chosen after group was determined.

- Large counts
    - For both data sets our sample sizes (n = 30 for Treatment One and n = 38 for Treatment Two) are greater than or equal to 30, which means both satisfies the Central Limit Theorem. Because both data sets meet the Central Limit Theorem we can assume that both of our sampling distribution for means of our Treatments are approximately normal.
- Independent
    - Volunteers only participated once and were only chosen from groups who had not observed any previous trials. Volunteers were also taken from a variety of groups

in an attempt to decrease the likelihood that any prior subject talked about the experiment with possible future subjects.

Our experiment meets both the Random and Large counts condition, with these conditions met we can proceed with the Two Sample t-test for $\mu_{\text{Treatment 1}}-\mu_{\text{Treatment 2}}$ at $\alpha = .05$. Because of our random assignment of treatments, we can make a valid inference about the cause and effect between competition type and time.

Treatment 1	Treatment 2
$\bar{x}_1 = 22.8103$	$\bar{x}_2 = 25.5010$
$s_{x1} = 13.1820$	$s_{x2} = 13.4032$
n = 30	n = 38
Min 7.99	Min 9.36
Q1 15.01	Q1 17.42
Median 18.415	Median 22.94
Q3 23.97	Q3 29.45
Max 62.15	Max 91.91

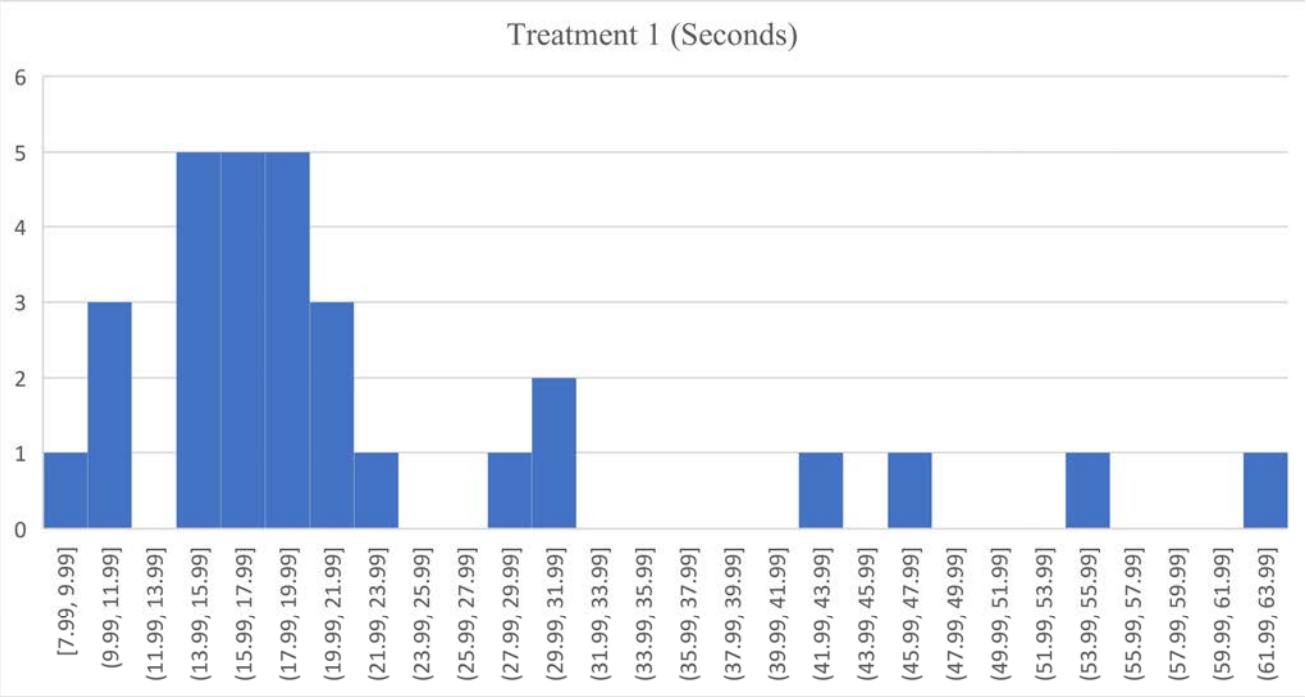
$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{{s_{x1}}^2}{n_1} + \frac{{s_{x2}}^2}{n_2}}}$$

$$t = \frac{(22.8103 - 25.5010) - (0)}{\sqrt{\frac{13.1820^2}{30} + \frac{13.4032^2}{38}}}$$

$$t = -.829591$$

P-value = 0.40991

Degrees of Freedom = 30 - 1 = 29


Treatment 1 (Seconds)
6
5
4
3
2
1
0
[7.99, 9.99]
(9.99, 11.99]
(11.99, 13.99]
(13.99, 15.99]
(15.99, 17.99]
(17.99, 19.99]
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(21.99, 23.99]
(23.99, 25.99]
(25.99, 27.99]
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(43.99, 45.99]
(45.99, 47.99]
(47.99, 49.99]
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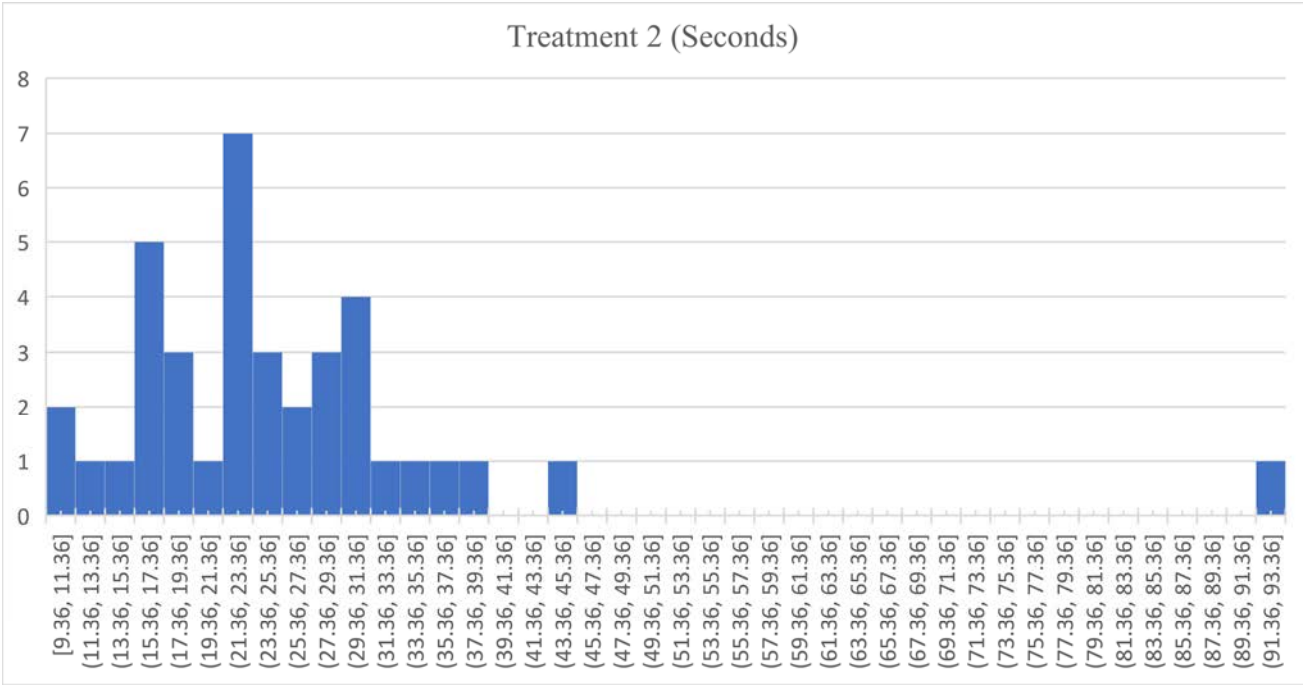
(51.99, 53.99]
(53.99, 55.99]
(55.99, 57.99]
(57.99, 59.99]
(59.99, 61.99]
(61.99, 63.99]


Treatment 2 (Seconds)
8
7
6
5
4
3
2
1
0
[9.36, 11.36]
(11.36, 13.36]
(13.36, 15.36]
(15.36, 17.36]
(17.36, 19.36]
(19.36, 21.36]
(21.36, 23.36]
(23.36, 25.36]
(25.36, 27.36]
(27.36, 29.36]
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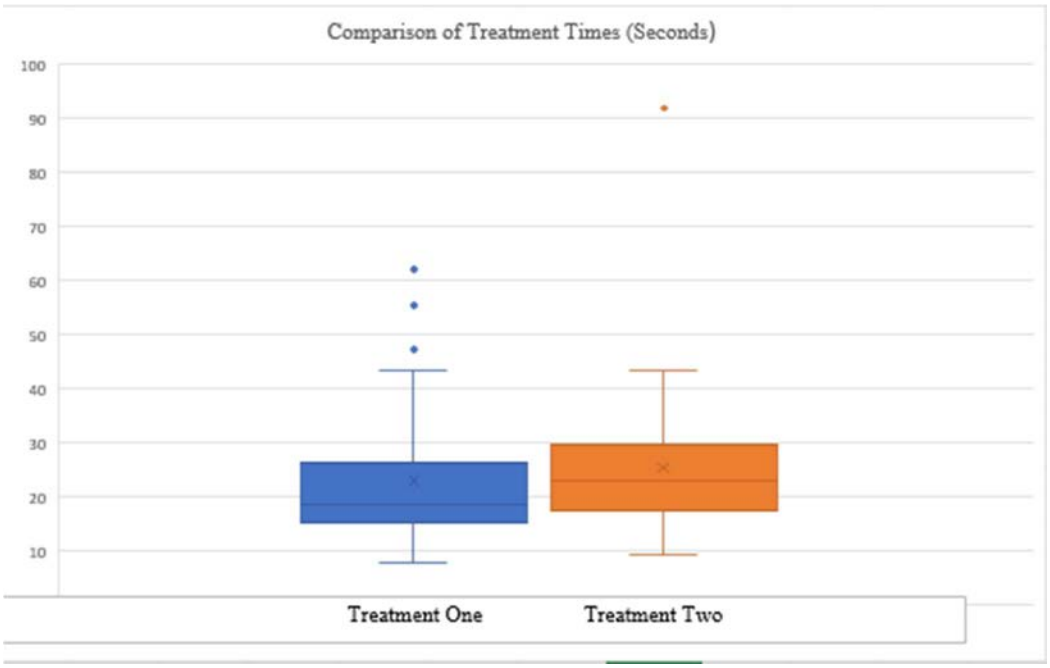

Observations of data:

We observed that both treatments' data are right skewed, and both have outliers significantly beyond an acceptable range to the right. Treatment one has three outliers, while Treatment two only has one, but treatment two's outlier is much farther out of the IQR * 1.5 boundary. Treatment one is centered at about 18.42 seconds, while Treatment two is centered around 22.94 seconds. Treatment two has a larger spread than Treatment One. Treatment one has a spread of 7.99 to 63.99, Treatment two has a spread from 9.36 to 91.91.

Conclusion:

Because the p-value of .40991 is significantly higher than the alpha level of 0.05 and all other common alpha levels, we fail to reject the null hypothesis. We do not have any convincing evidence that there is a difference between personal and impersonal competition. Therefore, we cannot conclude that ninth to eleventh Overlake High School Students can perform faster in one type of competition over the other. Due to the population we sampled, the results of this

experiment only have a scope of inference of nine to eleventh grade students at The Overlake School, but this data could possibly be applicable to other independent high schools.

Reflection:

Throughout the project, everyone we asked agreed to participate, so we had no nonresponse bias. Challenges occurred with the number of people we had to ask because we had to have enough volunteers in order for the Central Limit Theorem to apply in order to satisfy our large counts condition for inference, which could not be satisfied by an approximately normal distribution of our data due to large outliers causing a rightwards skew. A way we could have improved our experiment would have been randomization of who timed which volunteer. Another way we could have improved our experiment would have been telling the volunteers which side (top or bottom) they had to start the maze on. A way we could have done this is more specific instructions.

Another way to improve our experiment could have been moving both people to separate rooms in Treatment One because there could have been bias of only one volunteer being in a new environment. On a similar thread we could have had a more controlled environment for both treatments as we had the volunteers complete the maze in the environment they were in, regardless of the conditions. A more controlled environment could remove some confounding variables, such as noise levels, light levels and people in the vicinity. These location-based problems could not be feasibly fixed due to the layout of the campus and lack of available rooms.

Citations:

Van Yperen and Leander, "The Overpowering Effect of Social Comparison Information" (*Personality and Social Psychology Bulletin*, May 2014)

Depiction of Competition. August 2, 2016. Photograph. Accessed May 30, 2018. http://anthillonline.com/why-i-embrace-competitionand-you-should-too/.

Kilduff G. J. (2014). Driven to Win: Rivalry, Motivation, and Performance. Social Psychological and Personality Science. DOI: 10.1177/1948550614539770

Appendix:

Script to ask students to participate: Do you two have a few moments to participate in a maze competition for our statistics experiment?

Script said if volunteers were assigned to treatment one:

We would like for you to compete in a maze competition. Our current best score for this maze is eighteen seconds. Try to beat this score. You are competing against this time. I will time you. Say when you are done. Start now.

Script said if volunteers were assigned to treatment two:

Please sit back to back. We would like for you both to compete against each other in a maze competition, you will both have the same maze. Please continue the maze even if one of you has finished. You are competing against each other. I will time you. Say when you are done. Start now.

Pairing	Treatment One (Seconds)	Treatment Two (Seconds)
1	15.53	21.42
1	16.51	30.86
2	47.38	16.95
2	55.52	35.92
3	7.99	34.6
3	19.23	37.5
4	16.09	13.33
4	31.78	21.85
5	18.23	25.57
5	21.38	17.26
6	21.9	22.83
6	17.68	16.03
7	14.63	17.88
7	21.88	30.16
8	14.95	29.45
8	15.01	27.68
9	30.86	22.15
9	43.56	16.96
10	10.19	14.68
10	18.62	25.23
11	17.56	17.42
11	18.69	9.36
12	18.6	30.46
12	11.03	24.36
13	29.23	25.75
13	17.38	20.16
14	23.96	32.48
14	62.15	28.72
15	14.83	17.69
15	11.96	29.03
16		21.9
16		23.05
17		11.08
17		16.55
18		22.5
18		43.55
19		91.91
19		24.76

16 by 16 orthogonal maze