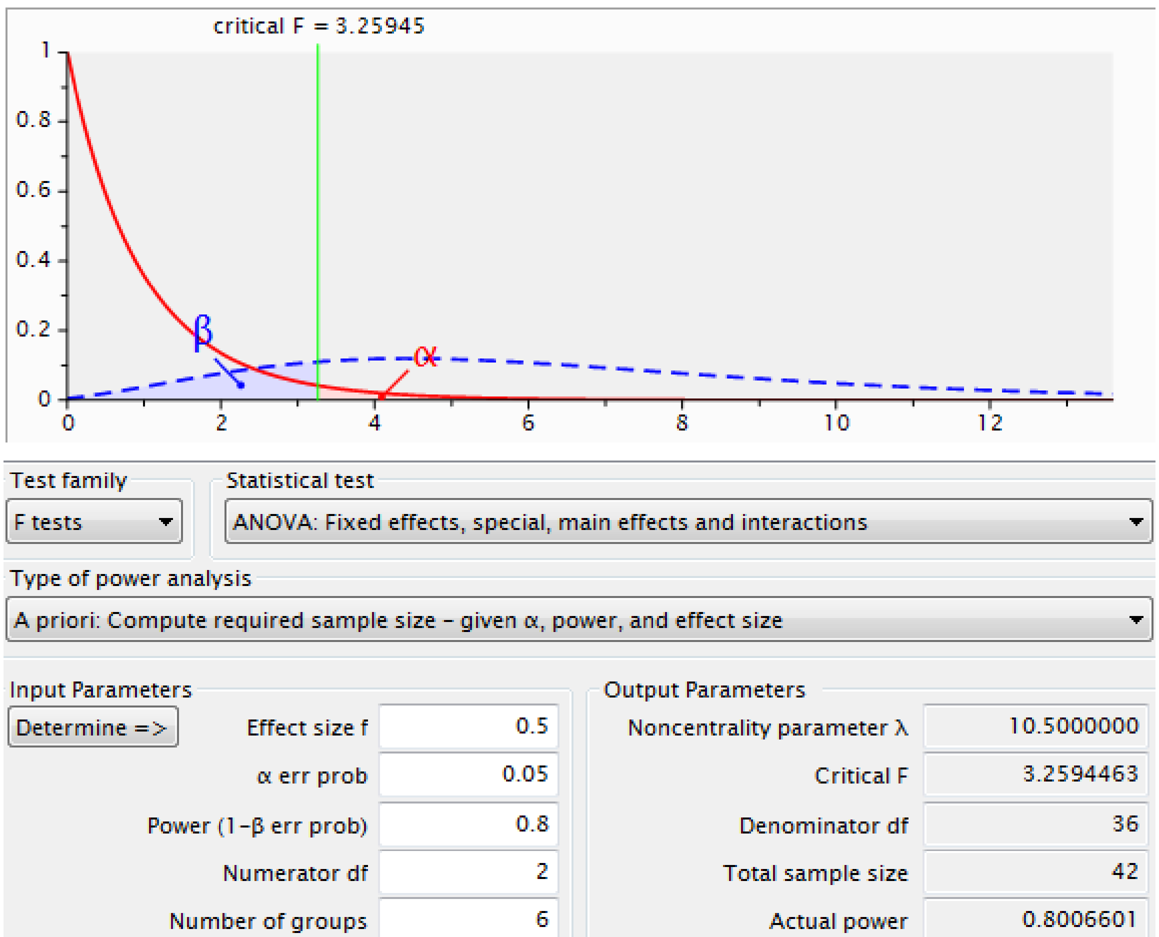
Xiaoyu Wang



Sample size: 42 subjects

```
> sd(projectdata$time)
[1] 5.416068
```

According to our data, our standard deviation is roughly 5.4. When we observe the interaction plot graph, the mean difference is expected to be 2.7 seconds as the significant increase in outdoor 100m running after getting treatment. This means that the effect size that we are looking for is 0.5.

However, we want the effect size to be small, because we want to be able to determine if our experiment work even a little bit. And also, we want the sample size to be small so that we do not need to spend too much time on too many subjects. Eventually, we set our effect size on d=0.5 and power=0.8. Then, we will have approximately 42 subjects in total according to the G power calculation.

After computing the power calculation, we decide to have 42 samples in total, and each block has 7 samples randomly assigned. According to our preliminary data, the required sample size is strongly correlated to our pre-analysis.

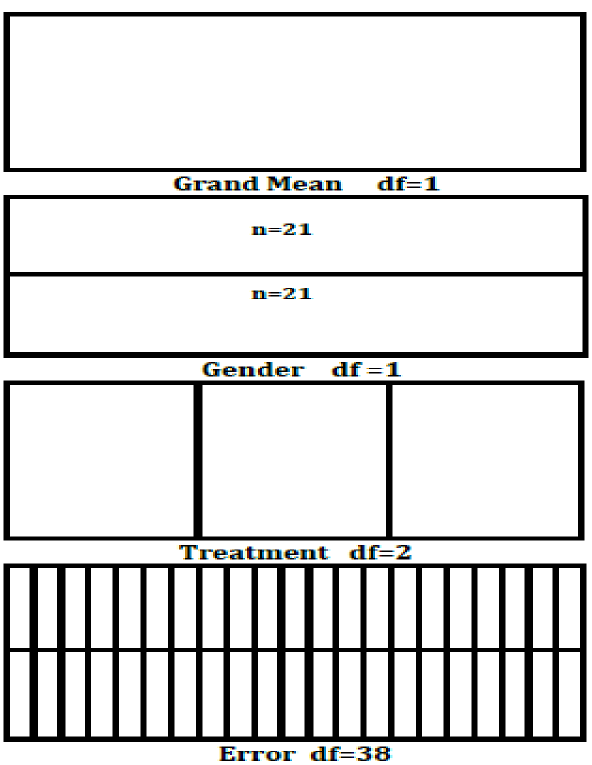
What's more, since we have the sample size is 42, we believe the project can be carried out in the time allowed. With the effect size 0.5, standard deviation in 5.4, we will have an 80% chance of seeing a difference of 2.7 seconds or faster.

The collected data is given below:

	name	gender	treatment	time
1	Rebeka Novak	f	Adrenaline	22.0
2	Chloe Castro	f	Adrenaline	20.1
3	Nanami Lopez	f	Adrenaline	21.2
4	Maria Durand	f	Adrenaline	20.1
5	Eva Durand	f	Adrenaline	19.2
6	Emily Fiala	f	Adrenaline	18.1
7	Aya Carrasco	f	Adrenaline	16.2
8	rosalie steiner	f	Energy Drink	22.7
9	Siobhan Kennedy	f	Energy Drink	19.3
10	Monserrat Carrasco	f	Energy Drink	15.2
11	Alejandra Durand	f	Energy Drink	22.6
12	Ciara Durand	f	Energy Drink	12.6
13	Antonia Durand	f	Energy Drink	10.3
14	Pia Summers	f	Energy Drink	17.7
15	Tjasa Gonzalez	f	Methamphetamine	24.0
16	Anna Bernard	f	Methamphetamine	13.5
17	Nanami McCarthy	f	Methamphetamine	14.4
18	Ellen Durand	f	Methamphetamine	10.2
19	Sophie Kennedy	f	Methamphetamine	15.1
20	Sophie Takahashi	f	Methamphetamine	23.0
21	Mayu Carrasco	f	Methamphetamine	14.3

22	Ian McCarthy	m	Adrenaline	25.8
23	Gal Hajek	m	Adrenaline	16.8
24	Javier Durand	m	Adrenaline	24.2
25	Cristian Rodriguez	m	Adrenaline	20.0
26	Gabriel Bernard	m	Adrenaline	12.2
27	Francisco Carrasco	m	Adrenaline	18.4
28	Ryan Durand	m	Adrenaline	21.6
29	Kyle McCarthy	m	Energy Drink	21.3
30	Takumi Durand	m	Energy Drink	6.6
31	Shin Rodriguez	m	Energy Drink	10.4
32	Benjamin Durand	m	Energy Drink	7.9
33	Bastian Gonzalez	m	Energy Drink	18.1
34	Naoki Carrasco	m	Energy Drink	5.7
35	Alexander Durand	m	Energy Drink	12.1
36	Conor Bernard	m	Methamphetamine	25.0
37	Kaito Durand	m	Methamphetamine	21.6
38	Felipe Gonzalez	m	Methamphetamine	16.0
39	Luis Durand	m	Methamphetamine	15.7
40	Evan Lopez	m	Methamphetamine	20.0
41	Dan Durand	m	Methamphetamine	6.3
42	Lucas Durand	m	Methamphetamine	11.1

Our Design:



Factor Diagram CB[1]: Total 42 units and we blocking on gender. Our treatment has three levels (Adrenaline, Energy Drink, Methamphetamine), Each unit of block randomly get one treatment, and each block gets a complete set of treatment.

In the procedure of collecting data, we use randomly assignment. In our experiment, we have treatments (controllable variable) in 3 levels, and we have gender (nuisance variable) as the nuisance block, and outdoor 100m running time as our response variable. Firstly, we separate 42 into men group and women group with 21 subjects in each. So, we randomly select 7 subjects in our men sample, and assign 3 groups of 7 subjects into each of 3 treatment levels. And also, we selected another 21 subjects in women group with the same arrangement.

In addition, in our experiment, we will exclude some types of people and condition. For example, we collect the data only from the healthy islanders. In other words, we exclude the subjects who are pregnant or have severe disease like Glycuresis. Also, we don't want to data from the subject who is too young and too old since the test may be harmful to the subjects. Therefore, we try our best to collect the subject whose age between 10 and 60.

What's more, the reason why we want to exclude them is that it will affect our result. In the procedure of our experiment, we found that if our data include those subjects we want to exclude above, we would obtain large standard error. Also, due to this large standard error, it may affect the effect size and sample size we choose. It is not a good new both to us and the investors since it will require us to have a large sample size, which means more work to do and more cost! That's why we want to exclude them.

We tried BF[1] first.

> m0 <- aov(time~factor(treatment),data=d1)

> summary(m0)

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(treatment)	2	196.3	98.14	3.803	0.031 *
Residuals	39	1006.4	25.81		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

We anaylyze the data collected. According to the p-value, our treatments on adrenaline, energy drink and methamphetamine are significant effective to the running test since the p-value is smaller than 0.05. We are sure to reject the null hypothesis.

> model.tables(m0)

Tables of effects

factor(treatment)

factor(treatment)

Adrenaline	Energy Drink	Methamphetamine
2.8357	-2.4071	-0.4286

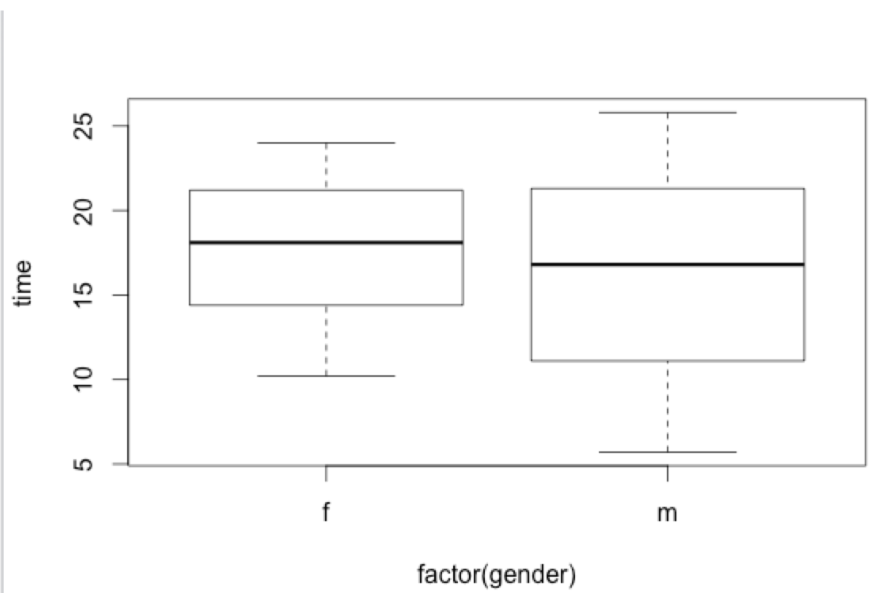
The estimated effects for Adrenaline is 2.8357.

The estimated effects for Energy Drinkis -2.4071.

The estimated effects for Methamphetamine is -0.4286.

Blocking on the gender to increase power!

Plot of gender:



The mean difference between female and male are not that big.

Then, we try to analyze the completed block design.

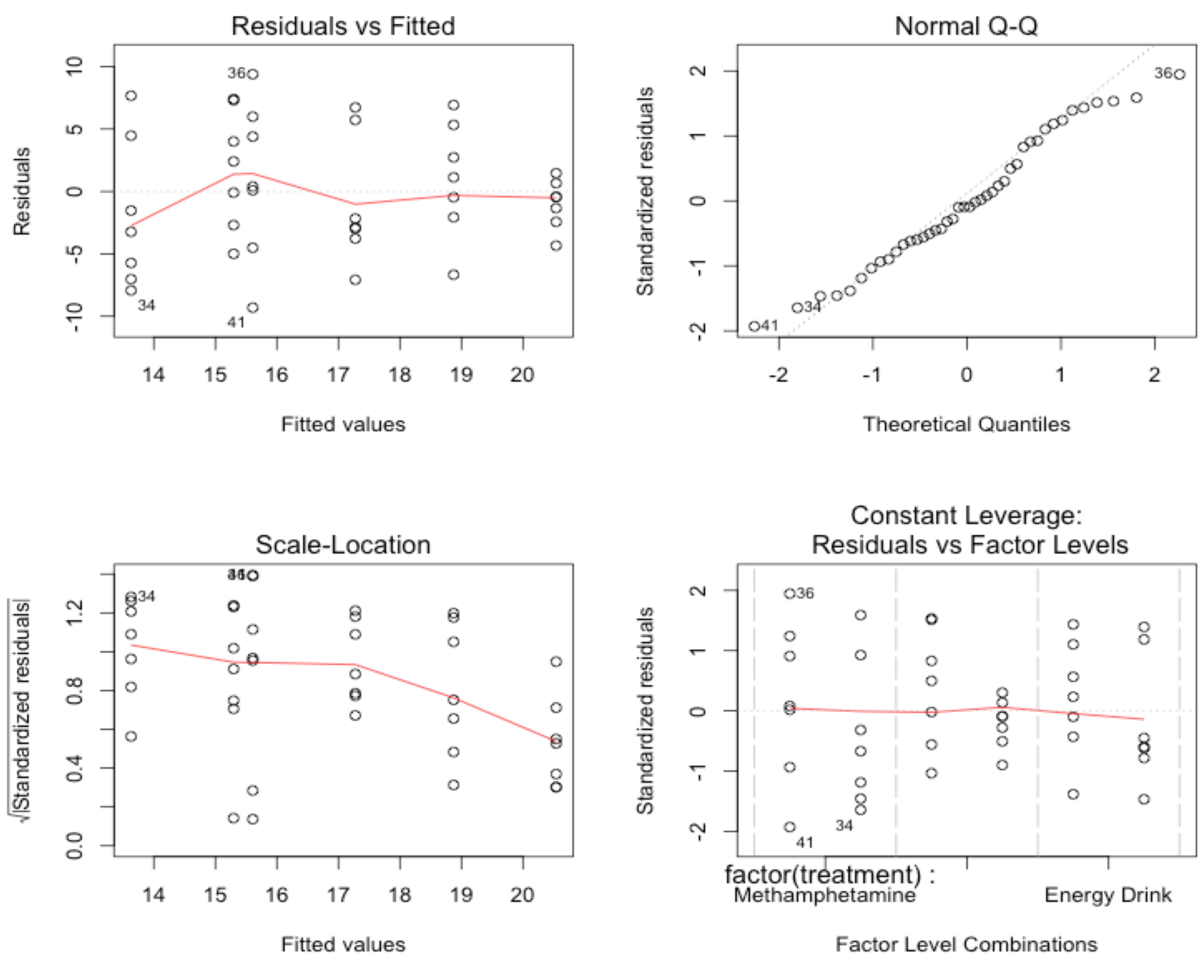
> m1 <- aov(time~factor(treatment)+factor(gender),data=d1)

> summary(m1)

	Df Sum	Sq Mean	Sq F value	Pr(>F)
factor(treatment)	2 196.3	98.14	3.816	0.0309 *
factor(gender)	1 29.2	29.17	1.134	0.2936
Residuals	38 977.2	25.72		

Conclusion: Gender is a nuisance factor that we are not interesting, but after blocking on gender, the p-value decreased from 0.031 to 0.039 and power increased. The effect of treatments is become more statically significant after we blocking on gender.

Residual VS Fitted value and QQ Normal:



The Residuals are averaged near zero, which shows our experiment and dada collected are mostly appropriate, and the two factorial model structures is correct. The qq plot follows normal population according to the above graph.

Try BF[2] to check whether interaction helps.

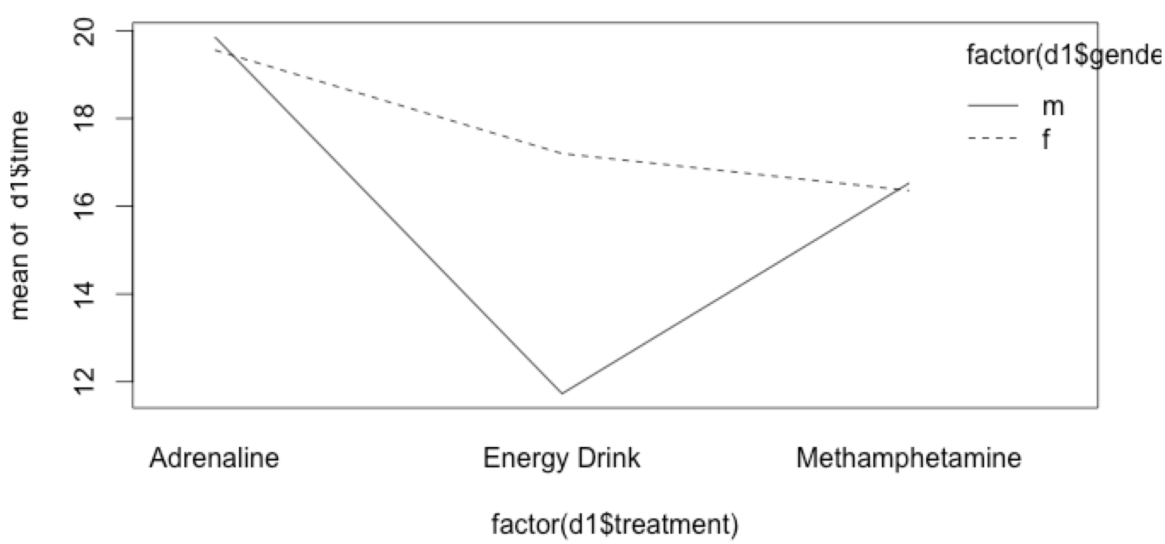
> m2 <- aov(time~factor(treatment)*factor(gender),data=d1)

> summary(m2)

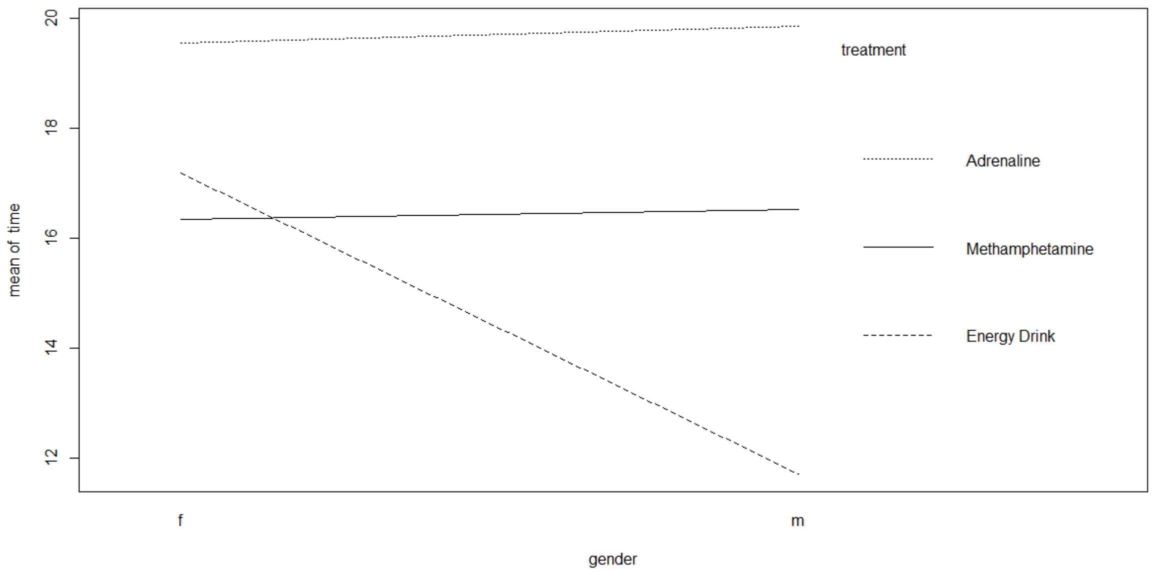
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(treatment)	2	196.3	98.14	3.920	0.0288 *
factor(gender)	1	29.2	29.17	1.165	0.2876
factor(treatment):factor(gender)	2	76.0	38.01	1.519	0.2327
Residuals	36	901.2	25.03		

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

From the interaction we see difference between groups, since the p-value of interaction is greater than 0.05, we conclude that the interaction is not statistically significant. Therefore, the CB[1] is the best design for our experiment.



The interaction of treatment and gender graphs shows that energy drink will help to increase the performance of athletes especially for men. In compare to other two treatments, energy drink is a better booster.



This is another type of interaction plot shows clearly that energy drink has a better effect on athletes over methamphetamine and adrenaline injection. And also, we can see that methamphetamine and adrenaline has equal effect on both men and women.

Changes from your initial project description:

1. We change the 3 levels amount of methamphetamine injection into 3 levels of treatment which are methamphetamine, adrenaline and energy drink. (Treatment variable changed)
2. Adding nuisance factor as gender, re-correct original nuisance factor
3. We tried to avoid all other nuisance factor by highly selected subjects in order to improve the precision of our experiment.

Conclusion:

All in all, the purpose of our study is to help athletes and runners by using energy drinks and injections to strengthen their performance on outdoor 100m running. On our study, we believe that we still can do some improvements for increase the precision and significance. First ting, we can increase the sample size of our study, Right now, the effect size we use is 0.5, which is not bad but not perfect. Looking at the summary of the Anova test below, we found that the p-values of treatment factor is a bit closer to greater than 0.05. If we use the small effect size like 0.01, then our sample size will be larger. In this way, the factors may have much lower p-values and lead to more convincing result.

In addition, we have a much better idea to design a more convincible design, which is Splited Plot/Repeated Measurement design. According to our study, we only can understand the significance of the difference among adrenaline, methamphetamine and energy drink to strengthen athletes' ability, but we cannot find out the result of the individual treatment improvement, which is how much a treatment can shorten athletes' seconds on their runs. By using SP/RM mixed with gender blocking, we may conclude a better outcome by adding another treatment factor with 2 levels in before getting injection treatment and after.