Written Explanations

Group 1: In general, we felt as though our data was not a clear nor perfect example of the negative phototaxis that we predicted to see. Based upon the p-value being greater than 0.10, we cannot reject the null hypothesis. Therefore, there was not a large enough difference in observations between the control and experimental groups. We expected to see an average angle of ≈ 0º. However, that was not the case as seen in our data since most bugs traveled more towards the light. However, there was more consistency in the bugs heading towards the 0º angle in the control group. In general, we believe that the main source of error was the light leakage from nearby groups. Furthermore, there was not a perfect way to control for the initial position of the pill bugs once we placed them on the arena. Each bug started at an angled position, likely different from the bug prior, which we believe could have caused a skewed data collection if bugs tended to travel in their initial facing direction.

Group 2: The pill bugs did not display significant phototaxis in response to the light. In the classroom, it is difficult to control other factors that may influence the behavior of the pill bugs. Specifically, our station is located in the back of the room, so the light from other groups' stations may have influenced some of our trials. Additionally, there are other light sources, such as the projector light and any computer light or outdoor light. The box may not be a perfect system to block out additional light sources. Additionally, because this is just a single class period, the small sample size for each group could impact the accuracy of our results.

Group 3: Our group members are Lukas Bleichner, RIley Spingler, David Su, and Skylar Lee. One factor we considered that could have affected the experiment was the lighting from other tables and the projector. In the future, we could have the box placed upright or set up the experiment in an isolated room.

Group 4: We hypothesized that the pillbugs would exhibit negative phototaxis. Our results showed that there was no statistically significant difference between the experimental group and the control group.

There were several confounding variables in our experiment. We did not conduct this experiment in a lightless room; even though we tried to account for extraneous light from other sources with the cardboard box, the construction of the box was imperfect and light still leaked through. Moreover, light from the projector, other people's lamps, and from the hallway may have impacted our experiment. We also tested the control group first, which may have been different from other groups and impacted the results. Since we used the same paper cup for every bug, chemical contaminants may have impacted the

direction of pillbug movement. For future directions, we would try to conduct the experiment in a completely lightless room. We might also try to use a within-subjects design, instead of

Group 5: We tried to switch between control and experimental to prevent the time of being in the cup to be a confounding variable. The sounds of our voices could have scared them or encouraged them to come towards us. Aggressive dumping could have confused them, plus they were not in the center of the cup. The light also reflected off the side of the box, so a less reflective material should help prevent confounding light variables.

Group 7: We noticed that our results differed from our initial expectations - the experiment group did not show a significant orientation away from the light source. One potential issue we identified was additional light sources during the control group trials, including light from the PowerPoint projector and other group lamps. This may have affected our results, and it was challenging to control for these variables in the classroom setting.

Group 8: For our experimental group we calculated a mean angle of ~ 148 degrees, a mean vector length (r) of ~ 0.48, and a Rayleigh test p-value of ~ 0.54. The relationship and directionality of pill bug orientation wasn't statistically significant or strong. For our control group, we calculated a mean angle of ~ 91.1 degrees, a mean vector length (r) of ~ 0.28, and a Rayleigh test p-value of ~ 0.82. This indicates that the relationship wasn't statistically significant nor strong. Based on these finding we would assume that the pill bugs we tested didn't orient using a light source. Some variables that we would like to control for in future experiments would be the light immitted from other groups/sunlight/screens (external light sources not being tested), pill bug initial orientation, species variation, heat generated by the lamp, impacts of the lamp on non-subject pill bugs, and food items that were found in some of our cups.

Group 9: We found multiple possible sources of error that could have contributed to the ‘flipped’ nature of our results. We observed that the pillbugs often flipped onto their backs while trying to climb the edges of the covering cup, and when the cup was removed, they remained upside down. After being flipped right side up, the pillbugs immediately ran in the direction they were facing, without taking time to reorient themselves. In addition, we notcied a lot of stress on the bugs when having to move them from an unatural environment to another, and that could have impacted their rational thinking.

Results:

Group 1

```
Mean angle:  104.0315
Mean vector length (r):  0.5653705
Rayleigh test p-value:  0.4209517
```

Group 2

```
Mean angle:  92.2113
Mean vector length (r):  0.3897476
Rayleigh test p-value:  0.6735448
```

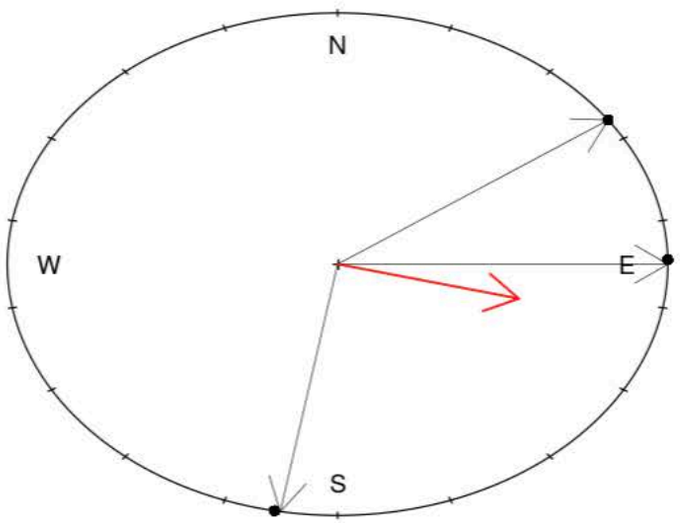
Watson's test to compare two groups

```
      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.0417
P-value > 0.10
```

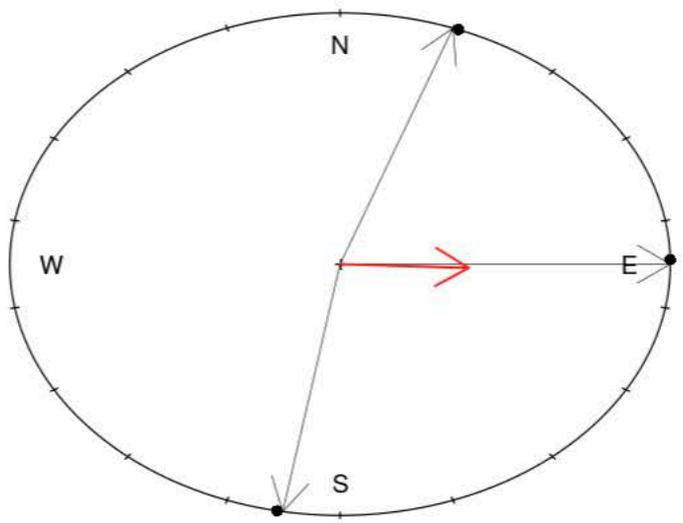
Plots

(data points shown in black, mean vector in red)

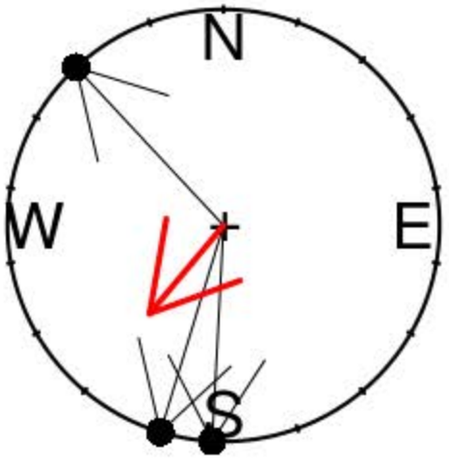
Group 1



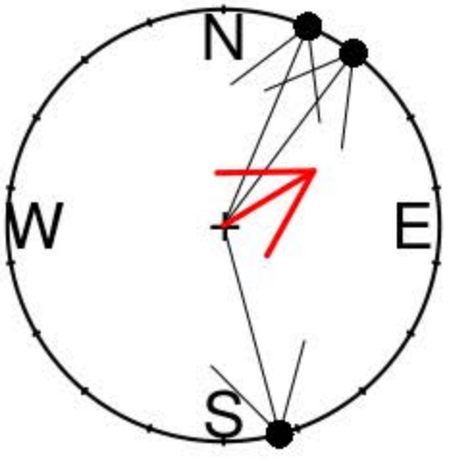
Group 2



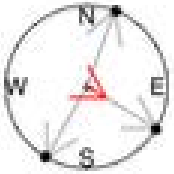
Group 1



Group 2

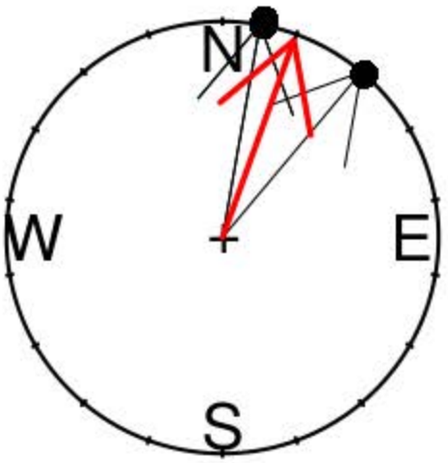


Group 1

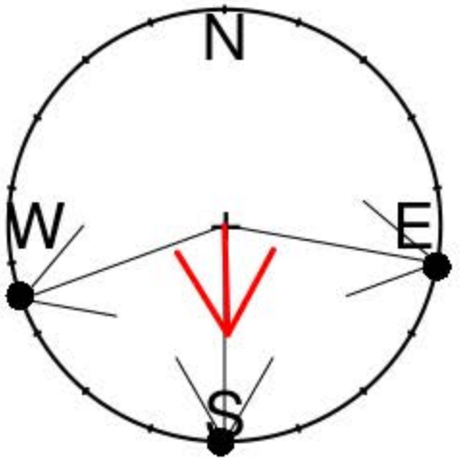


Group 2

Group 1



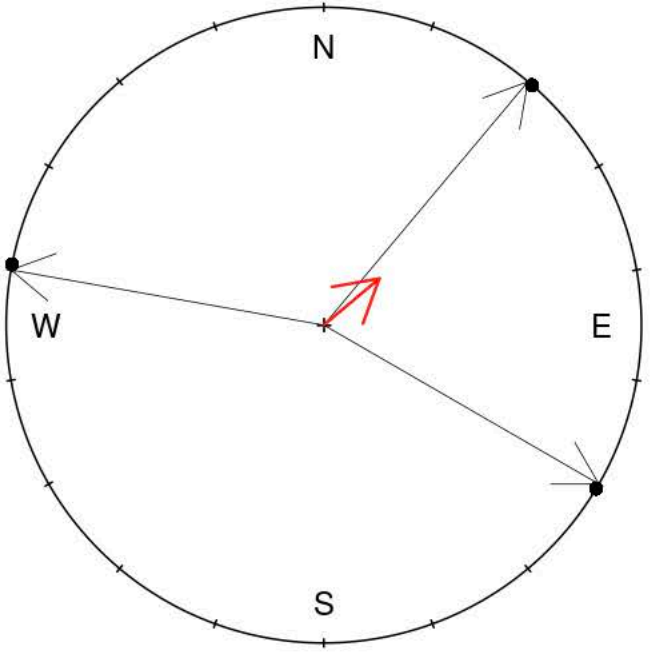
Group 2



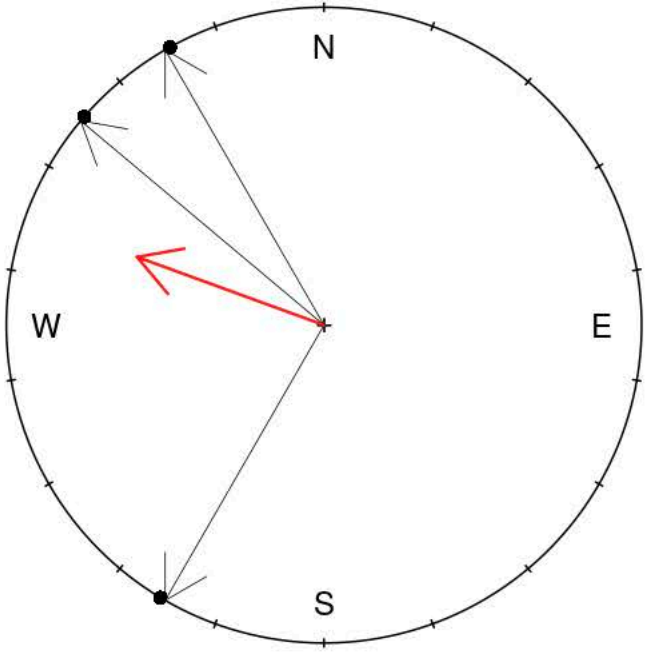
Plots

(data points shown in black, mean vector in red)

Group 1



Group 2



Results:

Group 1

```
Mean angle:  50
Mean vector length (r):  0.2280134
Rayleigh test p-value:  0.875822
```

Group 2

```
Mean angle:  290
Mean vector length (r):  0.6264617
Rayleigh test p-value:  0.3386594
```

Watson's test to compare two groups

```

      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.0787
P-value > 0.10

```

Results:

Group 1

```
Mean angle:  19.89609
Mean vector length (r):  0.969771
Rayleigh test p-value:  0.0445033
```

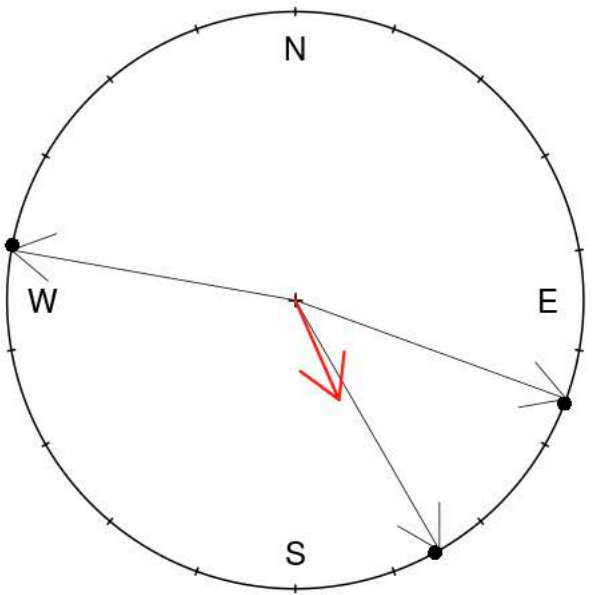
Group 2

```
Mean angle:  178.295
Mean vector length (r):  0.5054465
Rayleigh test p-value:  0.5063052
```

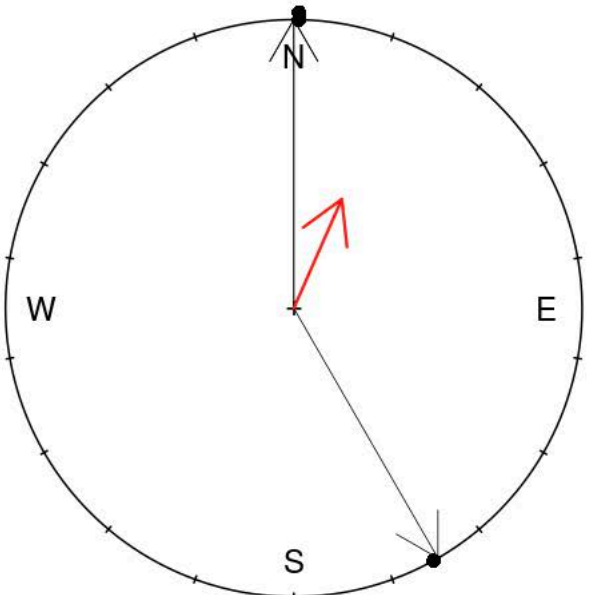
Watson's test to compare two groups

```

      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.1528
0.05 < P-value < 0.10

```

Group 1



Group 2



Results:

Group 1

```
Mean angle:  156.2621
Mean vector length (r):  0.3766664
Rayleigh test p-value:  0.6918911
```

Group 2

```
Mean angle:  23.79398
Mean vector length (r):  0.4131046
Rayleigh test p-value:  0.6403075
```

Watson's test to compare two groups

```
      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.0787
P-value > 0.10
```

Group 1: Enter a set of angles in degrees, one per line

150
110
280

Group 2: Enter a set of angles in degrees, one per line

0
150
0

Circular Data Analysis: by Robert Fitak

Group 1: Enter a set of angles in degrees, one per line

330
200
150

Group 2: Enter a set of angles in degrees, one per line

310
330
10

Save plot as file type

- (•) png
- ( ) pdf

Download the plots

Results:

Group 1

```
Mean angle:  200
Mean vector length (r):  0.3333333
Rayleigh test p-value:  0.7507996
```

Group 2

```
Mean angle:  336.3429
Mean vector length (r):  0.9074674
Rayleigh test p-value:  0.07425563
```

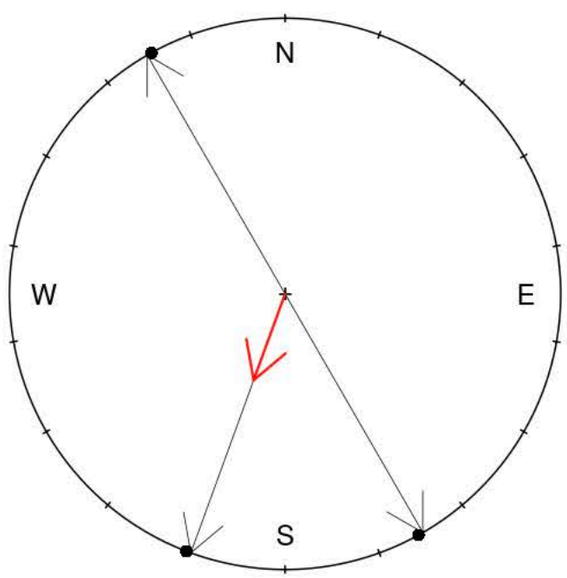
Watson's test to compare two groups

```
      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.0787
P-value > 0.10
```

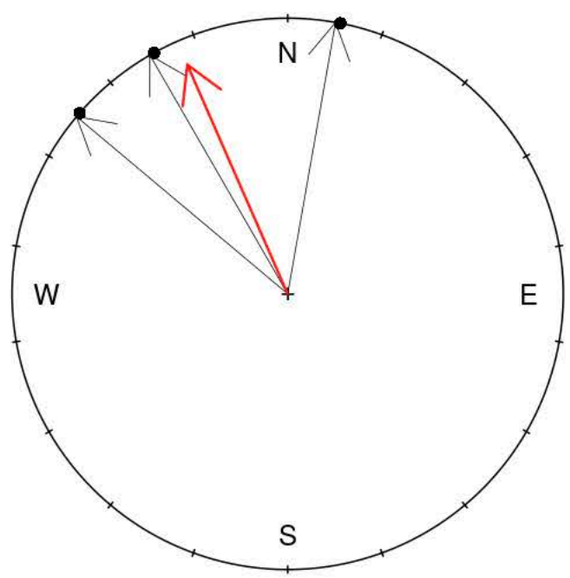
Plots

(data points shown in black, mean vector in red)

Group 1



Group 2



Results:

Group 1

```
Mean angle:  148.2227
Mean vector length (r):  0.4848823
Rayleigh test p-value:  0.536163
```

Group 2

```
Mean angle:  91.05325
Mean vector length (r):  0.2754972
Rayleigh test p-value:  0.8233026
```

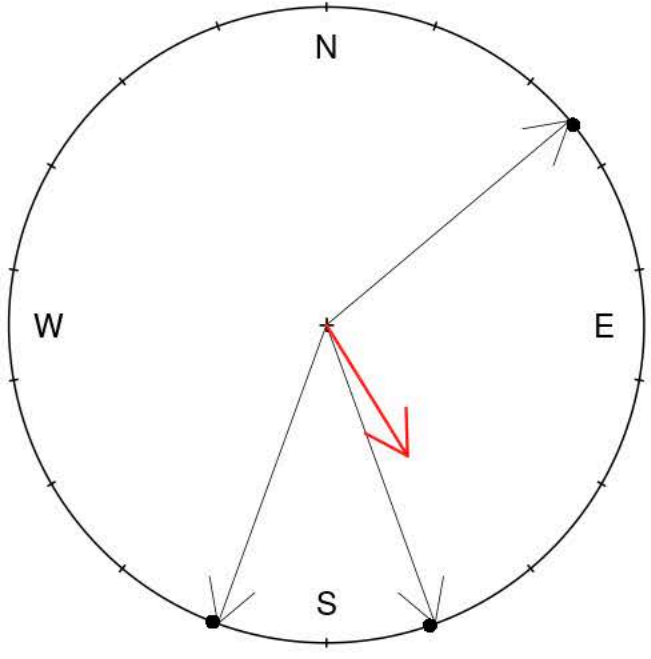
Watson's test to compare two groups

```

      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.0417
P-value > 0.10

```

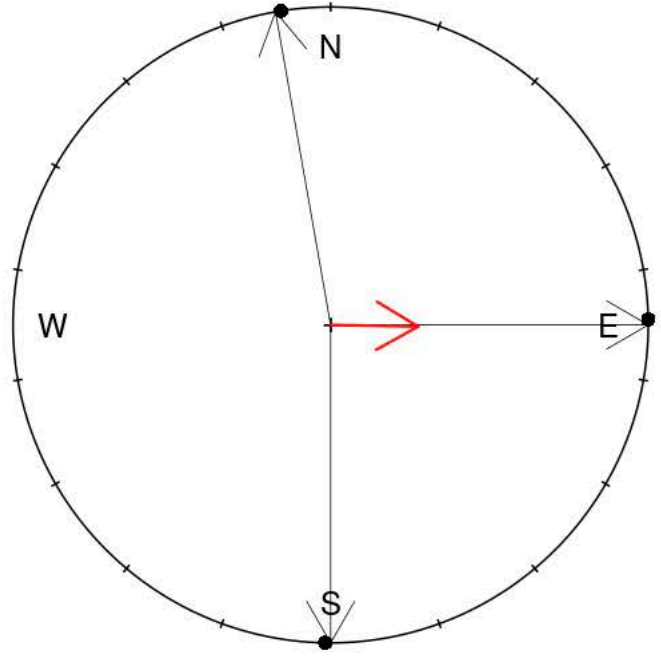
Plots

(data points shown in black, mean vector in red)

Group 1



Group 2



Results:

Group 1

```
Mean angle:  121.0532
Mean vector length (r):  0.2754972
Rayleigh test p-value:  0.8233026
```

Group 2

```
Mean angle:  129.0148
Mean vector length (r):  0.3037584
Rayleigh test p-value:  0.7888976
```

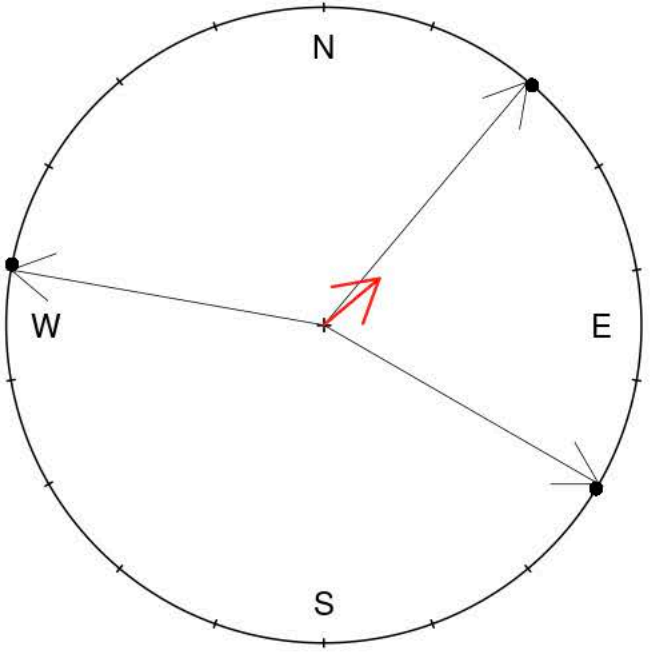
Watson's test to compare two groups

```
      Watson's Two-Sample Test of Homogeneity

Test Statistic: 0.0417
P-value > 0.10
```

Plots

(data points shown in black, mean vector in red)

Group 1



Group 2