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Determining Whether Drosophila melanogaster Have an Innate Directional Preference Based on the Ambient Magnetic Field of the Earth

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Introduction

The status of the fruit fly *Drosophila melanogaster* as a model organism for behavioral and genetic research makes it an attractive candidate for investigations of the genetic basis of magnetoreception. There are two main hypotheses for how animals detect Earth-strength magnetic fields. One hypothesis is that animals use magnetite, which forms long chains and serves as a magnetic dipole, while the other hypothesis is that animals have a light-dependent magnetic response utilizing cryptochrome. Several studies have found that *Drosophila* can orient to Earth-strength magnetic fields[1-4] using a mechanism consistent with a cryptochrome-based magnetoreceptor, but the specifics of the findings have varied. For example, two studies found that *Drosophila* have an innate directional preference[1-2] while two studies found that *Drosophila* need to be trained in order to have a directional preference[3-4]. Additionally, one study found that only male flies orient to magnetic fields[1], while the other studies found that both male and female flies orient to magnetic fields[2-4].

To help resolve the conflicting results of these studies, we aimed to determine if *Drosophila melanogaster* have an innate directional preference and if orientation differs between males and females. We used a sequential Y-maze housed within a Faraday cage, the purpose of which was to block out any radio frequency (RF) fields that may affect the choices of the flies.

Methods

- Wild-type flies (Generation 0) were collected from a composting site in Monmouth, OR.
- We built a progressive Y-maze to run the flies through (Figure 1). The maze allows individual flies ten choice points to go north or south (right or left).
- We built a Faraday cage using a wooden frame and aluminum wire mesh to completely surround the frame (Figure 2).
- We placed two fluorescent plastic light diffuser sheets over the Faraday cage to ensure a uniform light gradient.
- After an experimental run, flies were collected and anesthetized with CO_2. The total number of flies in each vial as well as the number of male and female flies in each vial were recorded.
- 20 runs through the maze were performed and the data was averaged to find the average vial number for each run.

Figure 1: Photo of the Y-maze inside the Faraday cage. The Faraday cage blocks radiofrequency fields which may affect directional choices of the flies.

Results

Prediction: If flies have a right or left directional bias, then the average vial number will be different on trials where 10 right choices = 10 compared to when 10 right choices = 0.

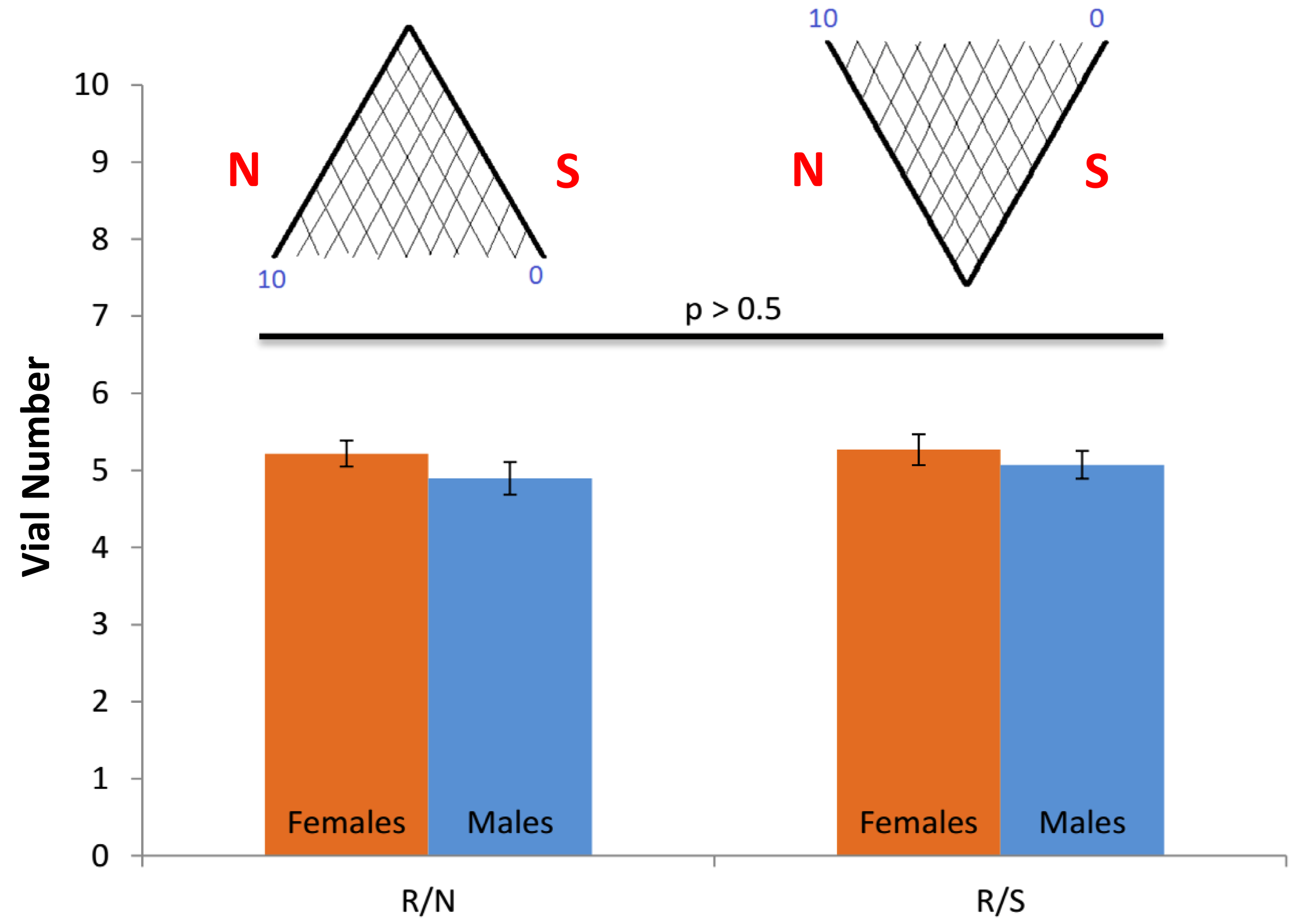

Figure 2: A comparison of maze trials with right to the north (n = 10) and right to the south (n = 10). Data were scored so 10 north choices were recorded as '10' and 10 south choices were recorded as '0', regardless of whether north was to the right or the left. Error bars represent the SEM for each group. Maze orientation is shown above the graph. Our results show that *Drosophila* do not have a right or left directional preference within the maze, and that orientation does not differ depending on the sex of the flies (ANOVA, $p > 0.5$).

Prediction: If flies have a magnetic field-based directional preference, then the average vial number will be different when 10 north choices = 10 compared to when 10 south choices = 10.

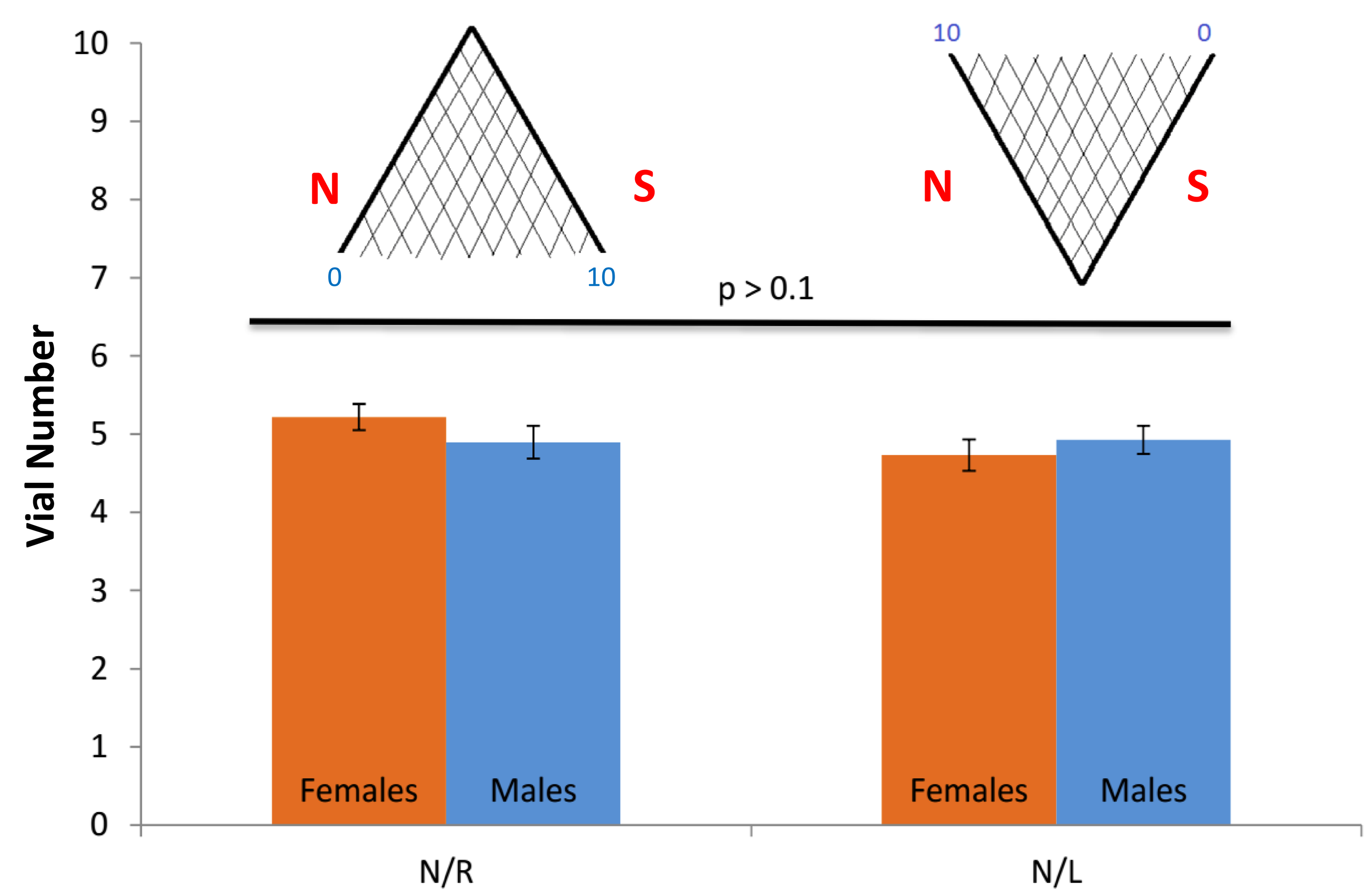

Figure 3: A comparison of maze trials with north to the right (n = 10) and north to the left (n = 10). Data were scored so 10 right choices were recorded as '0' and 10 left choices were recorded as '10'. Error bars represent the SEM. Orientations of the maze are shown above the graph. Our results show that naïve, non-trained flies have no significant preference for north or south within the 10 choice point Y-maze (ANOVA, $p > 0.1$).

Results

Prediction: If flies have a north or south directional preference, then the average vial number will be different than 5, which represents random choice at each branch point.

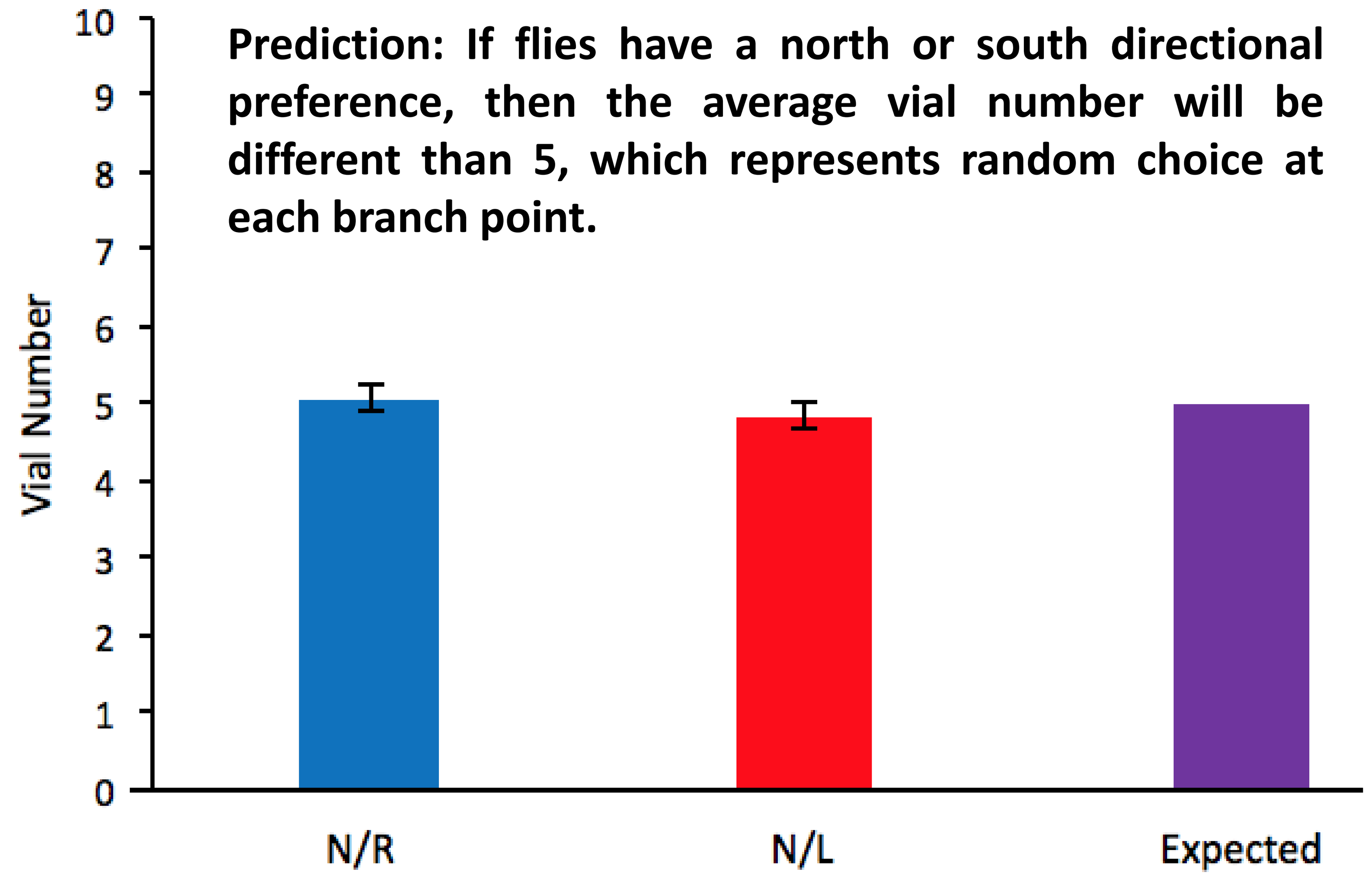

Figure 4: The average vial for flies exiting the maze were not significantly different from the expected value of 5.0 (Chi-squared test, $p > 0.9$). Data were scored so 10 right choices were recorded as '0' and 10 left choices were recorded as '10'. Error bars represent the SEM.

Conclusions and Future Directions

- Our results suggest that *Drosophila melanogaster* do not have an innate magnetic directional preference, which is consistent with previous studies that have required training before the flies orient to Earth-strength magnetic fields[3-4] (Figure 3 and 4).
- There was no bias within the maze that led to flies choosing right or left at the branch points (Figure 2).
- There was no significant difference in the directional preferences of male versus female flies (Figures 2 and 3).
- Because this study shows no innate directional preference in *Drosophila,* another endeavor in the future could use a similar experimental setup as this study except using a stronger applied magnetic field to see if the flies have an innate preference to magnetic fields that are several times stronger than Earth's ambient field[5].

References

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