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Innate food preference in the larval tobacco hornworm, *Manduca sexta*

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Abstract

Food preference can drive an organism to seek a specific food source even if another food, which can provide needed nutrition, is easier to obtain. Food preference can develop in different ways, including innate preference, i.e., organisms display food preference at birth, or learned preference, i.e., organisms develop food preference after previous experience with that food. The tobacco hornworm, *Manduca sexta*, shows learned preference; however, we lack information about innate food preference in *Manduca*. *Manduca sexta* larvae eat many different foods until they feed on a solanaceous plant, when they become more specific in their diet. This study focused on naive *Manduca sexta* larvae to determine if they show innate food preferences. Because early juveniles seek out solanaceous plants if they hatch on a different family of plants, I predicted that *Manduca sexta* prefer solanaceous plants over artificial food designed for captive animals. Based on trends seen in other studies, I also predicted that *Manduca* prefer plants that have not been fed upon previously.

To test my predictions, *Manduca sexta* were allowed to choose from live plants with damaged leaves (to simulate previous feeding by other insects), live plants with undamaged leaves, or lab food. I recorded which food source *Manduca* approached first and latency to select food. I found that there is no significant difference between latency time, or between the plant and lab food trials. There was a significant difference between the damaged and undamaged leaves. The Fig. 1 setup of the testing apparatus was placed on the center line in the middle of the food choices. A choice was made when the larva crossed the black line of the food side. Chi-squared test used to analyze. N=11, x\(^2\)=0.862, degrees of freedom (DF)=1, chi-squared critical value p=0.36 No statistical difference in results

![Chi-squared test](Image 428x439 to 457x509)

Fig. 1 The setup of the testing apparatus

![Latency times](Image 511x537 to 540x607)

Fig. 2: The damaged plant leaf, damaged with a lancet

![Solomon's 2](Image 569x598 to 598x668)

Fig. 3: The damaged leaf

Introduction

Food preference can develop in different ways. One of these ways being learned food preference, which is developing an affinity for a food after having experience with a food (Nyström, 2013). Another way is innate preference, which is an inheritable genetic preference for one food over another based on genetically imprinted nutritional needs (Singer, et al, 1992). *Manduca sexta* is an important model organism that has demonstrated learned food preference (Boer, 1992). Jermy, T., Hansen, F. E., & Dehier, V. G. (1968). Which have shown that larval *Manduca sexta* prefer to feed on host plant they have already fed on (de Boer, G., 1992). Jermy, T., Hansen, F. E., & Dehier, V. G. (1968). They also prefer non-damaged plants over damaged ones (Jermy and Dehier, 1968). Jermy, T., Hansen, F. E., & Dehier, V. G. (1968). (Nyström, E. (2013)). However, there is a lack of available information on innate preference in *Manduca sexta*. A precedence for the theory that they show innate preference comes from the fact that if an egg is laid on a nonhost plant, the resulting larvae actually seek out a suitable host plant. There is no statistical difference between the latency times.

![Average Latency Time](Image 742x742 to 771x812)

Fig. 4 The average latencies for food choice

![Chi-squared test](Image 791x862 to 820x932)

Fig. 5 The choices made in Treatment 1. Chi-squared test used to analyze. N=11, x\(^2\)=20.0587, degrees of freedom (DF)=1, chi-squared critical value p=0.05 No statistical difference in results

Objectives

This study analyzed the food preferences of naive *Manduca sexta* larvae, which are larvae that have not had the opportunity to feed on a host plant.

Predictions

1. *Manduca* prefer live plants over the lab food source. Based on the fact that newly hatched *Manduca* larva will actively seek out a more suitable host plant after having on a less suitable host plant (Nyström, 2013).
2. *Manduca* prefer the undamaged plants over the damaged ones. Based on the odors given off by damaged Solanaceae plants, that can signal predators of the feeding herbivore, and the *Manduca* reliance on olfactory senses in food selection (Kessler and Baldwin, 2001), *Nyström* (2013).

Methods

This study utilized 11 naive *Manduca sexta* larvae. The larvae were acquired from Carolina Biological, and staff verified that the animals were never allowed to feed on a host plant, and were reared on their own blend of a lab prepared food source. This study was conducted in 603A Science at the University of Southern Maine. This is a room used for *Manduca* sexta for laboratory use and provides optimal growing conditions.

I tested three different treatments: A live undamaged tomato plant vs. a grain based lab food, N=10, p=0.625, test statistic(s) = 0.55. Damaged and Lab food, N=9, p=0.0008, s=9.500. Damaged and Undamaged, N=10, P=0.4316, s=-8.5. There is no statistical difference between the latency times.

![Chi-squared test](Image 1056x1086 to 1085x1156)

Fig. 6 The choices made in Treatment 2. Chi-squared test used to analyze. N=11, x\(^2\)=20.0587, degrees of freedom (DF)=1, chi-squared critical value p=0.05 No statistical difference in results

Result

There is no significant difference in results. From the data we can see that there is no significant difference in preference between the undamaged plant, and the lab food, with the probability being more than 0.05. This is also true for the comparison between the damaged plant and the lab food, where again there is no statistical difference, p>0.05. There is also no significant differences in the latency times. From this we can conclude that there is no preference for any of these different food choices. Because of the nature of the experiment, we can conclude that there is no significant preference for a tomato plants that the *Manduca* has not been exposed to. These results could be do to several different factors the most important of which is the life stage to the *Manduca* used in the experiment. The 9 instar larvae were in the 4th instar, and 2 were in the 3rd instar, which are both late in the larval cycle. It has been observed that food preference is induced in the first instar, and that the larvae reared on an artificial medium remain polyphagous (Yamamoto, 1974). This could explain why they showed no preference, because they were past the life stage where they would have been the most attracted to the novel food source, and showed no preference because each of the foods, which are roughly equivalent in nutritional value, would have been equally attractive. It is also very likely that these results are due to experimental error, and a small sample size. The testing area may not be well suited for the experiment and a different apparatus, which features air pumps, such as the one featured in the Nyström paper, this would force the olfactory stimuli to the larva, and may allow it to better compare the two options. Also the small sample size and the fact that they all came from the same source may lead to skewed results.

![Chi-squared test](Image 1206x1236 to 1235x1306)

Fig. 7 The choices made in Treatment 3. Chi-squared test used to analyze. N=11, x\(^2\)=8.41, degrees of freedom (DF)=1, chi-squared critical value p=0.05 No statistical difference in results

Conclusion

1. The prediction is incorrect, there is no preference shown between the lab food and a tomato plant. There is no statistical difference between the different choices. There is also no statistical difference between the latency times which suggests that there is no preference based on the latency time it takes to choose between the two options, reinfocing the conclusion that there is no preference for either lab food or a live tomato plant.
2. This prediction was in fact reinforced by the results of the study. There was a clear, and statistical difference between the two choices. There is a preference for the undamaged plant, over the damaged one, while there is not a difference in latency time, there is a significant difference in the number of times the undamaged plant was chosen. It however cannot be concluded why the difference is seen.

Acknowledgements

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References