Thigmotaxis in mealworms: Effects of barrier height and illumination

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Twenty mealworms (*Tenebrio molitor*) were forced to encounter barriers of heights from 0 to 10 mm. Thigmotactic edge-following responses were affected by barrier height and illumination. When the barrier cast a shadow, edge following appeared at lower barrier heights and with less variability than when light source placement eliminated the shadow.

The behavior of the yellow mealworm (*Tenebrio molitor*) is often cited as an example of thigmotaxis (Warden et al, 1940; Fraenkel & Gunn, 1961). Upon encountering the edge of a solid object, the mealworm turns and follows the edge, keeping the length of its body in contact with the object. Upon reaching the end of the object, the mealworm turns in the direction of its stimulated side. Crozier (1924a, b) described these movements and interpreted them in terms of tropisms based on asymmetrical bodily stimulation.

In observing these reactions, however, one is aware of variation in this pattern. The mealworm often climbs over the object instead of following along its edge. The author was interested in uncovering factors which elicited and reduced the variability of the edge-following response. It seemed obvious that the height of the barrier should play a role in determining whether the following or climbing-over response is elicited. Since these larvae become more active with increasing light intensity (Crozier, 1924a, b), it was anticipated that different lighting conditions would result in differing frequencies of following and climbing. The present study was designed to relate barrier height and barrier illumination with consequent edge-following or edge-climbing responses in mealworms.

Method. Twenty *Tenebrio* larvae were used as Ss. These animals were assigned randomly to four groups of five, each group receiving a different random order of barrier heights.

Barrier heights were manipulated by means of an apparatus constructed from pine plywood. A square of plywood, 30 cm on a side, formed the base of the apparatus. A rectangular platform (7.5 cm x 28 cm) of the same plywood was glued to the base. A triangular (15 cm x 15 cm x 25 cm) piece of solid pine rested, unglued, on the base, the long side abutting the platform, serving as the barrier. The height of the barrier was adjusted by means of screws at each corner. Since the peak-to-peak screw thread distance was known, barrier height could easily be translated into screw turns.

All animals were twice presented with barrier heights ranging from 0 to 10 mm, in 1 mm increments. During the first presentation, a light source was placed in front of the barrier, so that no shadows were formed where the barrier met the platform. For the second presentation, the light was placed behind the barrier, forming a shadow on the platform at the barrier edge. The light source was two 15-W fluorescent lamps in a desk light fixture, placed 25 cm away from the barrier-platform juncture at an angle of 60 deg from horizontal. The width of the shadow was half the barrier height. The platform was covered with white paper to maximize the contrast between light and shadow.

Each group of animals was placed on the platform and prodded gently with a watercolor brush until each encountered and reacted to the barrier. If the S followed the barrier for 10 cm, a following response was recorded. If the S crawled over the barrier so that all of its legs were on top of the triangle, a crawl-over response was noted. When the response did not fall into either of these categories (e.g., backing away, veering off the edge), the animal was prodded back into position to come into head-on contact with the edge. In between trials and while other groups were being run, each group was kept in a paper cup with wheat germ in which to burrow.

Results and Discussion. The results, shown graphically in Fig. 1 in terms of frequency of edge-following, include an additional data point at 15 mm. This latter was included when crawl-over responses persisted at 10 mm in the No Shadow condition.

Two conclusions can be drawn from inspection of the graph. First, it appears that there is less variation in the behavior of the

Fig. 1. Frequency of edge-following responses.

mealworms in the Shadow condition (i.e., the upward slope of the line is sharper). The barrier height threshold for eliciting the edge-following response is more well-defined when the barrier casts a shadow than when it does not. This conclusion can be supported statistically by taking the number of less-frequently-given responses at each barrier height as a measure of response variability. The mean number of minority responses in the No Shadow condition was 4.00, while the mean for the Shadow trials was 2.42. The difference between these means was significant at the .02 level, two-tailed ($t = 3.04$, $df = 10$).

The second conclusion is that the threshold height for edge-following was lower in the Shadow condition than in the No Shadow condition. If we interpolate from the graph, edge-following is shown by a majority of the mealworms at a barrier height of 2.82 mm in the Shadow condition, contrasted with a barrier height of 5.50 mm in the No Shadow condition. A measure more amenable to statistical testing is the height at which each animal showed its first edge-following response. The mean height in the Shadow condition was 3.40 mm, while the mean in the No Shadow condition was 6.10 mm. This difference was significant at the .01 level, two-tailed ($t = 2.79$, $df = 38$).

These results suggest that differences in light surrounding solid objects strongly affect thigmotactic behavior. Perhaps, thigmotaxis and negative phototaxis in mealworms are additive determinants of behavior. Such a view would support the findings of Crozier (1924a, b), who worked with translucent barriers of fixed height. Edge-following seems to be a behavior which can be elicited and modified by a number of dissimilar factors.

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NOTE

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