Visually Mediated Snapping in the Bulldog Ant: A Perceptual Ambiguity between Size and Distance

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Summary. 1. The isolated head of the bulldog ant, Myrmecia gulosa, snaps its mandibles in a predictable way in response to an approaching target, allowing the isolation of a single visually mediated component from the complex prey capture repertoire of intact animals.

2. The timing of the response depends on both the size of the target and its position relative to the animal’s visual midline (Figs. 2, 12, 13). Except for a latency component, the snapping is velocity independent (Fig. 3).

3. Only 14% of the animals tested continued to respond to the targets when vision in one eye was occluded. Although monocular responses occurred at the same mean target distance as binocular responses, the variance was significantly greater (Figs. 4, 5).

4. Optical measurements of the visual field of M. gulosa indicate a binocular overlap of nearly 60° (Figs. 7, 9).

5. Correlation of behavioral and optical measurements suggest that the snapping is triggered when the edge of any size target comes into the visual field of a small group of facets (Figs. 9, 10).

6. These experiments with the isolated head preparation show that the bulldog ant cannot judge the absolute distance of a target in the visual field when limited to primary visual cues, and suggest that two eyes are better than one simply because they provide more input.

Introduction

The accurate localization of objects in space is clearly a major sensory capability, particularly in prey capture and defense. Among invertebrates, those which capture prey by striking have received most attention in the study of distance judgements [Aeschna larvae (Odonata): Baldus, 1926; Etienne, 1969; Cicindela larvae (Coleoptera): Friederichs, 1931; mantids: Maldonado et al., 1967; Maldonado et al., 1967].
But no neural mechanism has yet been described for distance estimation. On the basis of trials with constant sized targets, the distance judgements thus far observed have been described as absolute (Baldus, 1926; Friederichs, 1931; Maldonado and Barros-Pita, 1970), but the little-noted presentation of different sized targets in these studies suggests that a size/distance ambiguity may, in fact, occur. In addition, while the use of two eyes is almost certainly involved in localization of prey, the nature of this involvement has been obscured by the common assumption that distance is being judged by means of a binocular interaction.

Because object localization is typically a complex behavior involving both visual and non-visual sensory inputs (e.g., Maldonado et al., 1967; Robertson, 1971), it is clearly valuable for study purposes to be able to extricate from the complex a single aspect which involves only one sensory modality. To this end, the experiments described below employ the visually mediated snapping performed by isolated ant heads in response to an approaching target. In this system, it was possible to test the bulldog ant for the ability to judge distance solely on the basis of primary visual cues, without the complications of intact freely moving animals.

Materials and Methods

Experimental Animal

Animals used in this study were major workers of the Australian bulldog ant *Myrmecia gulosa* Fabricius, the larger of the two castes in this species, and the group responsible for foraging and defense duties (Wilson, 1963). Several hundred workers of both castes and some larvae from the same nest were provided with a large nest box complete with areas for tunnelling and foraging (adapted from Freeland, 1958), and the animals appeared to live and behave quite normally until depletion necessitated another collection (4-6 months).

The ants were fed daily with honey water and freshly killed wax moth larvae or cockroaches, and were maintained at 26 °C with 14 hours of light daily.

Animals selected for experimentation were those major workers which would react defensively to forceps inserted into the nest for collecting and feeding purposes. This criterion was used because all major workers may not be equally involved in defense and prey capture duties due to age dependent division of labor (Wilson, 1963). Individuals thus selected were segregated in small jars containing some nest dirt and eucalyptus leaves and left overnight before an experiment. This appeared in preliminary experiments to increase the probability that the preparation would actively respond.

Preparation of Animals for Behavioral Experiments

Before an experiment, the ant was cooled just to the point of inactivity, tethered by a stick waxed to its thorax, and then allowed to recover with its legs in contact with a small styrofoam ball, which it would grasp and walk on when it had warmed fully. Then objects were presented to the ant to test its alertness. When an ant had recovered to the extent that it would behave like a normal uncooled animal, it was beheaded and the antennae were excised close to their bases. The head was then mounted and centered on the approach radius to the target.