Optically and acoustically evoked escape behaviour in grasshoppers

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It was hypothesized that hearing in silent grasshoppers plays a role in escape behaviour, as is known of other insects (Riede et al., 1990). Reactions to acoustic stimuli of high intensity provoked interruption of respiration, hindleg-twitching and contractions of the body (Fig. 1), but it was impossible to elicit a jump.

Jumps can be elicited reliably by expanding optical stimuli. Because of rapid habituation in the laboratory, grasshoppers were stimulated individually in the field by an opening umbrella. The percentage of elicited jumps as a function of distance shows a steep decline between 120 and 200 cm which allows the definition of FD_{50} as the flight distance where 50% of stimulated animals jump. For *Aeropus sibiricus* (singing) and *Podisma pedestris* (wingless, non-singing), both inhabitants of alpine meadows, FD_{50} is around 165 cm, corresponding to an expansion velocity of 70^{o}/s and an angular object size of 30^{o}.

Is there any multimodal interaction of the unspecific reactions to acoustic stimuli with optically evoked escape reactions? The steep decline of the psychometric curve allows sensitive tests of shifts of escape parameters by measuring percentage of jumps at or near FD_{50}. Simultaneous presentation of optic and acoustic stimuli at 160 cm did not provoke significant change in jump percentage compared to pure visual stimulation. This is in contrast to electrophysiological data which indicate excitatory input to jump-triggering interneurons (Pearson and Robertson, 1981). The separate processing of acoustical and optical stimuli as well as the rapid habituation indicates that in intact animals additional circuits are modifying the basic scheme of jump control as worked out by electrophysiologists.

The observed unspecific reactions to strong acoustic stimuli resemble the "orientation" and "startle" responses known from vertebrates. They are not a relevant selection pressure for the maintenance of such an expensive structure like a tympanal organ. Therefore, the function of hearing in short-winged and silent grasshoppers remains unclear.

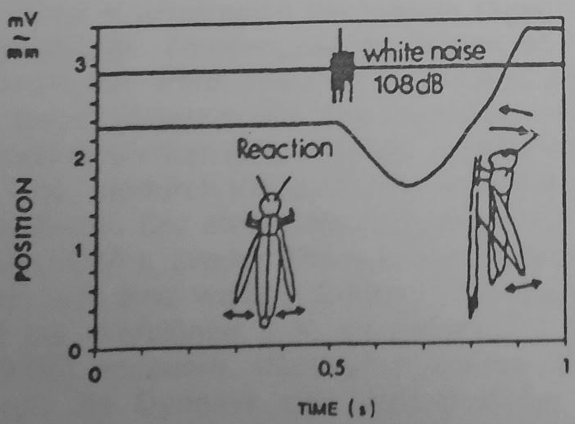

Fig. 1: Optoelectronic registration of reactions to high-intensity acoustic stimuli. The untethered grasshopper is sitting on a rod. Body twitches were measured by projecting the image of a reflex foil attached to the forehead on a position-sensitive photoelement. The output voltage is proportional to the distance of the animal's head from the rod (curve "Reaction"). Appendages move as indicated by arrows.

References
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Riede K., Kämper, G & Höfler, I (1990) Tympana, auditory thresholds and projection areas of tympanal nerves in singing and silent grasshoppers. Zoomorphology: in press

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