Multi-neuronal responses from locusts presented with complex object motion

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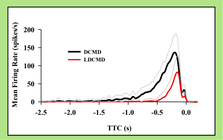
INTRODUCTION

Locust visual motion detection involves the Descending Contralateral Movement Detector (DCMD) and Late DCMD (LDCMD - inset)[1], each of which responds to approaching objects. The DCMD has been implicated in mediating collision avoidance behaviour[2-4] and firing rate modulation also reflects trajectory changes associated with compound object motion[5]. We used multi-channel recordings from the ventral nerve cord, spike sorting and principal component analysis to determine if putative neural populations respond to simple looms and/or complex object motion.

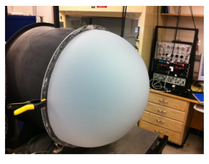
DCMD (black) and LDCMD (red) Response to a 7 cm disc looming towards The center of the locust eye. Data aligned to time to projected collision (TTC = 0 s). From Gray et al. (2010).



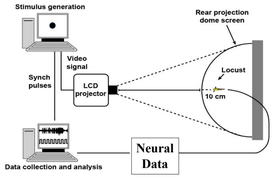
METHODS

Locusts (n=20) placed in the set-up (A) were presented with simple and complex object motion trajectories (7 cm disc at 3 m/s, B) during multichannel recording from the ventral nerve cord (C).

A

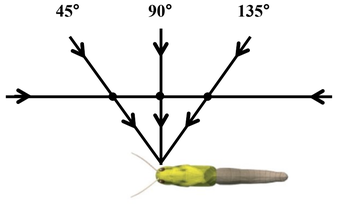


Rear projection screen

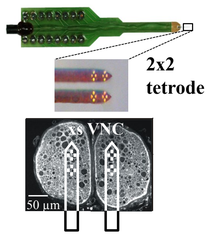


Recording set-up

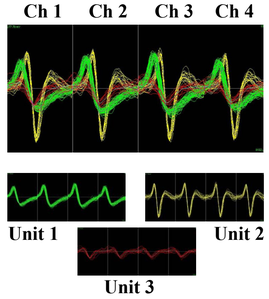
B



C



Electrode configuration

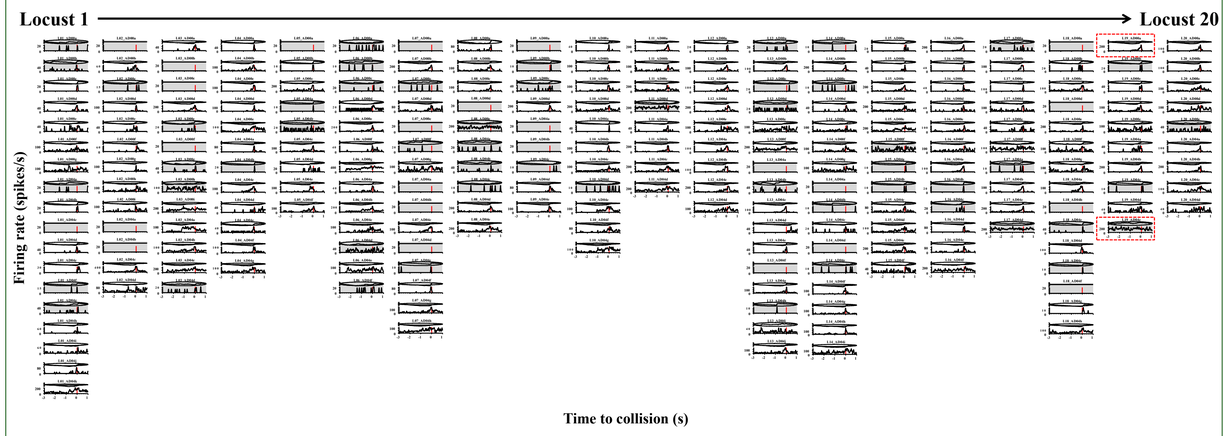


Spike sorting

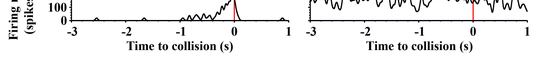
RESULTS

Multineuronal responses to looming from 90°

Responses of discriminated units from each locust presented with a 90° loom. Data plotted as a cumulative sum within a 99% confidence interval ellipse (top) and peristimulus time histogram (bottom) of Gaussian-smoothed (50 ms bin) firing rate aligned to time of projected collision (red vertical line).



Sample responses to looming (red dashed outline)

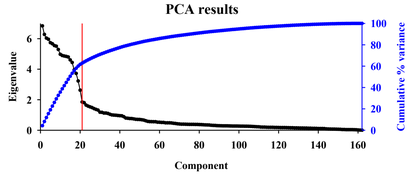


Unit looming response statistics (mean ± S.D./locust)			
	Total units	Response	No response
#	240 (12 ± 2.8)	162 (8 ± 2.1)	78 (4 ± 2.4)
%		67.5 (69)	32.5 (31)

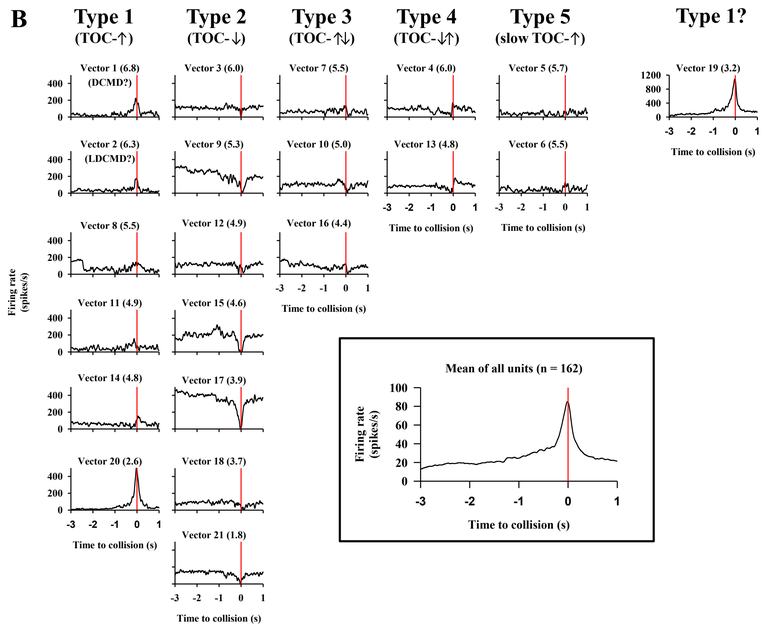
Principle component analysis reveals unique response types

A) Scree plot from PCA (50 ms bins) on units responding to looming (non-shaded above). 21 components with eigenvalues >1 (red line) accounted for 63% of the variation in the data. B) Population vectors (with eigenvalues) of 21 components responding to looming from 90° were divided into 5 general response types based on time of collision (TOC)-associated firing rate modulation. Inset - average response to looming from 162 units.

A

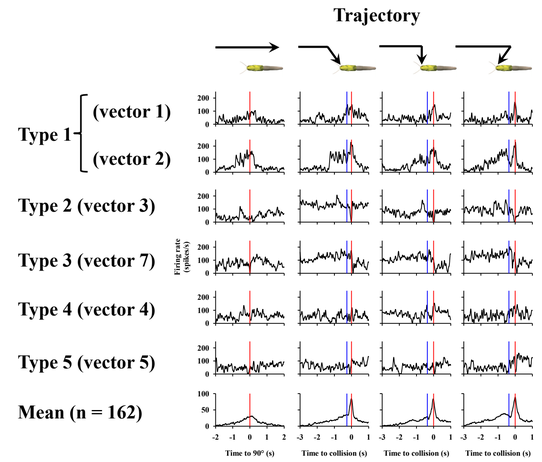


B



Type responses to different trajectories

Firing rates of vectors with largest eigenvalues from each Type (plus vector 2 from Type 1) were aligned (red line) with time at 90° azimuth (T90, translating) or TOC (compound). Blue line indicates time of transition (TOT). Bottom plots represent mean firing rate of all units (n = 162).



SUMMARY

- **Multiple locust neurons (mean = 8) respond to a looming object.**
- **PCA reveals 5 response types based on TOC-associated firing rate modulation.**
- **Response type activity reflects properties of compound object motion.**
- **Future analysis and experiments will examine relationships across types and responses in flying locusts, respectively.**

ACKNOWLEDGEMENTS & REFERENCES

Acknowledgements

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References

[1]Gray et al. (2010) *J. Comp. Physiol. A.* 196:927-38. [2]Santer et al. (2006) *J. Neurophysiol.* 95:3391-3400. [3]Santer et al. (2007) *J. Comp. Physiol. A.* 194:69-77. [4]Fotowat & Gabbiani (2007) *J. Neurosci.* 27:10047-59. [5]McMillan & Gray (2012) *J. Neurophysiol.* 108:1052-68.