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The decision to move: response times, neuronal circuits and sensory memory in a simple vertebrate

Alan Roberts, Roman Borisyuk, Edgar Buhl, Andrea Ferrario, Stella Koutsikou, Wen-Chang Li and Stephen R. Soffe

Article citation details
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Review timeline

Original submission:	4 February 2019	
Revised submission:	27 February 2019	
Final acceptance:	28 February 2019	

Note: Reports are unedited and appear as submitted by the referee. The review history appears in chronological order.

Review History

RSPB-2019-0297.R0 (Original submission)

Review form: Reviewer 1

Recommendation
Accept with minor revision (please list in comments)

Scientific importance: Is the manuscript an original and important contribution to its field?
Good

General interest: Is the paper of sufficient general interest?
Excellent

Quality of the paper: Is the overall quality of the paper suitable?
Good

Is the length of the paper justified?
Yes

Should the paper be seen by a specialist statistical reviewer?
No

Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.
No

It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.

Is it accessible?
N/A

Is it clear?
N/A

Is it adequate?
N/A

Do you have any ethical concerns with this paper?
No

Comments to the Author
Could maybe extend the introduction to say what is known generally about reaction times etc… The focus on eye movements is ok, but there are other aspects to consider, and even for eye movements there are various models that can be briefly outlined.

Line 56-58: What pathways are referred to here? From eyes to cortex, but what areas are referred to here, the visual cortex or frontal eye fields etc..?

Line 113: Expand on the cf to reference 28. What differs in this reference to the five functional stages mentioned here?

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Line 210: "major and critical", this statement can be deleted, it seems to over emphasise something that can be covered just by saying "The conclusion…".

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Line 284: I can see how variability in direction could help in avoiding predation, but how would variability in the delay to onset help?

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Review form: Reviewer 2 (Donald H Edwards)

Recommendation
Accept as is

Scientific importance: Is the manuscript an original and important contribution to its field?
Excellent

General interest: Is the paper of sufficient general interest?
Excellent

Quality of the paper: Is the overall quality of the paper suitable?
Excellent

Is the length of the paper justified?
Yes

Should the paper be seen by a specialist statistical reviewer?
No

Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.
No

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N/A

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Comments to the Author
This is a lovely paper that reviews recent evidence for a small network of “sensory memory” cells interposed between the sensory input and hindbrain decision networks, and provides a theory of how the entire system works to provide the tadpole with a variable delay escape response to unexpected stimuli. All higher animals have both short latency emergency escape responses and longer latency, more variable responses. These have been studied most completely in the crayfish and larval fish, where the escape circuits have been completely traced and the long-latency circuits have been outlined but not described in detail. This paper shows that a small network of neurons in the hindbrain of larval zebrafish responds to a brief touch of the animal’s trunk with an extended discharge that serves as a “sensory memory” of the touch. The discharge climbs, and if it reaches threshold for exciting reticulospinal networks that excites spinal motor circuits, the animal will initiate a swimming response. The hindbrain network is known largely for its effects, producing accumulating EPSPs in postsynaptic neurons that then fire repeatedly; the actual cells themselves remain unidentified. A computational simulation is described (but not presented) which shows that a self-exciting network can serve the role of the hindbrain network. The networks described here for “sensory memory” are likely to be common among many species. In crayfish, for example, the non-giant swimming network generates long-latency swimming only to an UNEXPECTED touch. A much shorter latency (little longer than the command-evoked escapes) occurs when the attack is expected. The longer time needed for unexpected attacks is to use the “sensory memory” to generate an appropriate motor plan in response to the site of the attack. That planning is done before an expected attack as the crayfish sees the attacker approaching.
This paper provides a valuable foundation for exploration the neural mechanisms of voluntary movements in a tractable system.

Decision letter (RSPB-2019-0297.R0)

25-Feb-2019

Dear Dr Roberts

I am pleased to inform you that your manuscript RSPB-2019-0297 entitled "The decision to move: response times, neuronal circuits and sensory memory in a simple vertebrate." has been accepted for publication in Proceedings B.

The referee(s) have recommended publication, but also suggest some minor revisions to your manuscript. Therefore, I invite you to respond to the referee(s)' comments and revise your manuscript. Because the schedule for publication is very tight, it is a condition of publication that you submit the revised version of your manuscript within 7 days. If you do not think you will be able to meet this date please let us know.

To revise your manuscript, log into https://mc.manuscriptcentral.com/prsb and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript and upload a new version through your Author Centre.

When submitting your revised manuscript, you will be able to respond to the comments made by the referee(s) and upload a file "Response to Referees". You can use this to document any changes you make to the original manuscript. We require a copy of the manuscript with revisions made since the previous version marked as 'tracked changes' to be included in the 'response to referees' document.

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2) A separate electronic file of each figure (tiff, EPS or print-quality PDF preferred). The format should be produced directly from original creation package, or original software format. PowerPoint files are not accepted.

3) Electronic supplementary material: this should be contained in a separate file and where possible, all ESM should be combined into a single file. All supplementary materials accompanying an accepted article will be treated as in their final form. They will be published alongside the paper on the journal website and posted on the online figshare repository. Files on figshare will be made available approximately one week before the accompanying article so that the supplementary material can be attributed a unique DOI.

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4) A media summary: a short non-technical summary (up to 100 words) of the key findings/importance of your manuscript.

5) Data accessibility section and data citation
It is a condition of publication that data supporting your paper are made available either in the electronic supplementary material or through an appropriate repository.

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- Final DNA sequence assembly uploaded as online supplemental material
- Climate data and MaxEnt input files: Dryad doi:10.5521/dryad.12311

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Once again, thank you for submitting your manuscript to Proceedings B and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Sincerely,

Proceedings B
mailto: proceedingsb@royalsociety.org

Associate Editor
Board Member: 1
Comments to Author:
This is a very nice paper on the sensory memory system in the tadpole. I am pleased to recommend that it be accepted with only minor revisions. Please see a few suggestions from the two reviewers.

Cheers,
Sarah Brosnan

Reviewer(s)' Comments to Author:

Referee: 1

Comments to the Author(s)
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Line 229: What role could inhibition serve? Is there a possibility that inhibition may be acting in this decision making circuit, and are their candidate inhibitory neurons? Were any models made using inhibition, or testing other mechanisms as opposed to testing the assumption that the putative exN’s were responsible for the input to the hdINs?

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Line 284: I can see how variability in direction could help in avoiding predation, but how would variability in the delay to onset help?

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Referee: 2

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swimming only to an UNEXPECTED touch. A much shorter latency (little longer than the command-evoked escapes) occurs when the attack is expected. The longer time needed for unexpected attacks is to use the "sensory memory" to generate an appropriate motor plan in response to the site of the attack. That planning is done before an expected attack as the crayfish sees the attacker approaching.
This paper provides a valuable foundation for exploration the neural mechanisms of voluntary movements in a tractable system.

Author's Response to Decision Letter for (RSPB-2019-0297.R0)

Referee: 1

Comments to the Author(s)
Could maybe extend the introduction to say what is known generally about reaction times etc… The focus on eye movements is ok, but there are other aspects to consider, and even for eye movements there are various models that can be briefly outlined.
The Introduction has been reduced to comply with length limit.

Line 56-58: What pathways are referred to here? From eyes to cortex, but what areas are referred to here, the visual cortex or frontal eye fields etc..?
The aim of this short review was mainly to cite reviews of work on other systems and refs 7 to 12 cover this paragraph.

Line 113: Expand on the cf to reference 28. What differs in this reference to the five functional stages mentioned here?
Sentence expanded to say: "as does the leech [28]."

Line 206: How easily can you rule out the dlc neurons as contributing to the EPSPs in Fig. 3e-f? It is possible to say that something does occur, but to state strongly that it could not occur is not so straightforward. I can see that the evidence you have suggests against a role for these cells, but can it be so strongly ruled out?
Sentence changed to: "It is difficult to see how this pattern of EPSPs could be produced directly by the brief burst of spikes fired at short latency by sensory pathway dlc neurons."

Line 210: "major and critical", this statement can be deleted, it seems to over emphasise something that can be covered just by saying "The conclusion…".
"major and critical" replaced by "novel".

Line 215: How variable is the firing of the exN neurons, is this greater than the variability of other types of cell etc… Is there anything more that you can say about these cells?
Further comments are not appropriate until more evidence is available on these neurons.

Line 224: Can you elaborate on the variability in synaptic strength in your model and the match to the activity in the hdINs? I realise this is referenced, but a little more detail here would help to follow the evidence for the role of these cells.
Inserted: "(maximum conductance of each synapse scaled by a randomly chosen value: 0.8, 0.6, 0.4, 0.2 or 0)"

Line 229: What role could inhibition serve? Is there a possibility that inhibition may be acting in this decision making circuit, and are their candidate inhibitory neurons? Were any models made

using inhibition, or testing other mechanisms as opposed to testing the assumption that the putative exN's were responsible for the input to the hdINs?
Inhibition is discussed later.

Line 253: Given that you don't know much about the exN's this section should probably say the exN's could combine two functions rather than saying that they do.
We have used the conditional as suggested.

Line 268: Some discussion of other models than variable integration would be useful. For example, striatal direct and indirect pathways in deciding whether a movement should/should not be released. This is also involved in the decision to make eye movements to a target (Hikosaka et al 2000).
A huge amount of material is not included because of lack of space.

Line 284: I can see how variability in direction could help in avoiding predation, but how would variability in the delay to onset help?
Any answer here would be speculative and complex!
The overview (from line292) makes some quite strong conclusions about the role of the exN's. Given the limited data available on these cells this section should be more measured in the claims for what these cells do and how they do it. The suggestions you make are fine, and serve as useful hypotheses for future work on these cells, but this section tends to read as if the role of these cells is known (you have stated earlier that little is known of these cells).
We have made the claims more measured.

Referee: 2
No responses requested.

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Decision letter (RSPB-2019-0297.R1)

28-Feb-2019

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You can expect to receive a proof of your article from our Production office in due course, please check your spam filter if you do not receive it. PLEASE NOTE: you will be given the exact page length of your paper which may be different from the estimation from Editorial and you may be asked to reduce your paper if it goes over the 10 page limit.

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Thank you for your fine contribution. On behalf of the Editors of the Proceedings B, we look forward to your continued contributions to the Journal.

Sincerely,
Proceedings B
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