Optogenetic manipulation of Drosophila larval motor circuits

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OPTOGENETIC MANIPULATION OF DROSOPHILA LARVA MOTOR CIRCUITS

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RATIONAL

PURPOSE:
Identify specific interneuron populations involved in muscle contraction in Drosophila larva through ontogenetic manipulation of motor neural circuits.

PREVIOUS FINDINGS:

<table>
<thead>
<tr>
<th>Control</th>
<th>7009</th>
</tr>
</thead>
<tbody>
<tr>
<td>36494</td>
<td>27637</td>
</tr>
<tr>
<td>Ventral Oblique</td>
<td>Ventral Longitudinal Lateral Transverse Lateral Oblique Dorsal Longitudinal</td>
</tr>
</tbody>
</table>

Figure 1: Muscle contraction order during forward crawling (Decker and Schaefer, 2014)

REFERENCES:

ACKNOWLEDGEMENTS:
Thank you to MC Decker for the use of her data in Figure 1.

METHODS

1. Use GAL4-UAS system to generate larvae with channelrhodopsin2 embedded in cell membranes of interneuron populations of interest.

2. Collect extracellular recordings of muscles during contraction in the dissected Drosophila larva. ChR2-stimulated action potentials lead to depolarizing potentials and contraction in muscle cells if the interneuron population of interest is important for Drosophila crawling neural circuits.

3. Compare recordings from negative control, positive control, and experimental populations to identify which interneuron populations are sufficient to generate muscle excitation. These interneuron populations are putative constituents of the Drosophila larval crawling neural circuity.

Table 1. Drosophila stock expression patterns

<table>
<thead>
<tr>
<th>Stock</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK371</td>
<td>Motor neurons (positive control)</td>
</tr>
<tr>
<td>6793</td>
<td>Acetylcholine</td>
</tr>
<tr>
<td>7009</td>
<td>Dopamine and serotonin</td>
</tr>
<tr>
<td>36494</td>
<td>Tyramine and octopamine</td>
</tr>
<tr>
<td>27637</td>
<td>Serotonin receptor 1B</td>
</tr>
<tr>
<td>24635</td>
<td>Glutamate</td>
</tr>
</tbody>
</table>

RESULTS

Figure 3: Extracellular recording of natural depolarizing potentials of Wild type muscle cells during contraction

Figure 4: Extracellular recording of depolarizing potentials in response to blue light activation of OK371 x ChR2 (motor neurons)

FUTURE DIRECTIONS

1. Extracellular recording from specific muscle groups to determine which interneuron populations are sufficient to generate muscle excitation in specific muscle groups.

2. Optogenetic activation of interneuron populations of interest with severed connections to the ganglia and brain lobes to determine if muscular excitation is dependent on communication with the brain, or if activation of interneuron populations is sufficient to generate muscle excitation.