

Representation and processing of odor information in the antennal lobe of *Drosophila melanogaster*

Dissertation zur Erlangung des akademischen Grades des
Doktors der Naturwissenschaften (Dr. rer. nat.)

eingereicht im Fachbereich Biologie, Chemie, Pharmazie
der Freien Universität Berlin

vorgelegt von

Ana Florencia Silbering
aus Buenos Aires, Argentinien

April, 2007

1. Gutachter: Prof. Dr. Randolph Menzel
2. Gutachter: Prof. Dr. C. Giovanni Galizia

Disputation am 30.05.2007

Chapters I and II are based on the following manuscripts:

- I. Odor concentration coding in the antennal lobe of *Drosophila melanogaster*
Silbering, A.F.; Okada, R.; Ito, K. and Galizia, C.G.
- II. Global inhibition and glomerulus specific connections shape the output of the antennal lobe in *Drosophila*
Silbering, A.F. and Galizia, C.G.

The following people contributed to these manuscripts:

- I. I performed all PN and LN recordings and some OSN recordings, analyzed the data and wrote the manuscript. R. Okada and K. Ito obtained and provided LN fly strains. Beate Eisermann performed most OSN recordings. Experimental design, data analysis and the manuscript were discussed with Giovanni Galizia.
- II. I performed all experiments and data analysis, and wrote the manuscript. Experimental design data analysis and the manuscript were discussed with Giovanni Galizia.

Table of contents

FIGURE AND TABLE INDEX -----	5
ABBREVIATIONS -----	6
INTRODUCTION -----	7
CHAPTER I -----	13
ODOR CONCENTRATION CODING IN THE ANTENNAL LOBE OF <i>DROSOPHILA</i>	
MELANOGASTER -----	13
<i>Summary</i> -----	<i>13</i>
<i>Introduction</i> -----	<i>13</i>
<i>Materials and Methods</i> -----	<i>15</i>
<i>Results</i> -----	<i>20</i>
<i>Discussion</i> -----	<i>35</i>
<i>Acknowledgements</i> -----	<i>39</i>
CHAPTER II -----	40
GLOBAL INHIBITION AND GLOMERULUS SPECIFIC CONNECTIONS SHAPE THE OUTPUT OF	
THE ANTENNAL LOBE IN <i>DROSOPHILA</i> -----	40
<i>Summary</i> -----	<i>40</i>
<i>Introduction</i> -----	<i>40</i>
<i>Materials and Methods</i> -----	<i>42</i>
<i>Results</i> -----	<i>48</i>
<i>Discussion</i> -----	<i>62</i>
<i>Acknowledgements</i> -----	<i>65</i>
<i>Appendix</i> -----	<i>66</i>
CONCLUSIONS -----	67
SUMMARY -----	72
ZUSAMMENFASSUNG -----	73
REFERENCE LIST -----	75
ACKNOWLEDGEMENTS -----	83
CURRICULUM VITAE -----	85

Figure and Table Index

FIGURE 1.1 - ODOR RESPONSES IN THE ANTENNAL LOBE OF <i>DROSOPHILA</i> -----	21
FIGURE 1.2 - SPATIAL RESPONSE PATTERNS ARE ODOR AND NEURON-TYPE SPECIFIC -----	22
FIGURE 1.3 - TEMPORAL RESPONSE PATTERNS ARE ODOR AND NEURON TYPE SPECIFIC -----	24
FIGURE 1.4 - INCREASING CONCENTRATIONS ACTIVATE MORE GLOMERULI AND INCREASE RESPONSE AMPLITUDES-----	27
FIGURE 1.5 - INCREASING CONCENTRATION CHANGES THE RESPONSE DYNAMICS IN SOME GLOMERULI -----	29
FIGURE 1.6 - COMBINATORIAL ODOR RESPONSES ACROSS CONCENTRATIONS FOR THE THREE TESTED ODORS-----	30
FIGURE 1.7 - INTERGLOMERULAR INTERACTIONS MODIFY THE COMBINATORIAL ODOR REPRESENTATION -----	32
FIGURE 2.1 - REPRESENTATION OF ODOR MIXTURES IN THE AL -----	50
FIGURE 2.2 - MIXTURE SUPPRESSION AT THE OSN LEVEL-----	52
FIGURE 2.3 - MIXTURE INTERACTIONS IN OSNS AND PNs -----	54
FIGURE 2.4 - OSNS AND PNs SHOW DIFFERENT MIXTURE INTERACTION PROFILES-----	56
TABLE 2.1 - CORRELATION BETWEEN INPUT AND INTERACTION INDEX IN SINGLE GLOMERULI -	57
FIGURE 2.5 - GLOMERULUS SPECIFIC INTERACTIONS SHAPE MIXTURE RESPONSES IN PNs -----	58
FIGURE 2.6 - PTX MODULATES PN RESPONSES-----	61
TABLE S1 - RESPONSES TO THE MIXTURES AND LOWER BOUND OF THE NO-INTERACTION INTERVAL -----	66
FIGURE 3.1 - TRANSFORMATION OF ODOR REPRESENTATIONS IN THE AL - TWO MODELS-----	71

Abbreviations

ACh	Acetyl choline
AL	Antennal lobe
cAMP	cyclic adenosine monophosphate
GABA	γ -amino butyric acid
GPCR	G-protein coupled receptor
IP ₃	Inositol triphosphate
KC	Kenyon cell
LN	Local neuron
MC	Mitral cell
OB	Olfactory bulb
Or	Odorant receptor gene
OR	Odorant receptor protein
OSN	Olfactory sensory neuron
PN	Projection neuron
Q ₂₅	First quartile
Q ₇₅	Third quartile