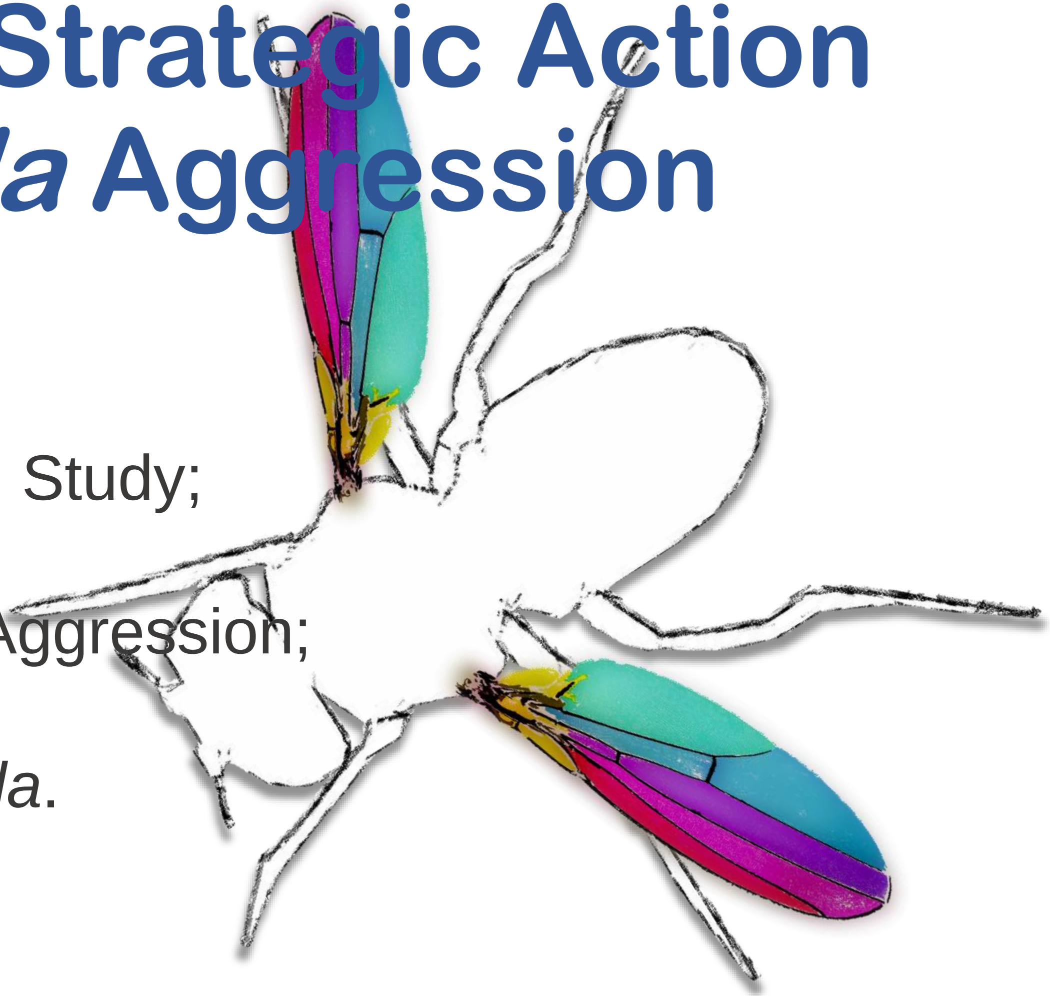
Neuromodulation and Strategic Action Choice in *Drosophila* Aggression



- Overview of The *Drosophila* Aggression Study;
- Strategic Action Choices in *Drosophila* Aggression;
- The winner and loser effect in *Drosophila*.

2021/3/4

Can Gao , Xiaoxiao Ji , Caihong Han

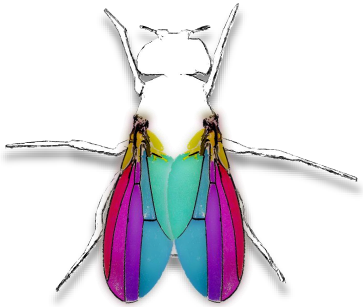
What is the purpose of aggression?

Food

Mating partners

Habitats

Stable dominance hierarchies (among social animals)



Overview of The *Drosophila* Aggression Study

Gao Can

The history of *Drosophila* aggression study

Alfred Henry Sturtevant
(1891 –1970)

Geographic Variation in the Territorial Success of *Drosophila melanogaster* Males

Ary A. Hoffmann[1]

Ary Hoffmann

Edward Kravitz

2008

Caltech

David Anderson

PNAS

A common genetic target for environmental and heritable influences on aggressiveness in *Drosophila*

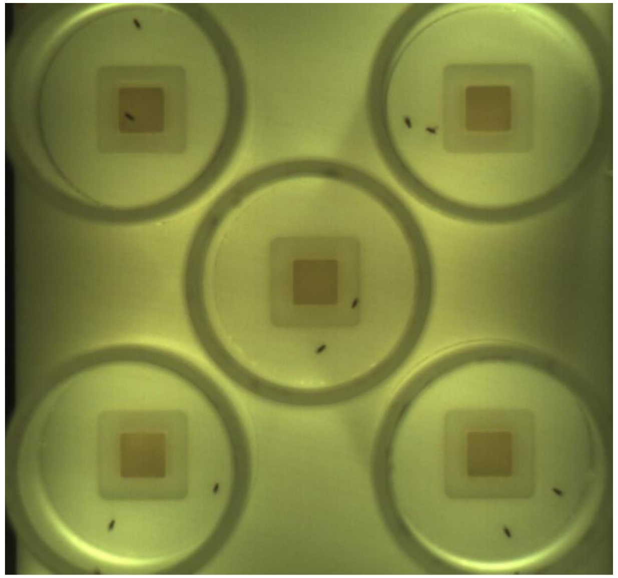
Liming Wang*, Heiko Dankert*†, Pietro Perona†, and David J. Anderson*‡§

*Division of Biology 216-76 and †Engineering and Applied Sciences 136-93 and ‡Howard Hughes Medical Institute, California Institute of Technology, Pasadena, CA 91125

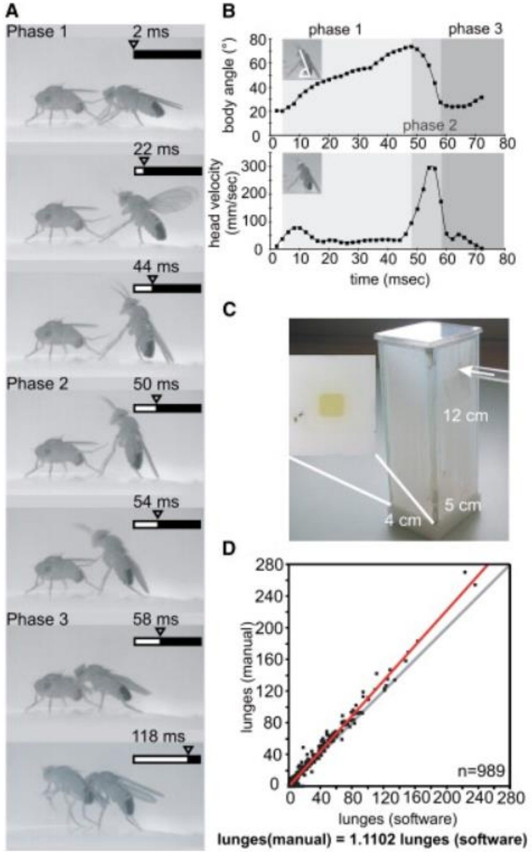
This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected on May 1, 2007.

Contributed by David J. Anderson, February 11, 2008 (sent for review November 12, 2007)

INAUGURAL ARTIC



The behavior of five pairs was video-captured for 20 min and analyzed manually, by counting the number of lunges in each arena.



Werner Heisenberg

Theoretical Physicist

Werner Karl Heisenberg was a German theoretical physicist and one of the key pioneers of quantum mechanics. He published his work in 1925 in a breakthrough paper. In the subsequent series of papers with Max Born and Pascual Jordan, during the same year, this matrix formulation of quantum mechanics was substantially elaborated. He is known for the uncertainty principle, which he published in 1927. Heisenberg was awarded the 1932 Nobel Prize in Physics "for the creation of quantum mechanics".

Wikipedia

Lived: Dec 05, 1901 - Feb 01, 1976 (age 74)

Spouse: Elisabeth Heisenberg (m. 1937)

Academic advisors: Max Born · Arnold Sommerfeld · Niels Bohr

Awards: Nobel Prize in Physics (1932) · Max Planck Medal (1933)

Education: Ludwig Maximilian University of Munich (1920 - 1923) · University of Göttingen

Children: Barbara Heisenberg (Daughter) · Martin Heisenberg (Son) · Jochen Heisenberg (Son) · Maria Heisenberg (Daughter) +

Martin Heisenberg

Martin Heisenberg is a German neurobiologist and geneticist. Before his retirement in 2008, he held the professorial chair for genetics and neurobiology at the Bio Centre of the University of Würzburg. Since then, he continues his research with a senior professorship at the Rudolf Virchow Center of the University of Würzburg. Heisenberg studied chemistry and molecular biology in Munich, Tübingen and Pasadena. In 1975 he became Professor of genetics and neurobiology at the University of Würzburg. Heisenberg's work has focused on the neurogenetics of Drosophila, with the aim of investigating the genetic foundations of the Drosophila brain by studying the effect of genetic mutations on brain function. In addition, Heisenberg contributed a number of essays on the topics of science in society, perception, as well as the question of the freedom of the will. He was elected as a member of the Leopoldina in 1989.

Wikipedia

Born: Aug 07, 1940 (age 80) · Munich, Germany

Spouse: Apollonia Gräfin zu Eulenburg

Parents: Werner Heisenberg (Father) · Elisabeth Heisenberg (Mother)

Siblings: Jochen Heisenberg (Brother) · Barbara Heisenberg (Sister) · Maria Heisenberg (Sister) · Wolfgang Heisenberg (Brother) +

Children: Benjamin Heisenberg (Son)

Education: University of Tübingen

Benjamin Heisenberg

German Film Director

Benjamin Heisenberg is a German film director and screenwriter. He has directed sixteen films since 1995. His film Schläfer was screened in the Un Certain Regard section at the 2005 Cannes Film Festival. His 2010 film, The Robber, was nominated for the Golden Bear at the 60th Berlin International Film Festival. He is also the grandson of Nobel Prize winning physicist Werner Heisenberg via father Martin Heisenberg. He is co-editor and co-publisher of the German film magazine Revolver.

Wikipedia IMDb

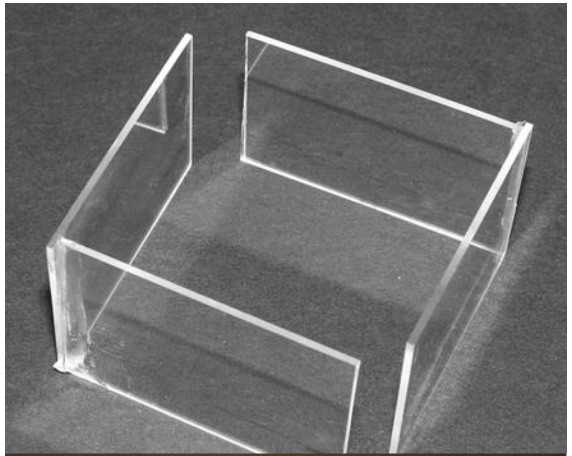
Born: Jun 09, 1974 (age 46) · Tübingen, Germany

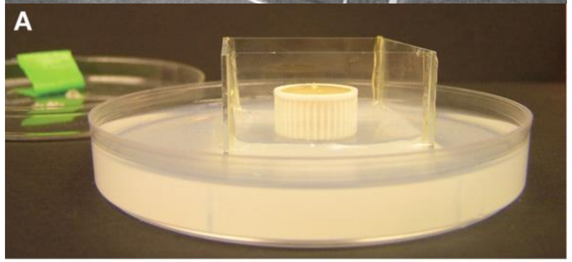
Parents: Martin Heisenberg (Father) · Apollonia Gräfin zu Eulenburg (Mother)

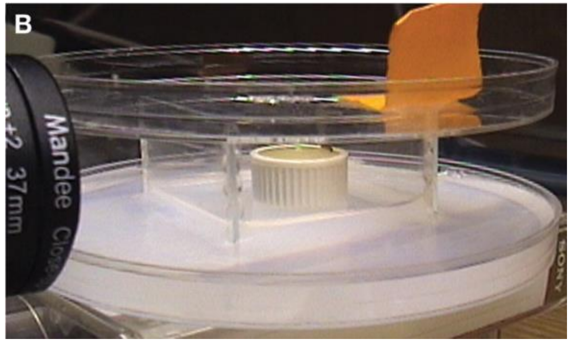
Education: Academy of Fine Arts, Munich

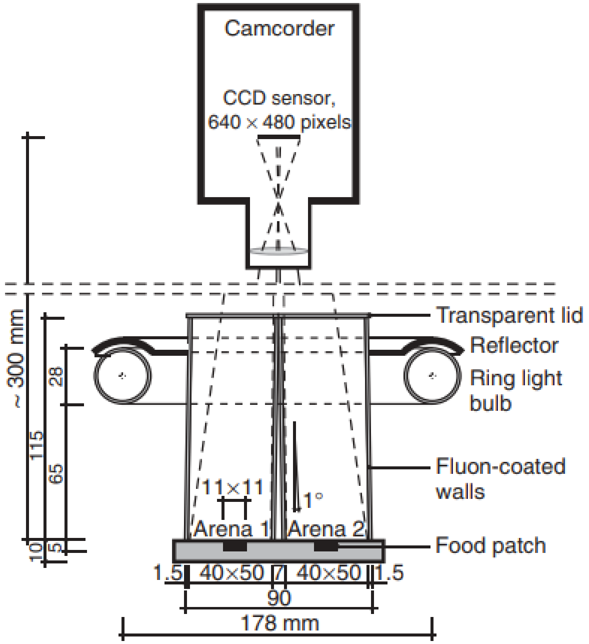
Siblings: Jochen Heisenberg (Brother)

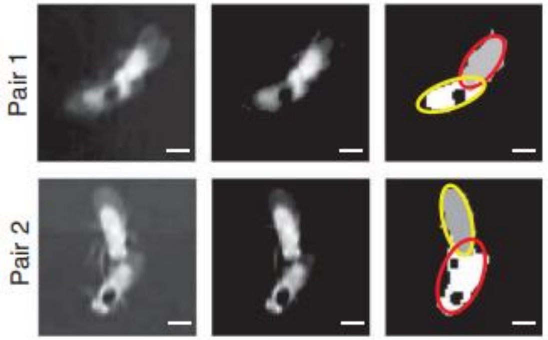
Two main paradigms of *Drosophila* aggression study

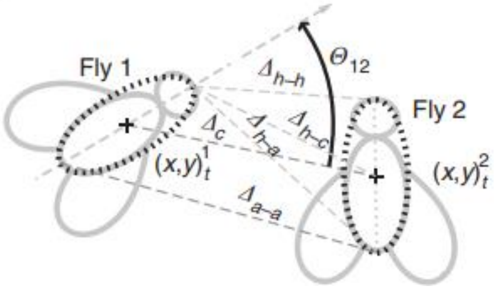












Behavioral System

- Arena
- Food
- Female

Recording System

- Camera
- Computer
- Light

Analysis System

- Human
- Semi-automatic software
- Fully-automatic software

Computational Vision at CALTECH

Home | Research | Publications | Data Sets | Courses | People

People


Sara Beery
* PhD Student


Eli Cole
PhD Student


Mason McGill
PhD Student


Joe Marino
* PhD Student


Caroline Murphy
* Group Administrator


Neehar Kondapaneni
PhD Student
=


Serim Ryou
* PhD Student


Jennifer Sun
PhD Student


Tony Zhang
* PhD Student

* = Photo by Ruud Barth


Pietro Perona
*Principal Investigatorœ

Vision Lab Alumni

PhDs

Matteo Ruggero Ronchi 2020
Grant Van Horn 2019
Ron Appel 2017
David Hall 2017
Krzysztof Chalupka 2017
Bo Chen 2016
Eyrun Eyjolfsdottir 2014
Carlos Gonzáles 2015
Greg Griffin 2013
Peter Welinder 2012
Ryan Gomes 2011
Marco Andreetto 2011
Mohamed Aly 2011
Merrielle Spain 2011
Anelia Angelova 2008
Claudio Fanti 2008
Pierre Moreels 2008
Anelia Angelova 2008
Christophe Basset 2007
Alex Holub 2007
Fei Fei Li 2005
SIlvio Savarese 2005
Domitilla del Vecchio 2005
Yang Song 2003
Xiaolin Feng 2002
Luis Goncalves 2000
Markus Weber 2000
Mario Enrique Munich 2000
Jean-Yves Bouguet 1999
Mike Burl 1997
Christophe Kolb 1997
Stefano Soatto 1996
Jennifer Sun 1996

Postdocs

Steve Branson
Boris Babenko
Evgeniy Bart
Arrigo Benedetti
Kristin Branson
Heiko Dankert
Piotr Dollar
Lihi Zelnik-Manor
Enrico Di Bernardo
Dieter Koller
Ali Lashgari
Michael Maire
Roberto Manduchi
Marzia Polito
Gudrun Socher
Yang Song
Marco Tartagni
Joe Weber
Max Welling

Pietro Perona

Eyjolfsdottir, Eyrun and Branson, Kristin and Yue, Yisong and Perona, Pietro (2017) *Learning recurrent representations for hierarchical behavior modeling.* In: 5th International Conference on Learning Representations (ICLR), 24-26 April 2017, To
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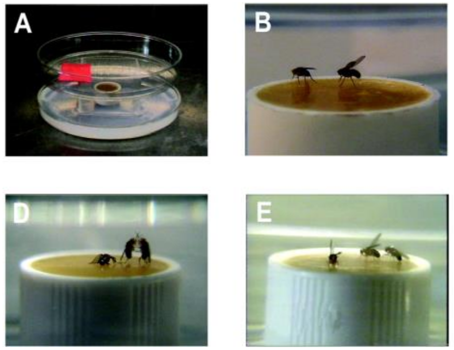
Edward Kravitz
David Anderson

2002

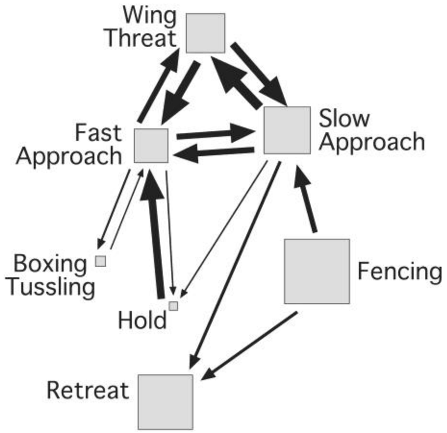
Fighting fruit flies: A model system for the study of aggression

PNAS

Selby Chen, Ann Yeelin Lee, Nina M. Bowens, Robert Huber, and Edward A. Kravitz



	Slow Approach	Fast Approach	Wing Threat	Fencing	Holding	Boxing Tussling	Retreat	Σ
Slow Approach	-	188	330	479	13	9	243	1262
Fast Approach	330	-	126	187	7	8	13	671
Wing Threat	437	148	-	213	6	5	35	844
Fencing	1437	112	214	-	8	20	421	2212
Holding	6	34	0	1	-	0	0	41
Boxing/ Tussling	19	4	4	14	1	-	4	46
Retreat	75	36	82	1059	1	7	-	1260
Σ	2304	522	756	1953	36	49	716	6336

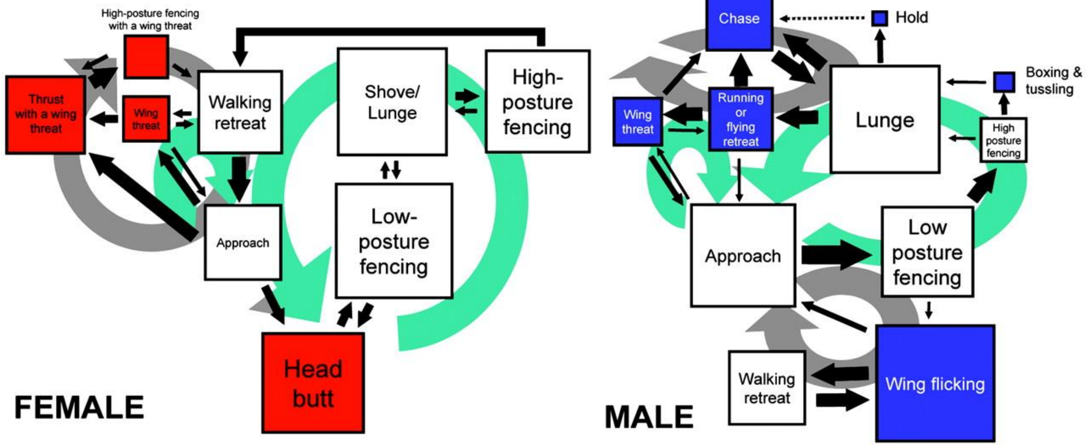


2004

Gender-selective patterns of aggressive behavior in *Drosophila melanogaster*

PNAS

Steven P. Nilsen, Yick-Bun Chan, Robert Huber, and Edward A. Kravitz

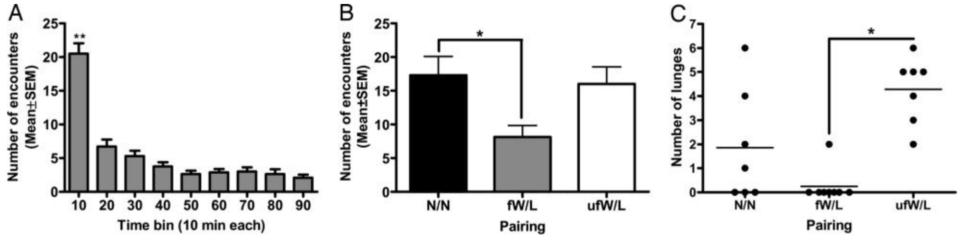


2006

PNAS

Learning and memory associated with aggression in *Drosophila melanogaster*

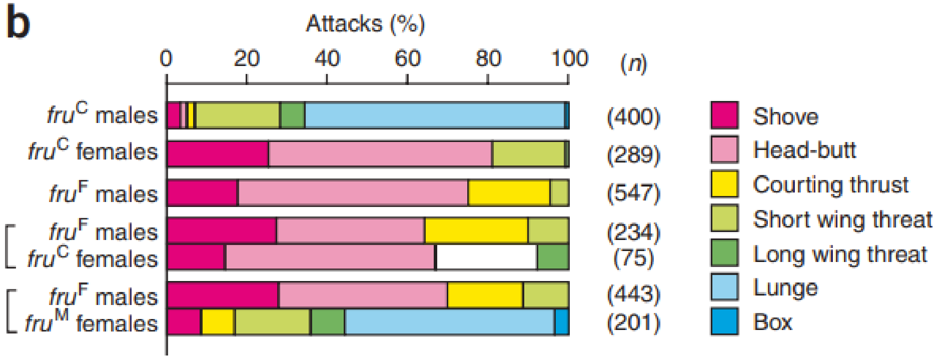
Alexandra Yurkovic, Oulu Wang, Alo C. Basu, and Edward A. Kravitz



nature neuroscience

fruitless regulates aggression and dominance in *Drosophila*

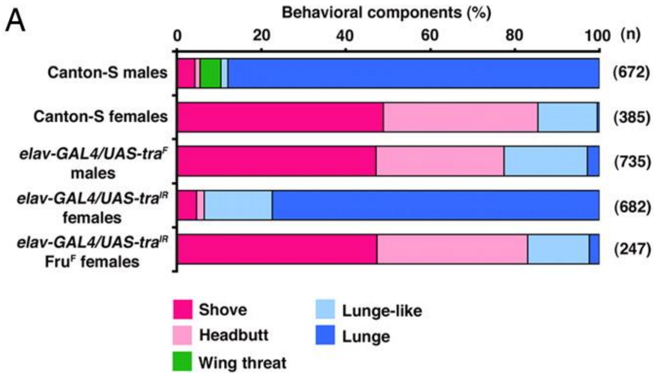
Eleftheria Vrontou[1], Steven P Nilsen[2], Ebru Demir[1], Edward A Kravitz[2] & Barry J Dickson[1]

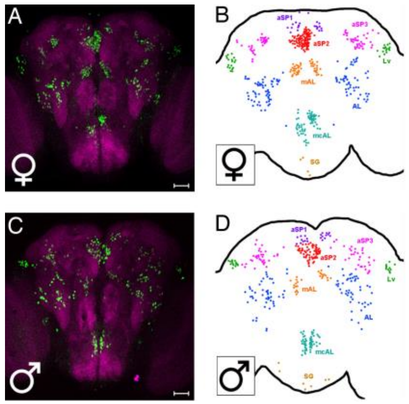


2007

PNAS

Specific subgroups of Fru^M neurons control sexually dimorphic patterns of aggression in *Drosophila melanogaster*





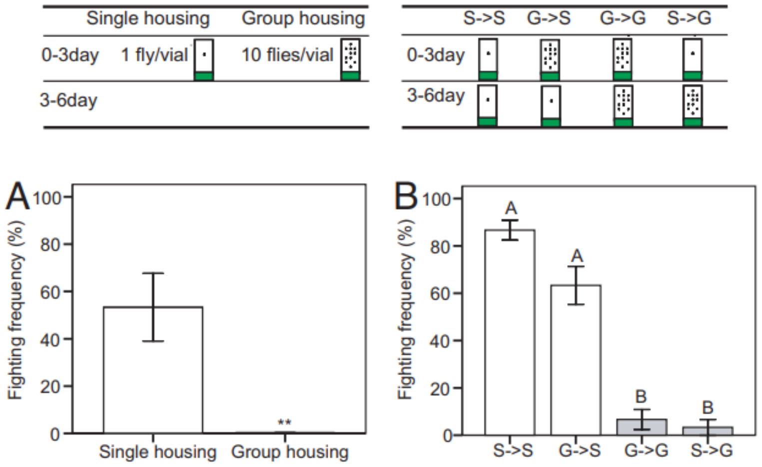
Group	Cell cluster	Canton-S (M)	I(3)31-GAL4/UAS-tra^{IR} (F)	1407-GAL4/UAS-tra^{IR} (F)	c1003-GAL4/UAS-tra^{IR} (F)	60IIA-GAL4/UAS-tra^{IR} (F)
1	*fru*-mAL	23 ± 2	25 ± 3	23 ± 5	17 ± 4	9 ± 4
	fru-PrMs	73 ± 7	68 ± 6	64 ± 6	54 ± 6	33 ± 3
2	*fru*-aSP2	42 ± 5	37 ± 6	38 ± 5	26 ± 6	12 ± 2
	fru-mcAL	31 ± 1	23 ± 4	25 ± 3	16 ± 4	12 ± 2
3	*fru*-AL	52 ± 6	40 ± 3	45 ± 8	37 ± 5	39 ± 5
	fru-P	56 ± 7	31 ± 5	32 ± 7	31 ± 5	38 ± 8
	fru-MsMt	38 ± 8	30 ± 4	33 ± 4	28 ± 6	18 ± 2
4	*fru*-aSP1	12 ± 2	12 ± 2	11 ± 3	11 ± 3	10 ± 2
	fru-aSP3	29 ± 5	31 ± 4	31 ± 3	24 ± 2	28 ± 5
	fru-SG	11 ± 2	3 ± 1	6 ± 2	1 ± 1	2 ± 1
	fru-pSP1	9 ± 2	3 ± 2	5 ± 2	3 ± 2	4 ± 1
	fru-pSP2	18 ± 3	16 ± 1	15 ± 1	12 ± 2	13 ± 2
	fru-pL	12 ± 2	10 ± 1	8 ± 4	5 ± 3	6 ± 3

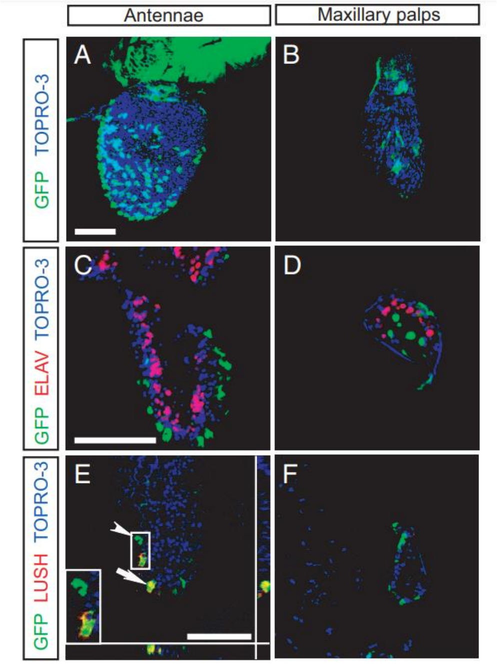
2008

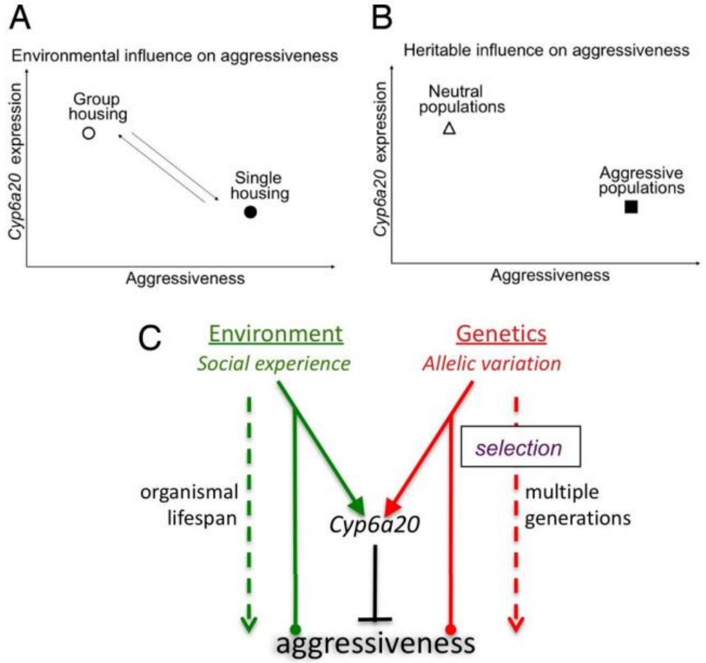
PNAS

A common genetic target for environmental and heritable influences on aggressiveness in *Drosophila*

Liming Wang*, Heiko Dankert*†, Pietro Perona†, and David J. Anderson*‡§





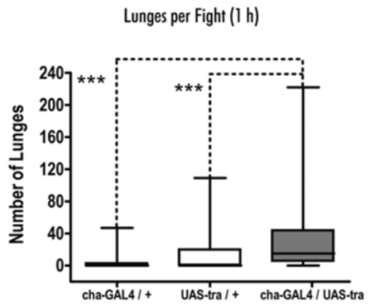


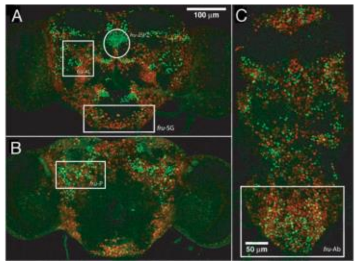
2009

Fly

Feminizing cholinergic neurons in a male Drosophila nervous system enhances aggression

Sibu Mundiyanapurath, Yick-Bun Chan, Adelaine K.W. Leung & Edward A. Kravitz

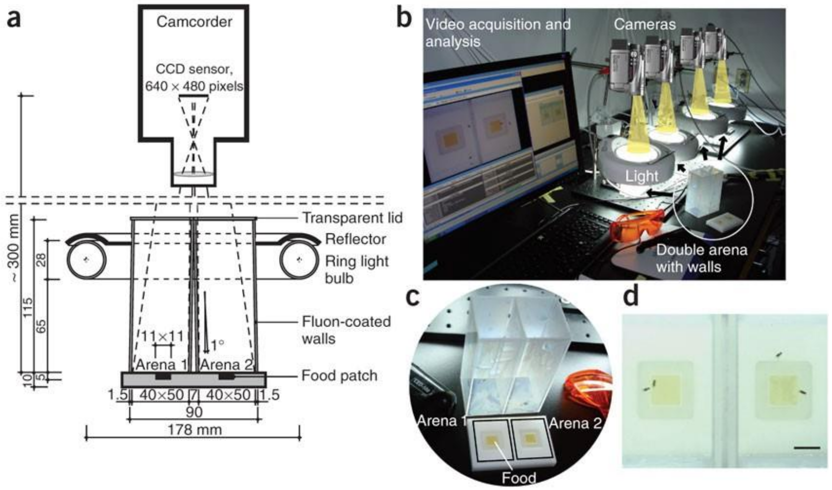


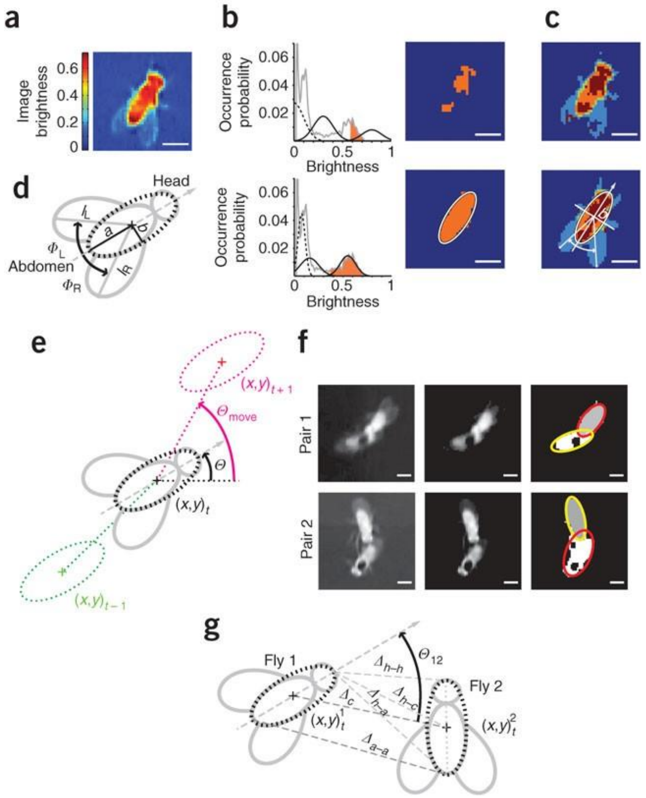


nature methods

Automated monitoring and analysis of social behavior in *Drosophila*

Heiko Dankert[1,2], Liming Wang[2], Eric D Hoopfer[2], David J Anderson[2] & Pietro Perona[1]

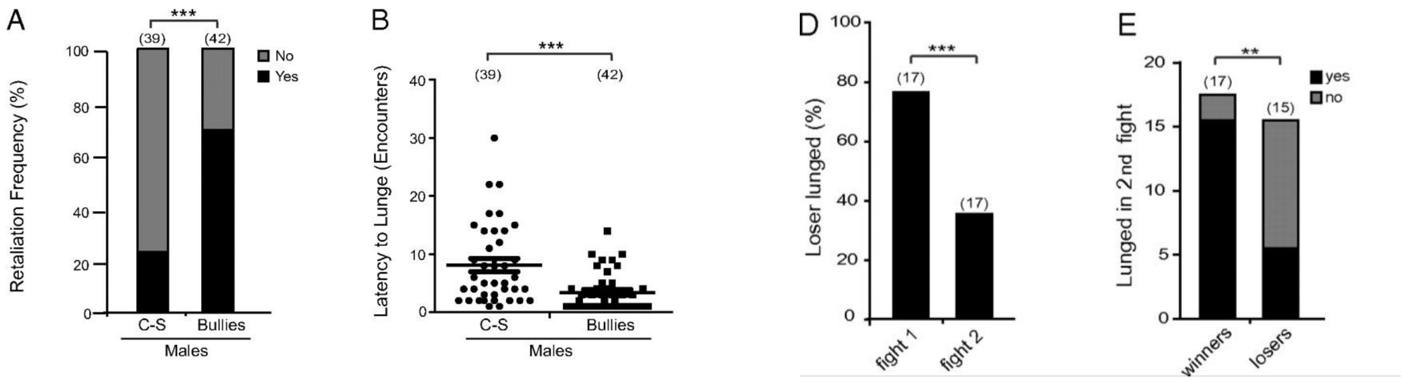




2010

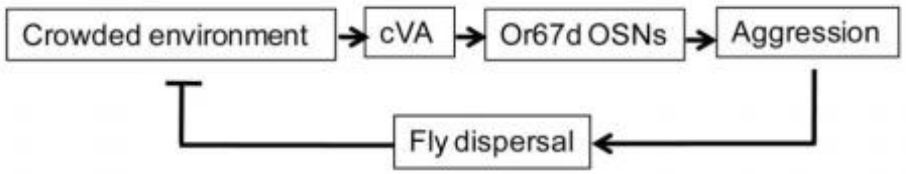
A single social defeat reduces aggression in a highly aggressive strain of *Drosophila*

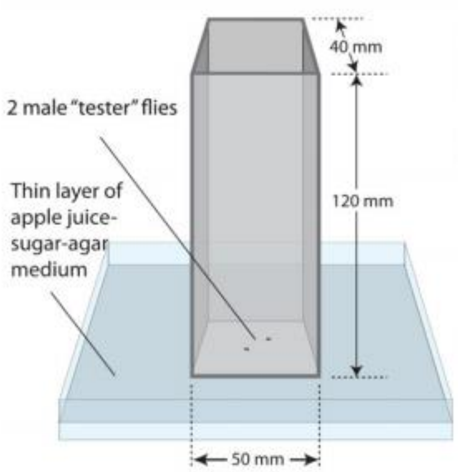
Jill K. M. Penn, Michael F. Zito, and Edward A. Kravitz

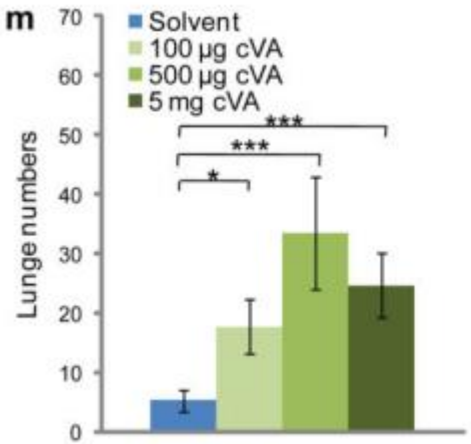


Identification of an aggression-promoting pheromone and its receptor neurons in *Drosophila*

Liming Wang[1] and David J. Anderson[1,2,*]







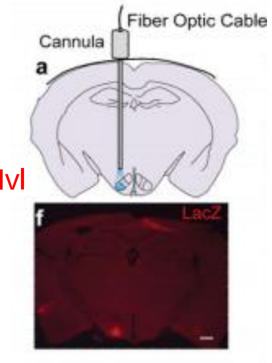
2011

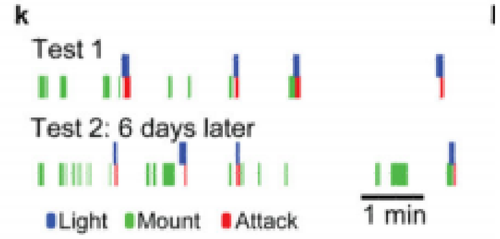
nature

Functional identification of an aggression locus in the mouse hypothalamus

Dayu Lin[1,2,5], Maureen P. Boyle[3], Piotr Dollar[4], Hyosang Lee[1], Pietro Perona[4], Ed S. Lein[3], and David J. Anderson[1,2,5]

VMHvl



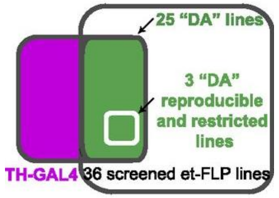


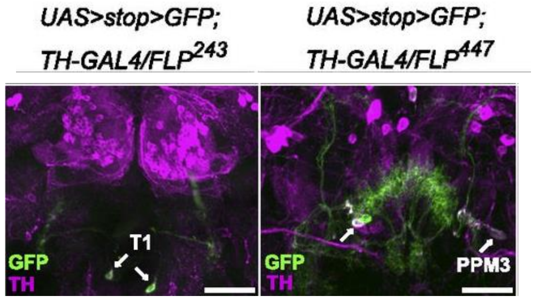
2013

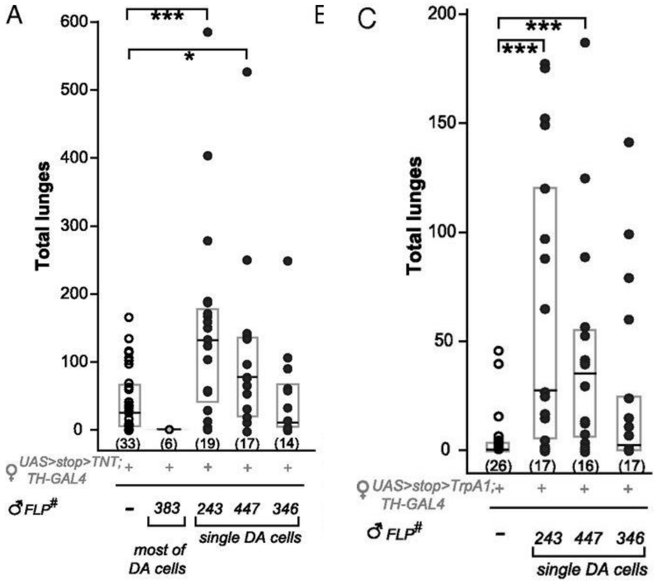
PNAS

Single dopaminergic neurons that modulate aggression in *Drosophila*

Olga V. Alekseyenko, Yick-Bun Chan, Ran Li, and Edward A. Kravitz





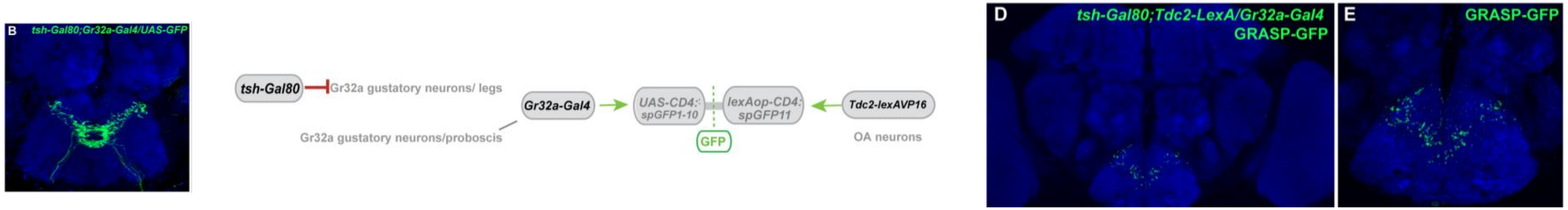


2014

PLOS | GENETICS

Octopamine Neuromodulation Regulates Gr32a-Linked Aggression and Courtship Pathways in *Drosophila* Males

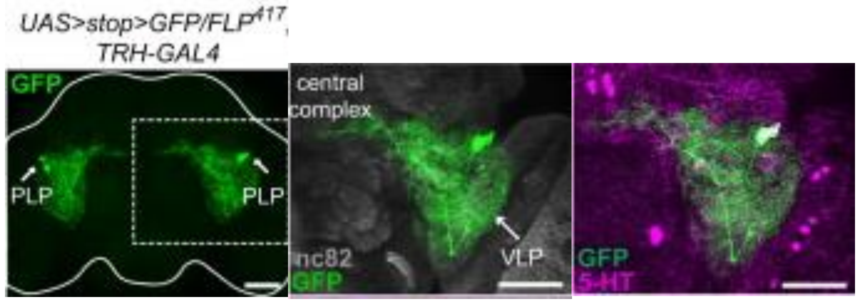
Jonathan C. Andrews, María Paz Fernández, Qin Yu, Greg P. Leary, Adelaine K. W. Leung, Michael P. Kavanaugh, Edward A. Kravitz, Sarah J. Certel

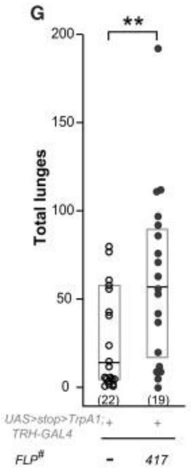


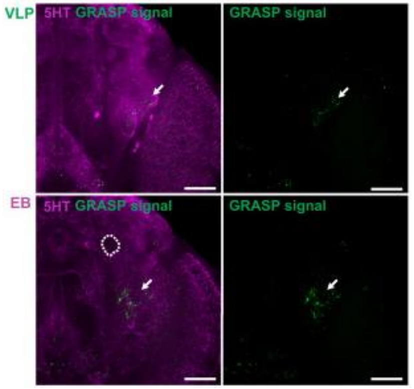
Current Biology

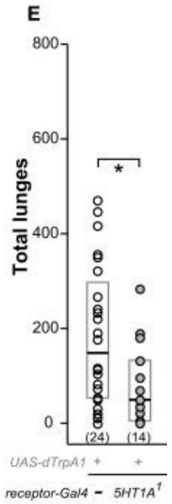
Single Serotonergic Neurons that Modulate Aggression in *Drosophila*

Olga V. Alekseyenko [1], Yick-Bun Chan [1], Maria de la Paz Fernandez [2], Torsten Bülow [3], Michael J. Pankratz [3], Edward A. Kravitz [1]



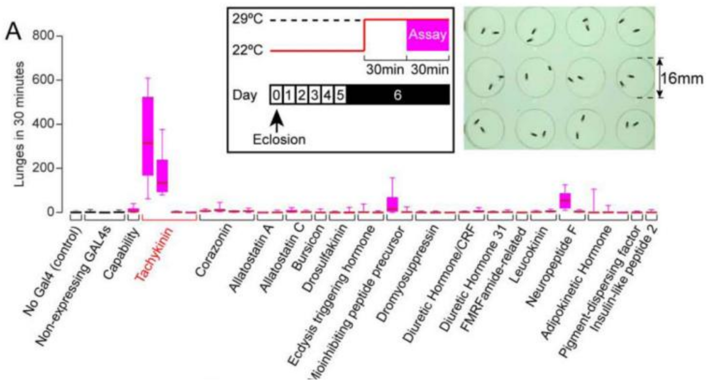


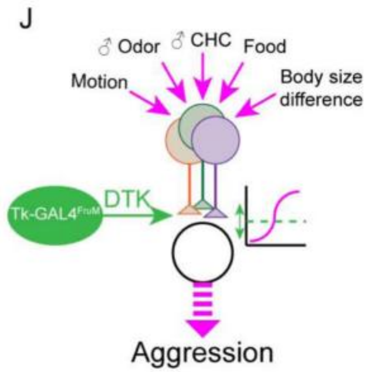


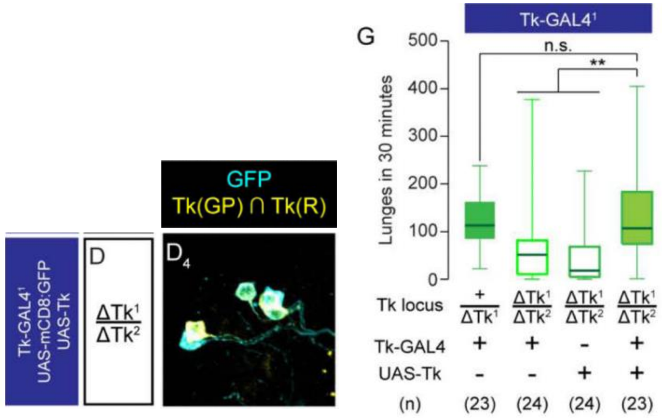


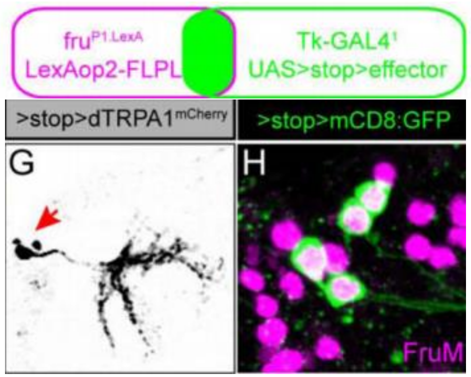
Tachykinin-expressing neurons control male-specific aggressive arousal in *Drosophila*

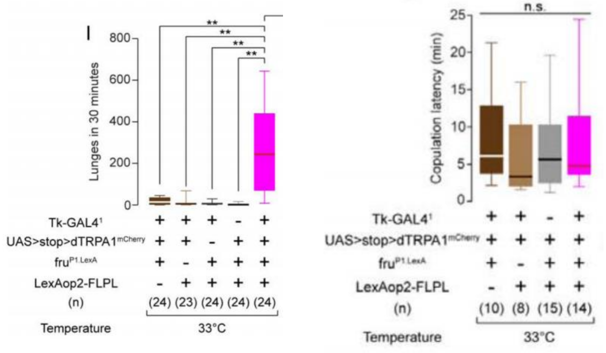
Kenta Asahina[1,2], Kiichi Watanabe[1,2], Brian J. Duistermars[1,2], Eric Hoopfer[1,2,4], Carlos Roberto González[3], Eyrún Arna Eyjólfsdóttir[3], Pietro Perona[3], and David J. Anderson[1,2]

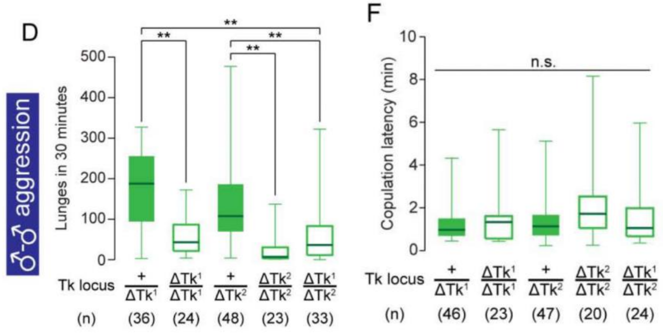












control male-male aggression
do not modulate courtship behavior

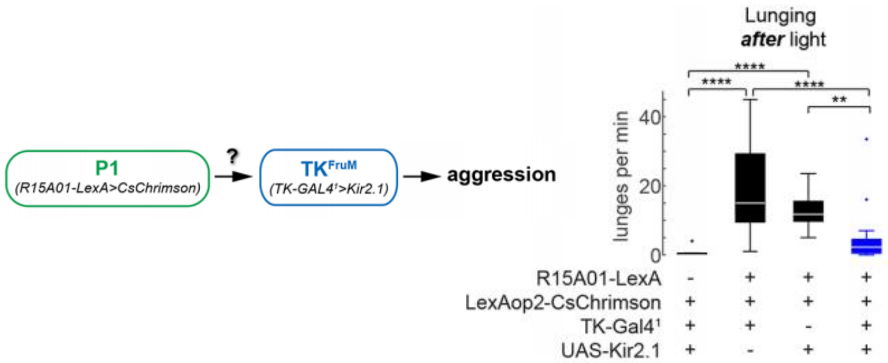
Tk specifically affect male-male aggression

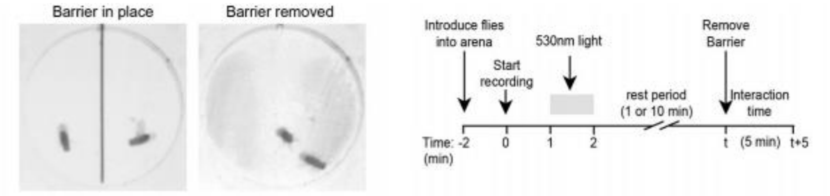
2015

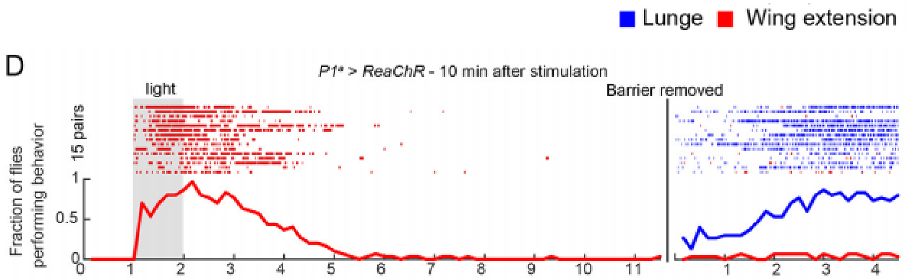
eLIFE

P1 interneurons promote a persistent internal state that enhances inter-male aggression in *Drosophila*

Eric D Hoopfer[1,2], Yonil Jung[2], Hidehiko K Inagaki[2], Gerald M Rubin[1], David J Anderson[2,3*]







2016

PNAS

Short and long-lasting behavioral consequences of agonistic encounters between male *Drosophila melanogaster*

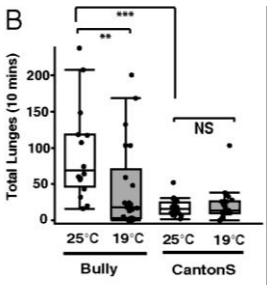
Séverine Trannoy, Jill Penn, Kenia Lucey, David Popovic, and Edward A. Kravitz

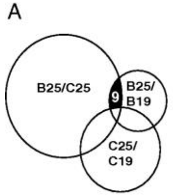
2017

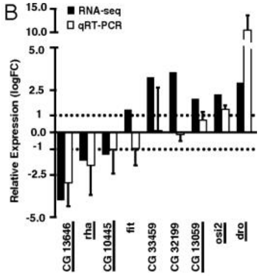
PNAS

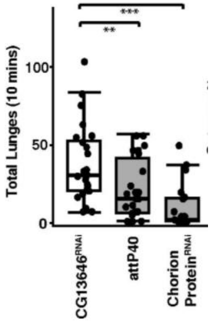
Putative transmembrane transporter modulates higher-level aggression in *Drosophila*

Budhaditya Chowdhury, Yick-Bun Chan, and Edward A. Kravitz





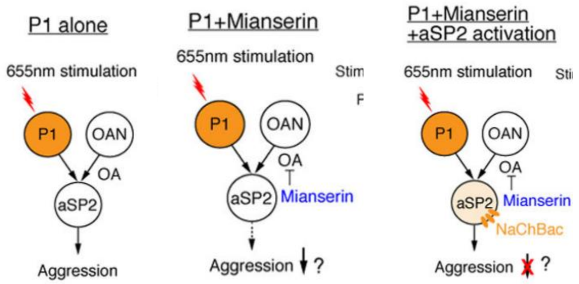


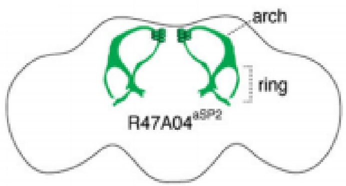


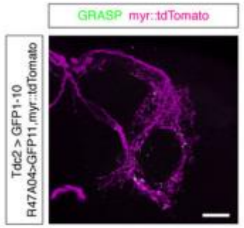
Neuron

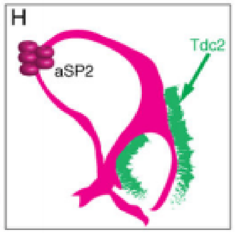
A circuit node that integrates convergent input from neuromodulatory and social behavior-promoting neurons to control aggression in *Drosophila*

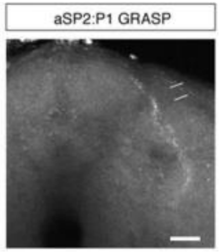
Kiichi Watanabe[1,2], Hui Chiu[1,2], Barret D. Pfeiffer[2,3,4], Allan Wong[2,4], Eric D. Hoopfer[1], Gerald M. Rubin[4], and David J. Anderson[1,2,5,*]

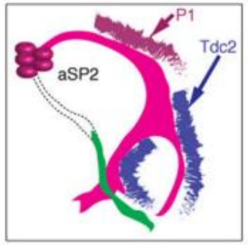


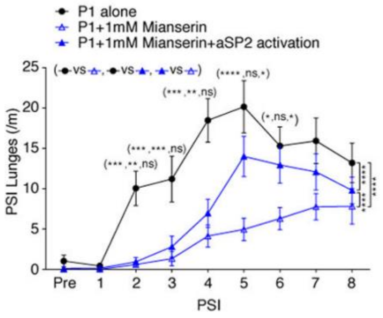










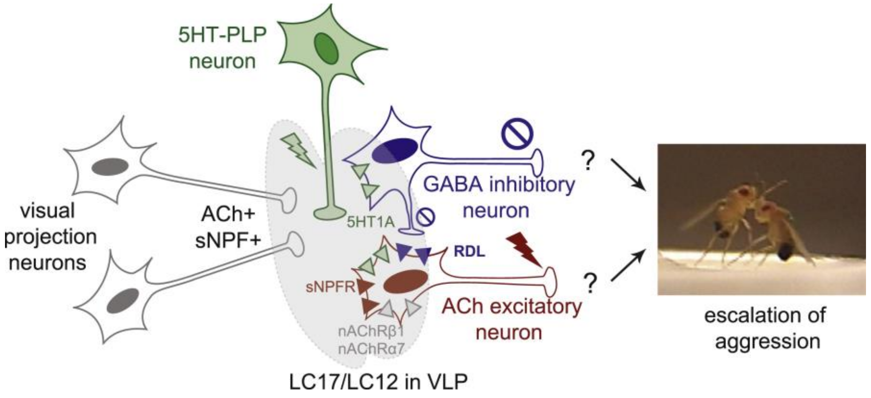


2019

Current Biology

Serotonergic Modulation of Aggression in *Drosophila* Involves GABAergic and Cholinergic Opposing Pathways

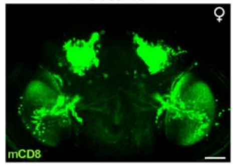
Olga V. Alekseyenko [1,2,3,5], Yick-Bun Chan [1,3], Benjamin W. Okaty [2], YoonJeung Chang [2], Susan M. Dymecki [2,4], Edward A. Kravitz [1,4]



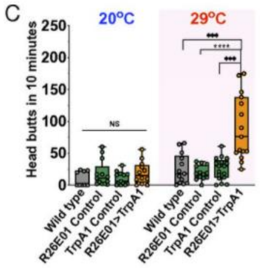
PNAS

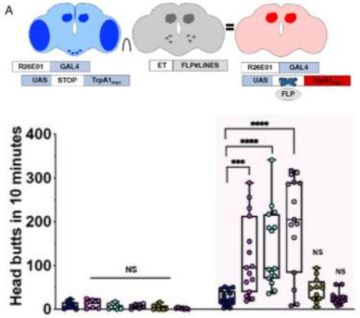
A small number of cholinergic neurons mediate hyperaggression in female *Drosophila*

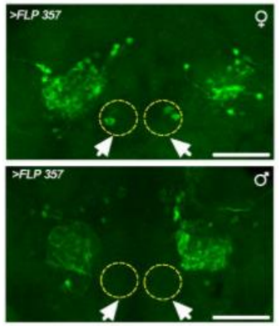
Caroline B. Palavicino-Maggio, Yick-Bun Chan, Claire McKellar, and Edward A. Kravitz

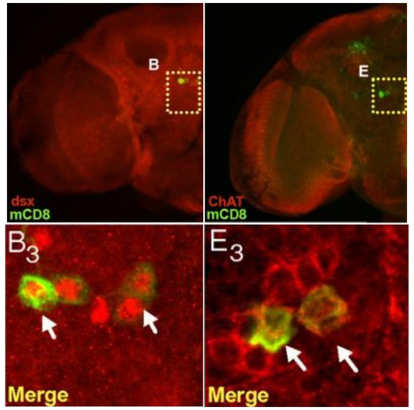


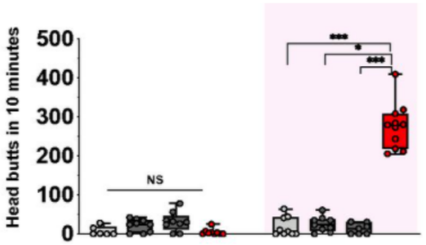
UAS-mCD8::GFP; R26E01-Gal4











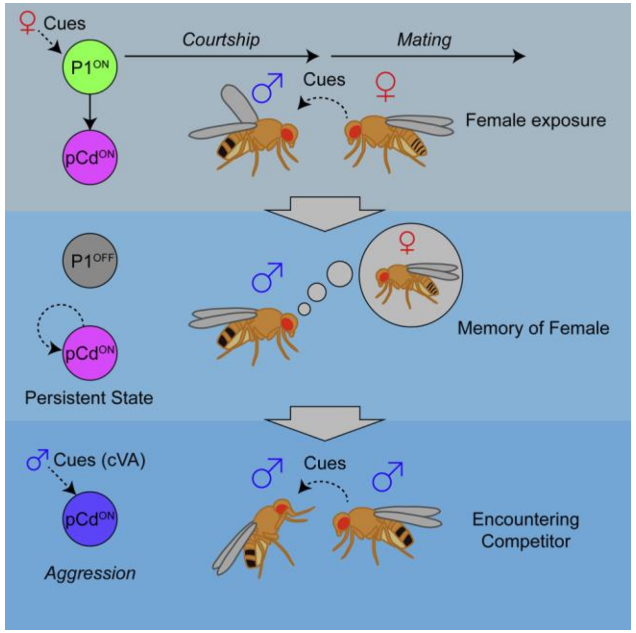
2020

Neuron

Article

Neurons that Function within an Integrator to Promote a Persistent Behavioral State in *Drosophila*

Yonil Jung [1], Ann Kennedy [1], Hui Chiu [1], Farhan Mohammad [2, 3, 4], Adam Claridge-Chang [2, 3], David J. Anderson [1, 5]

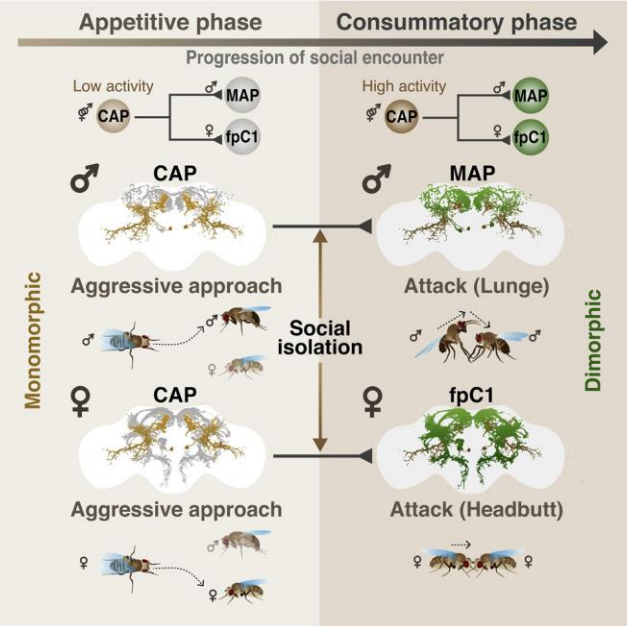


2021

Cell

Article

A circuit logic for sexually shared and dimorphic aggressive behaviors in *Drosophila*

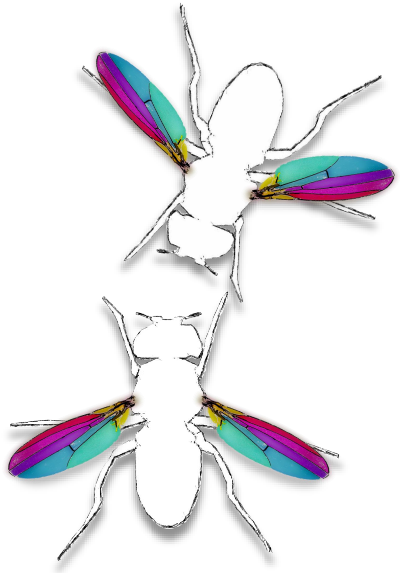


Edward Kravitz

David Anderson

- Model establishment (male & female)
- Loser effect
- DA, OA, 5-HT neuromodulation of aggression

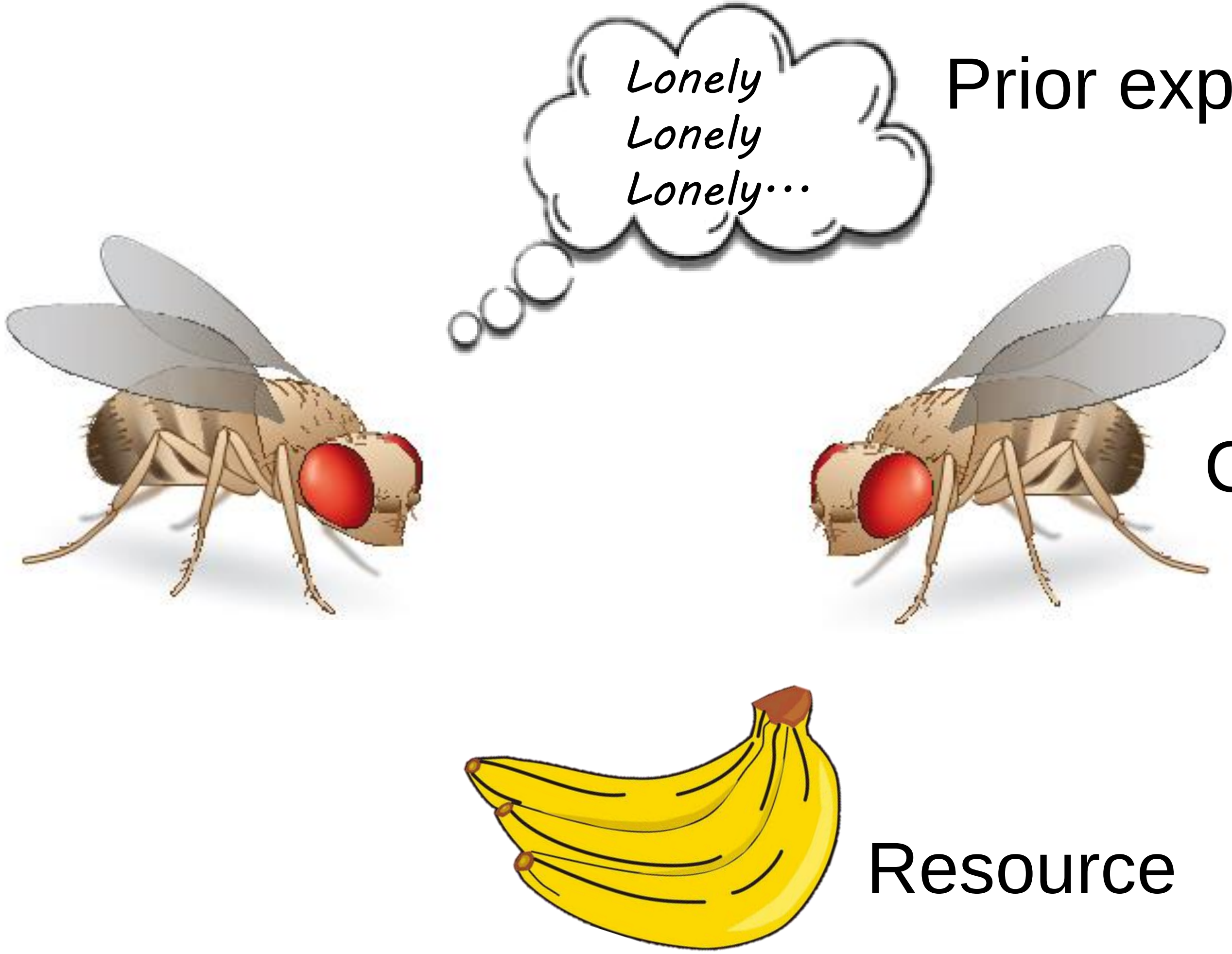
- Automated analysis of aggression
- cVA
- TK
- Persistent internal state
- Sexually dimorphic aggression circuit



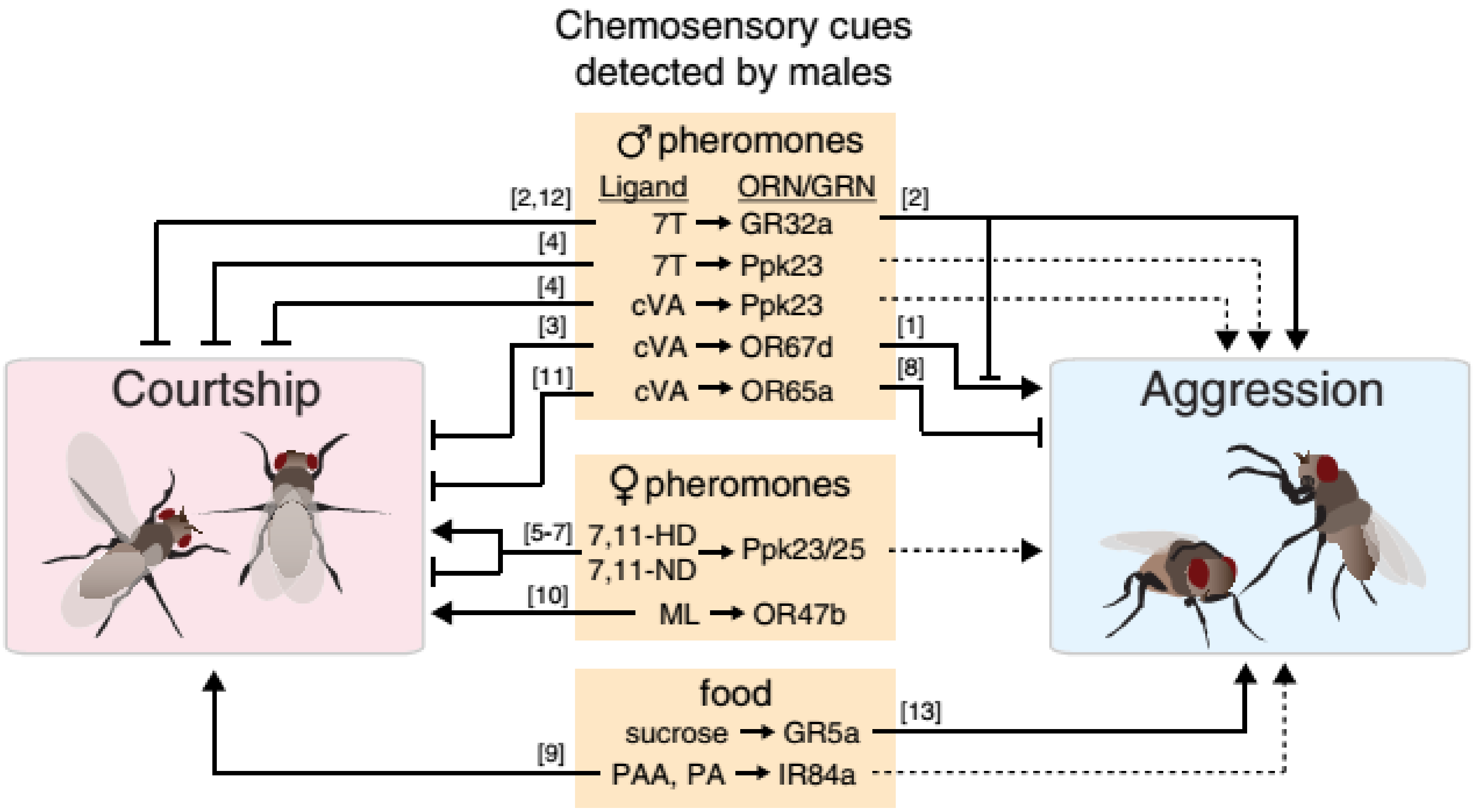
Strategic Action Choices in *Drosophila* Aggression

Ji Xiaoxiao

To fight or not to fight

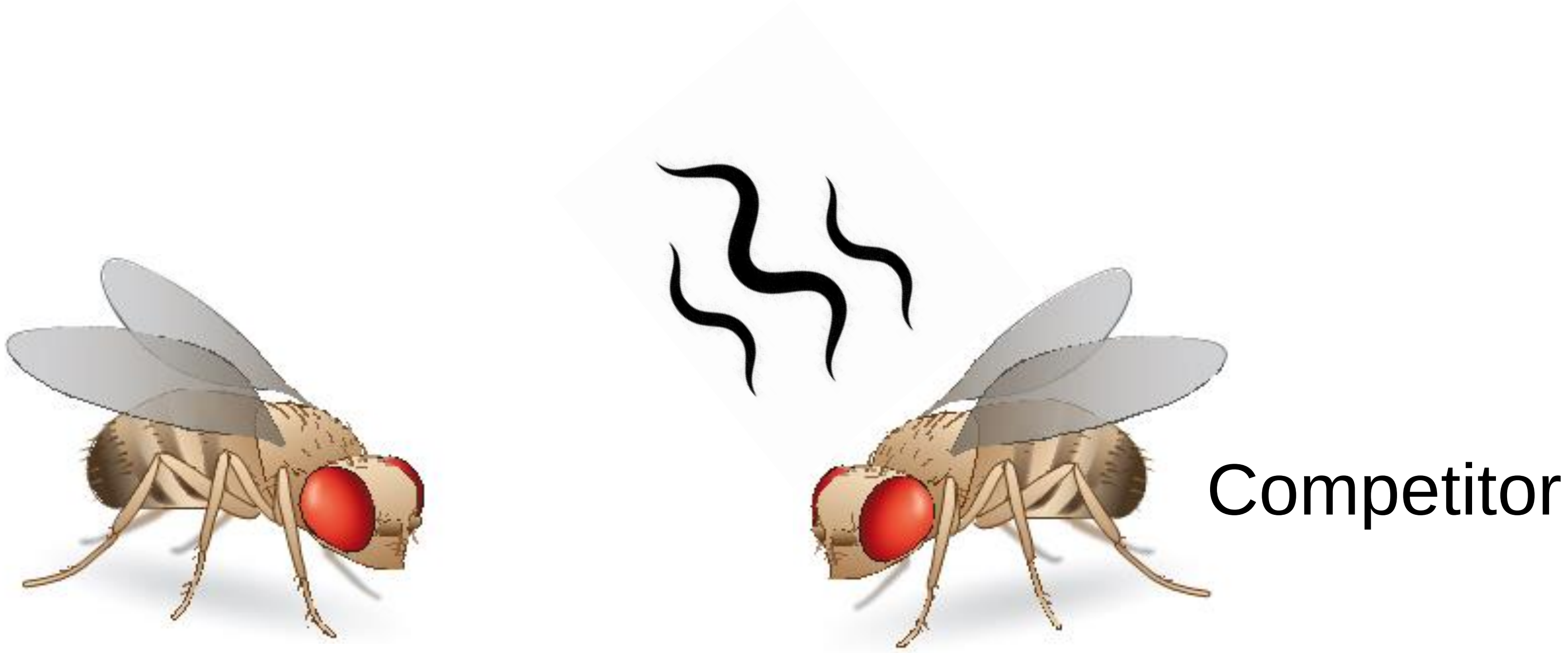


Whether the fly is a Competitor?

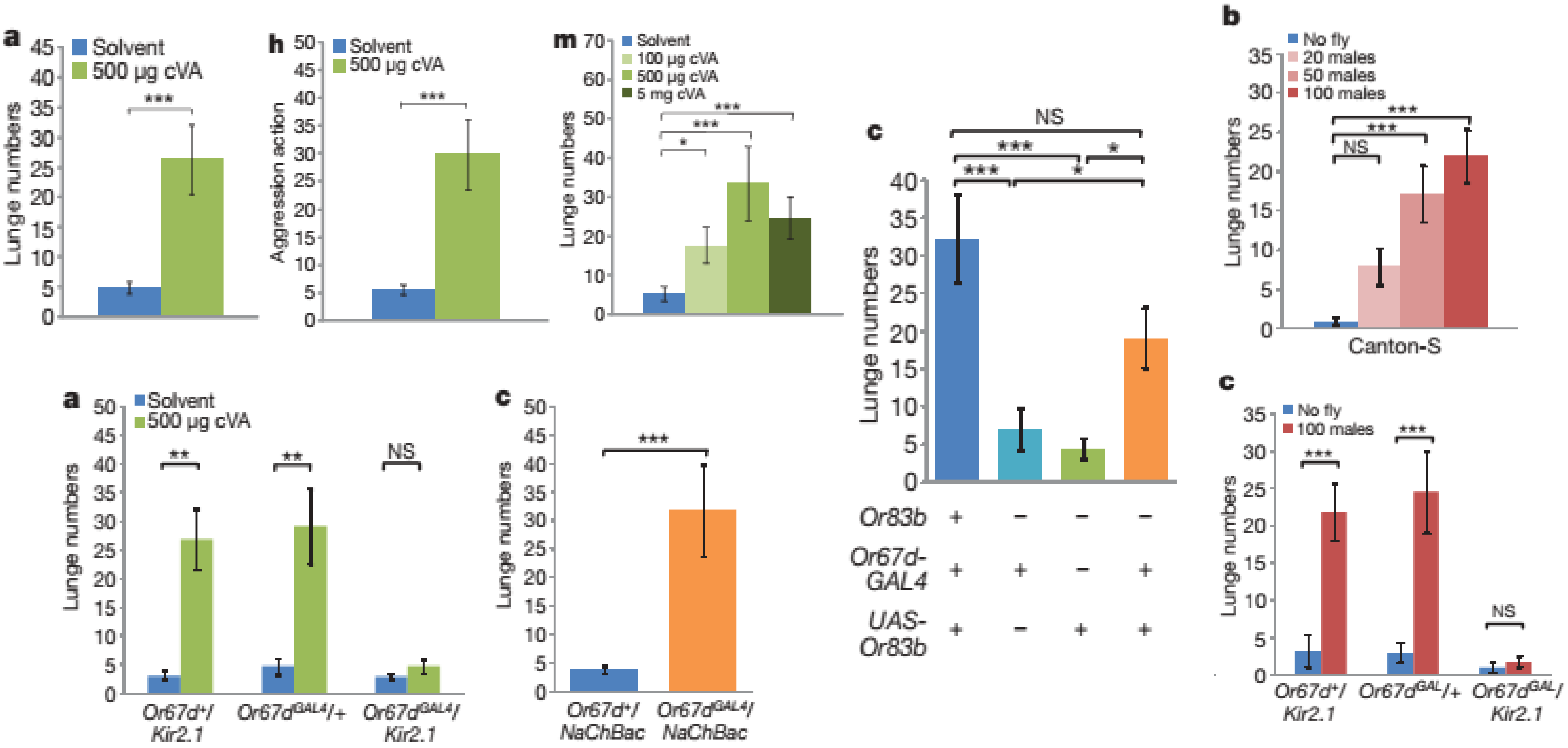


(Hoopfer, Curr Opin Neurobiol, 2016)

Olfactory cues

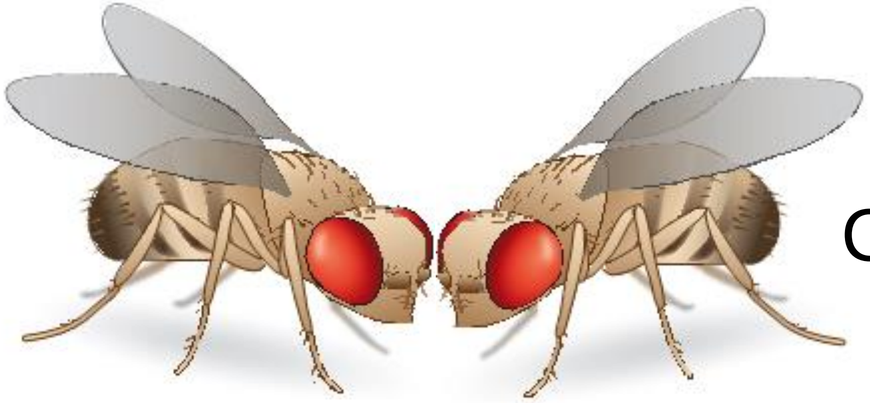


cVA promotes aggression by activating Or67d-expressing OSNs



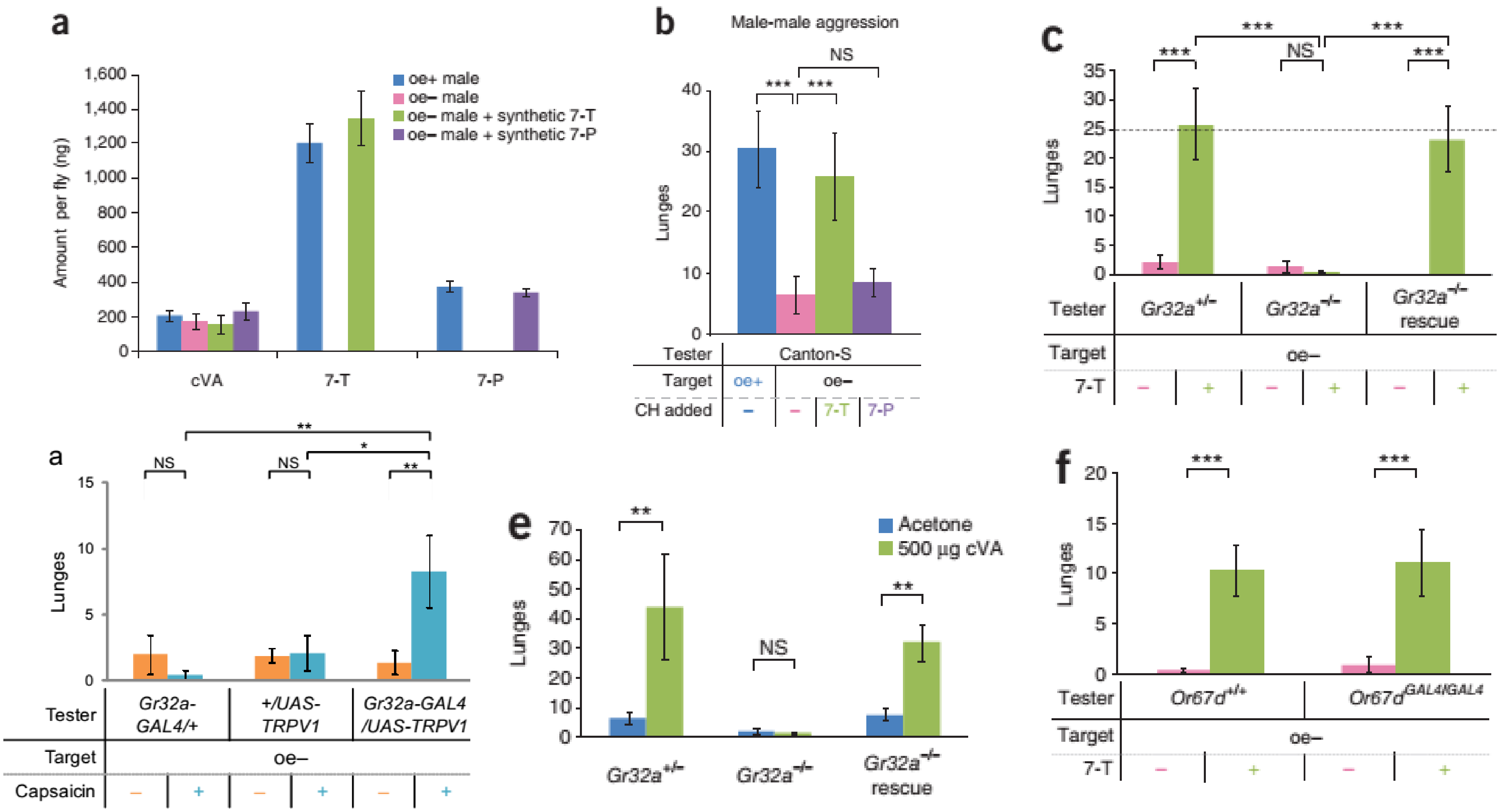
(Wang and Anderson, Nature, 2010)

Gustatory cues



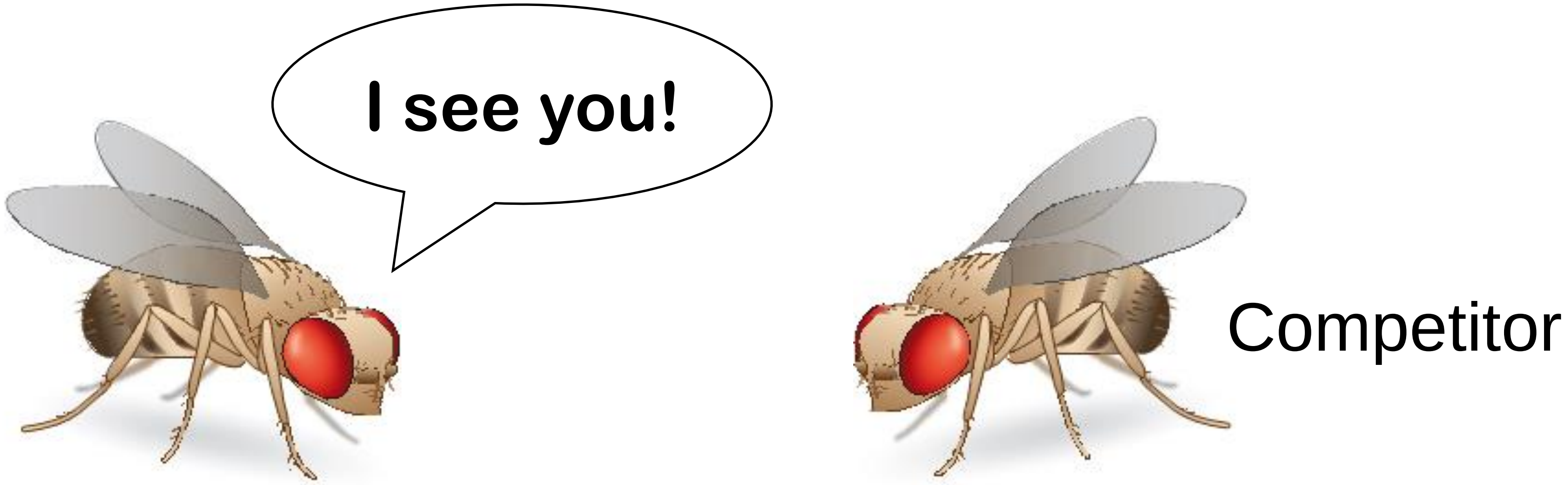
Competitor

(z)-7-tricosene (7T) induced aggression required the gustatory receptor Gr32a

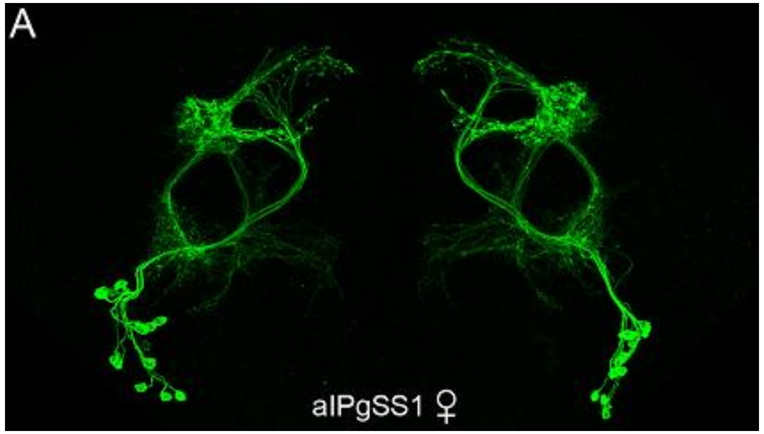


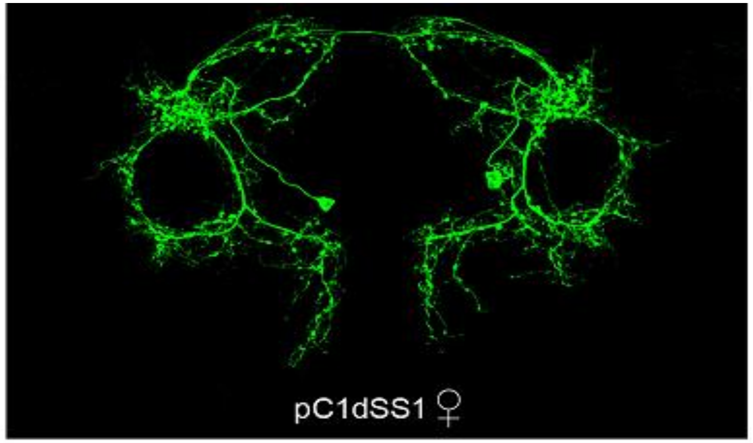
(Wang et al., Nat Neurosci, 2011)

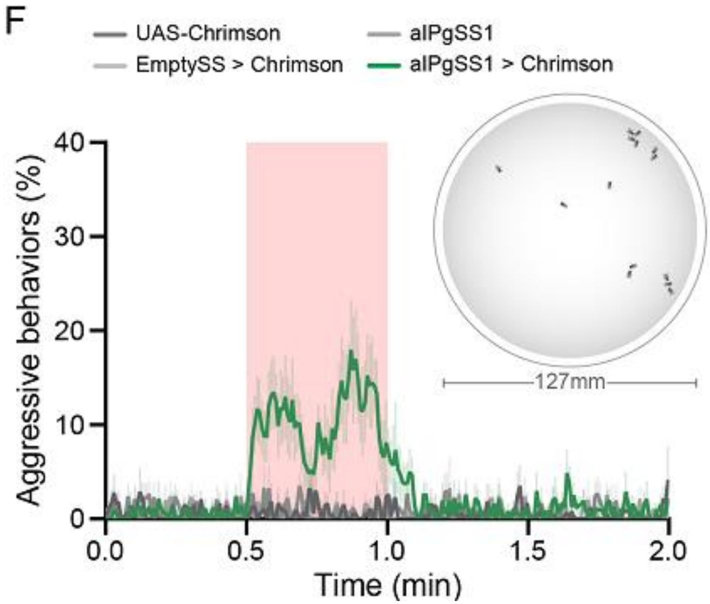
Visual cues

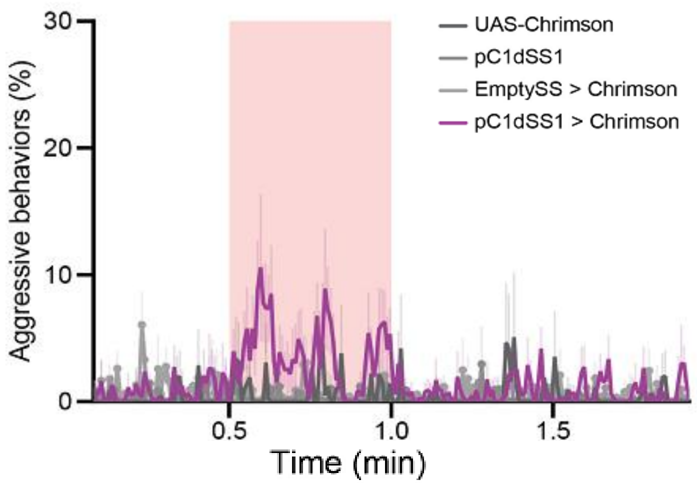


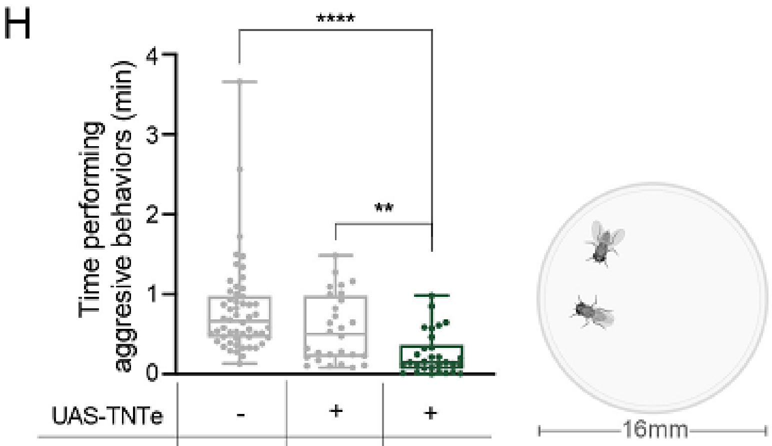
aIPg and pC1d are two key groups of neurons involved in female aggressive behaviors



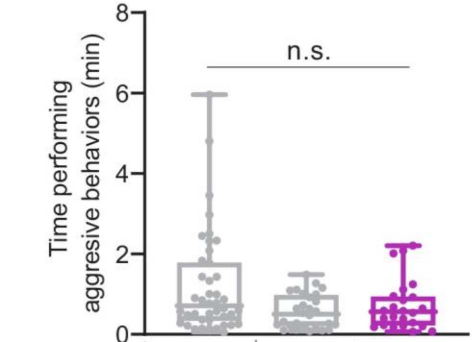








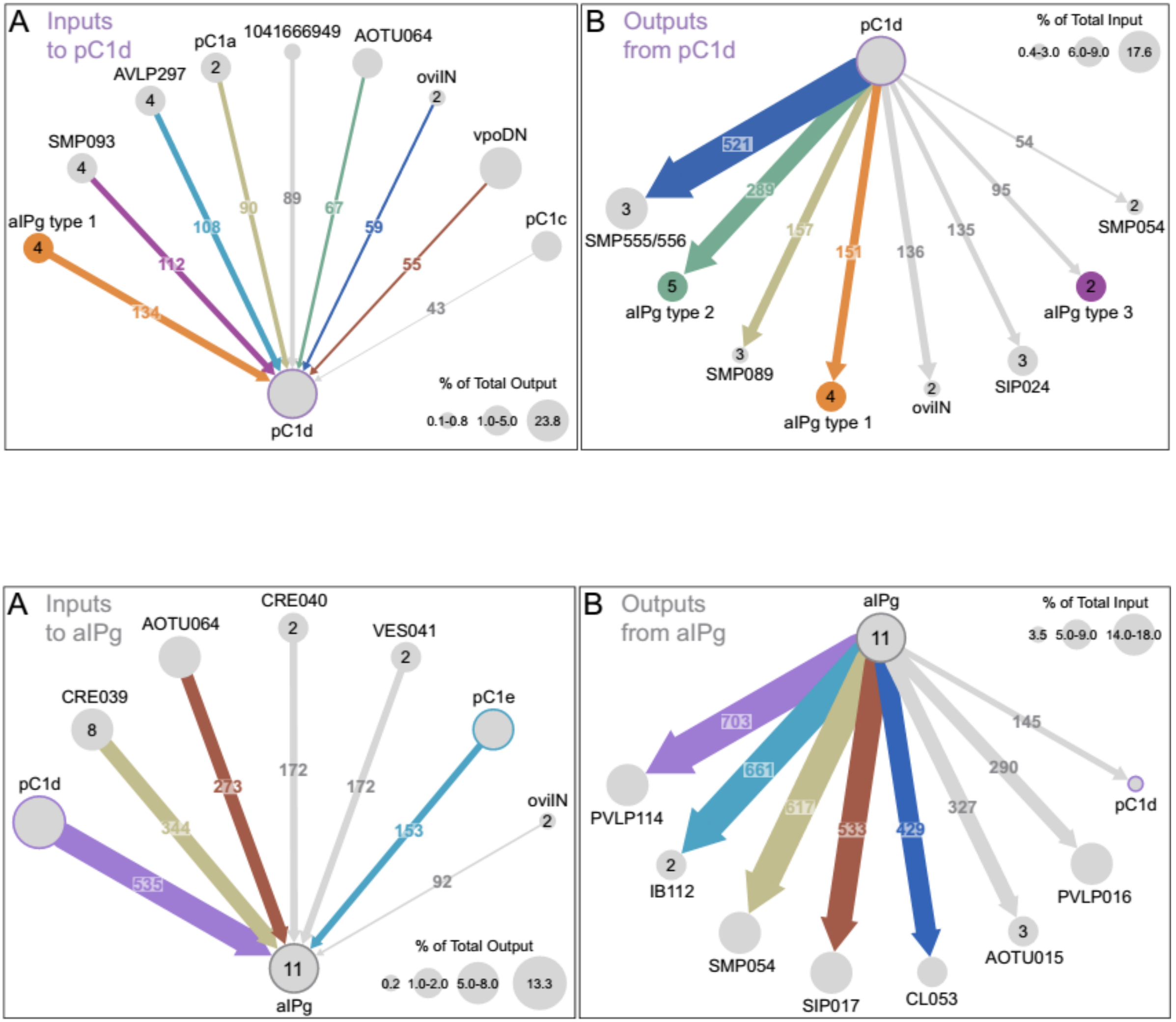
UAS-TNTe	-	+	+
UAS-GFP	+	-	-
EmptySS	-	+	-
aIPgSS1	+	-	+

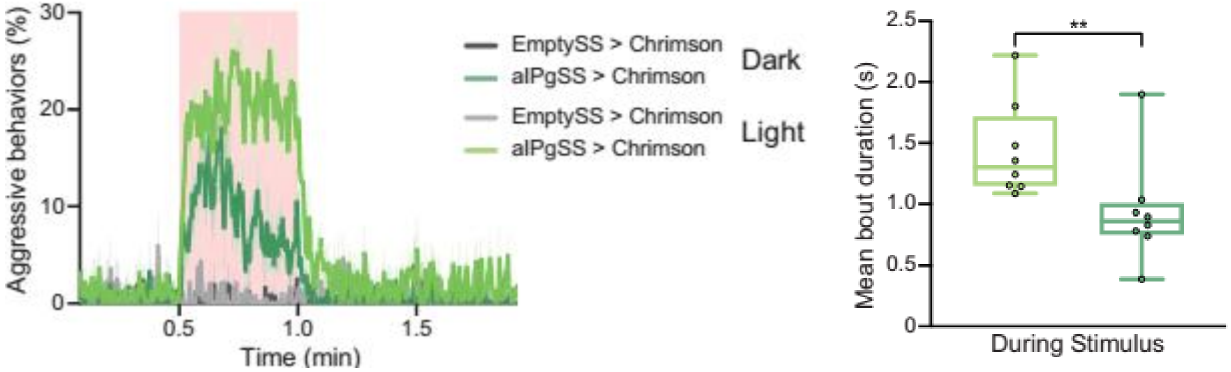


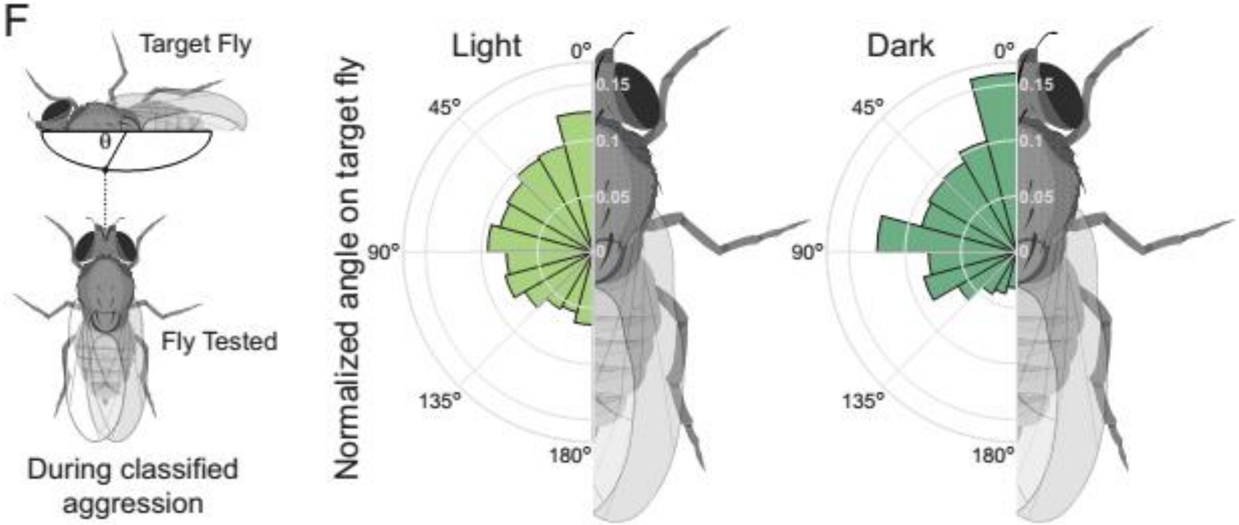
UAS-TNTe	-	+	+
UAS-GFP	+	-	-
EmptySS	-	+	-
pC1dSS1	+	-	+

(Schretter et al., Elife, 2020)

Absence of visual information alters aggressive behaviors following aIPg activation

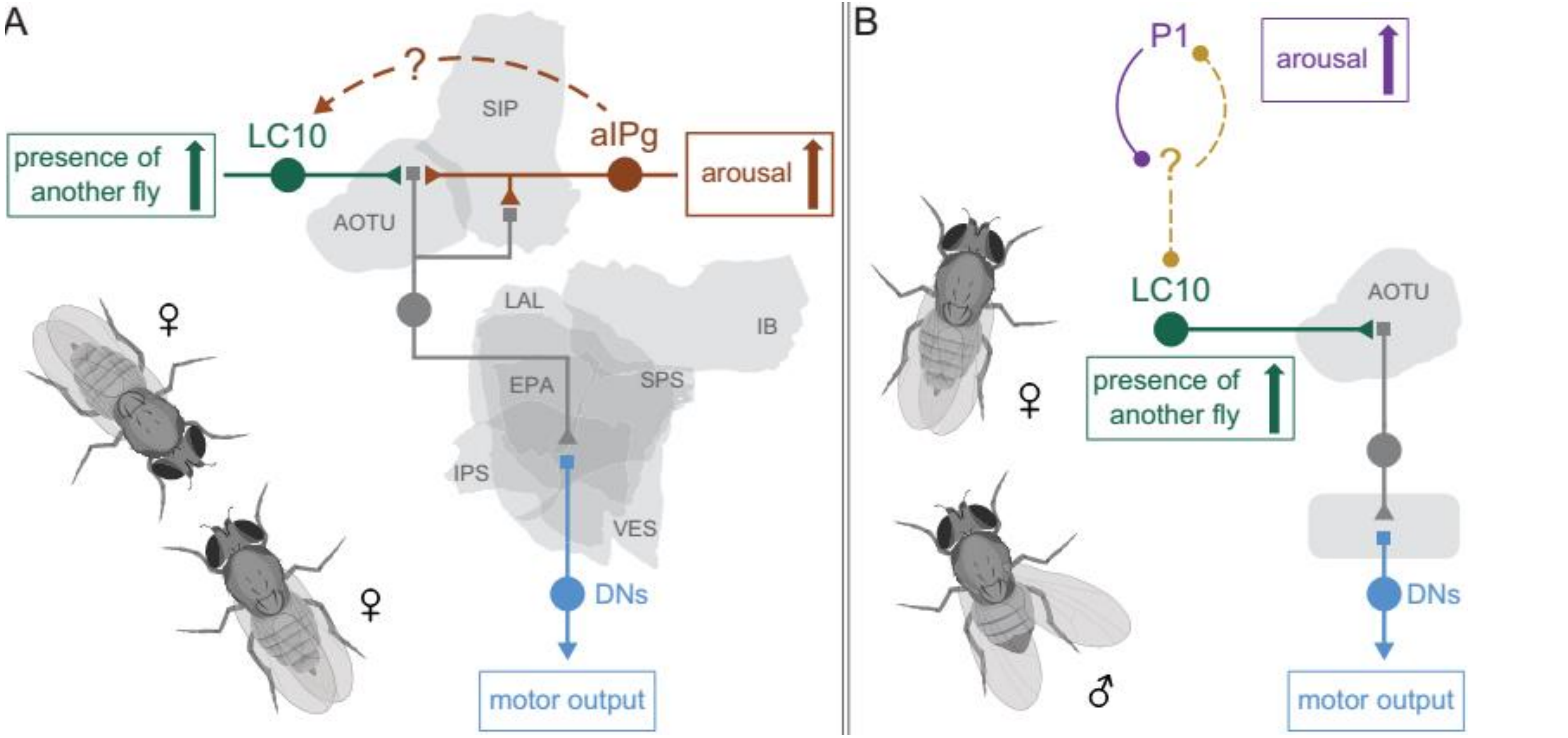






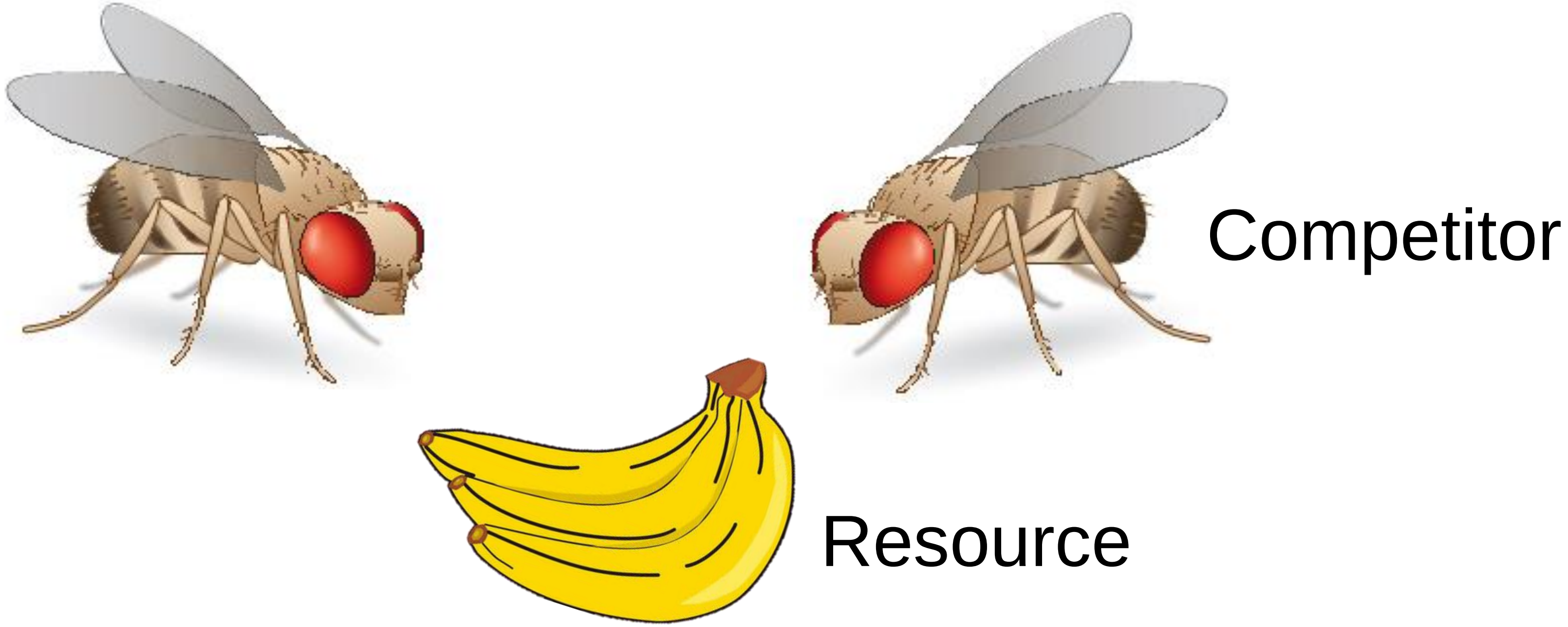
(Schretter et al., Elife, 2020)

A conceptual model for gating of visual information by aIPg neurons in females during aggression

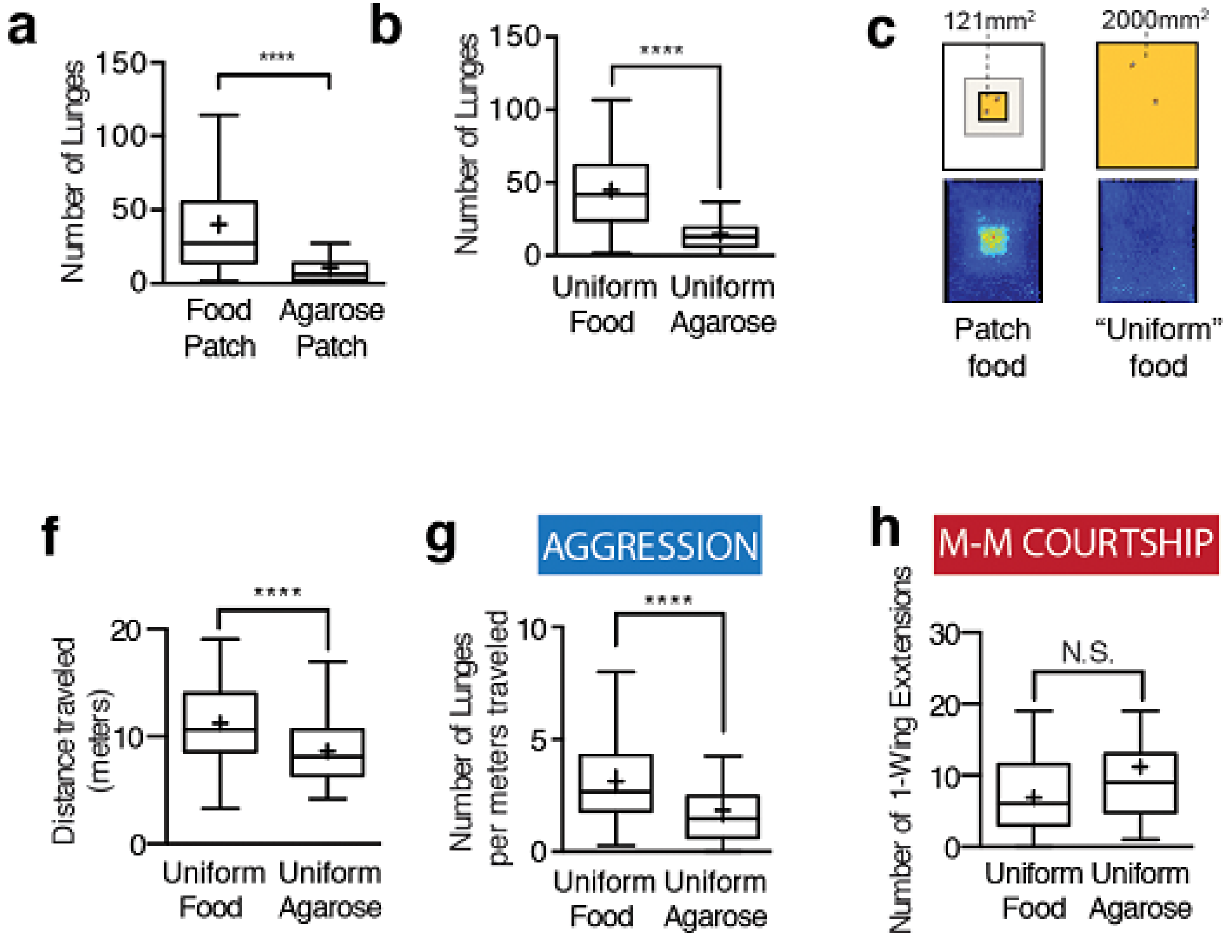


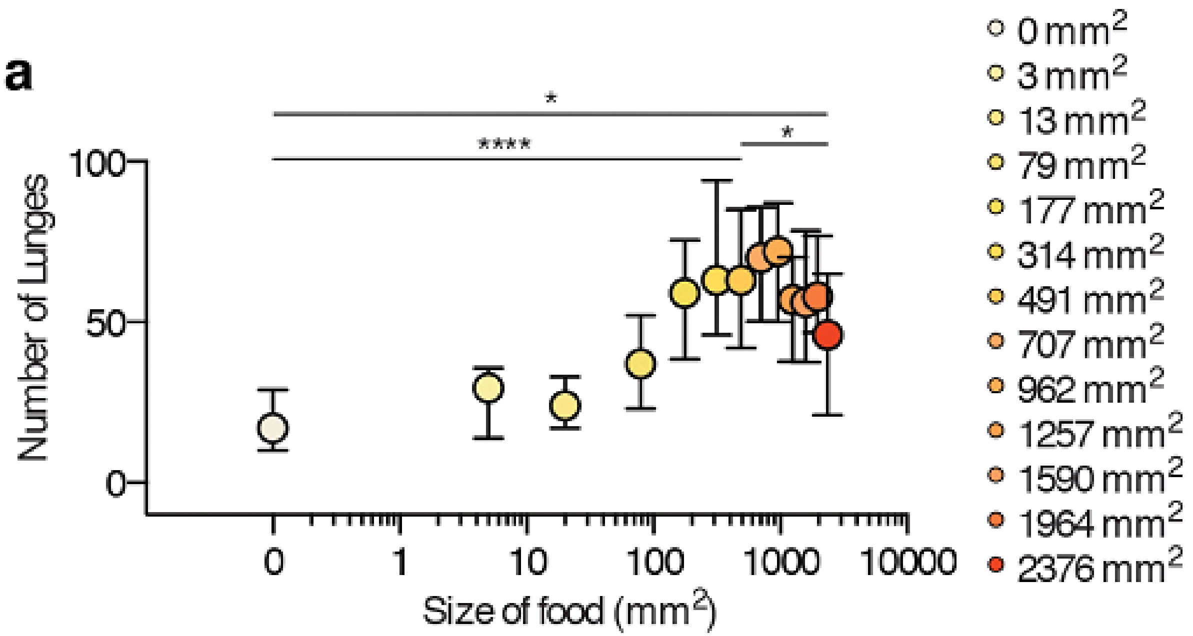
(Schretter et al., Elife, 2020)

Fight for resource



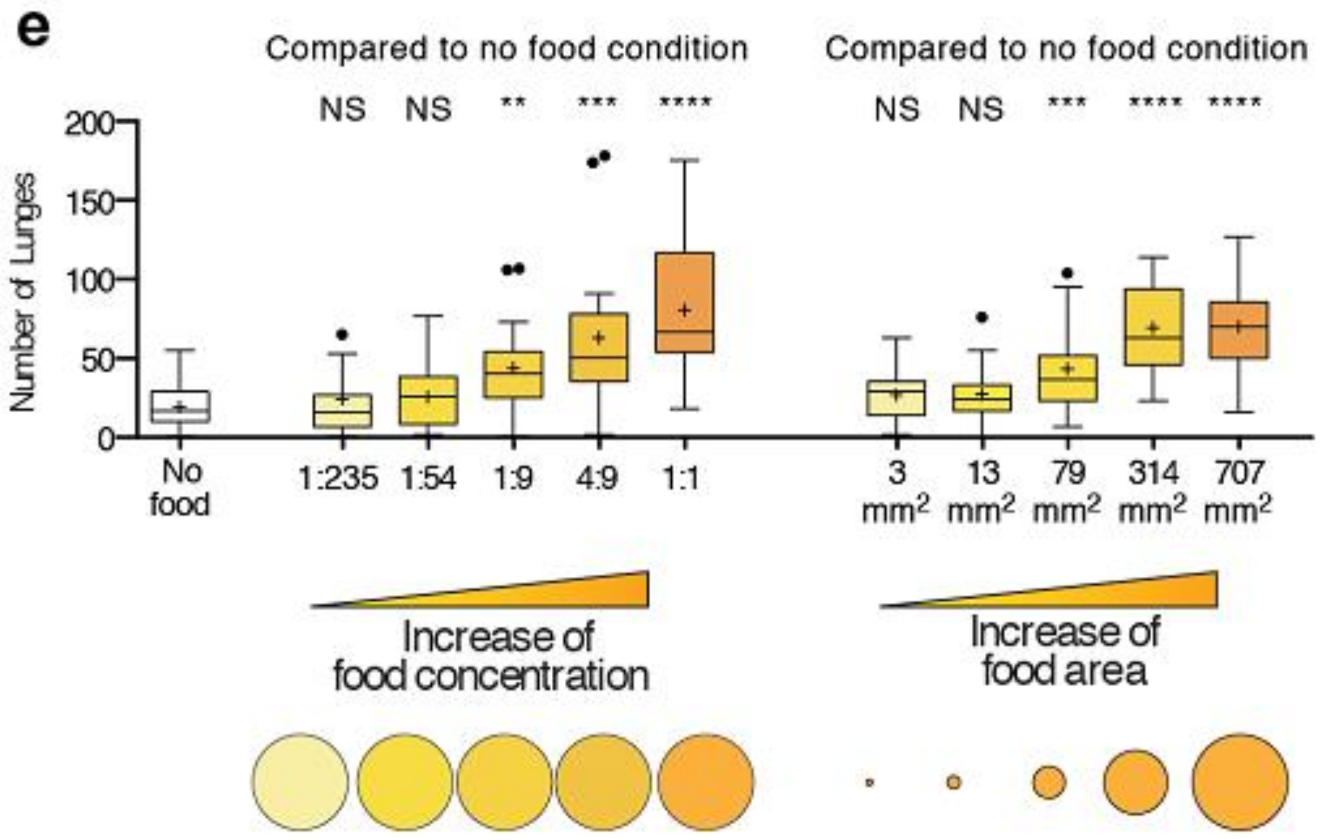
How food controls aggression in *Drosophila*



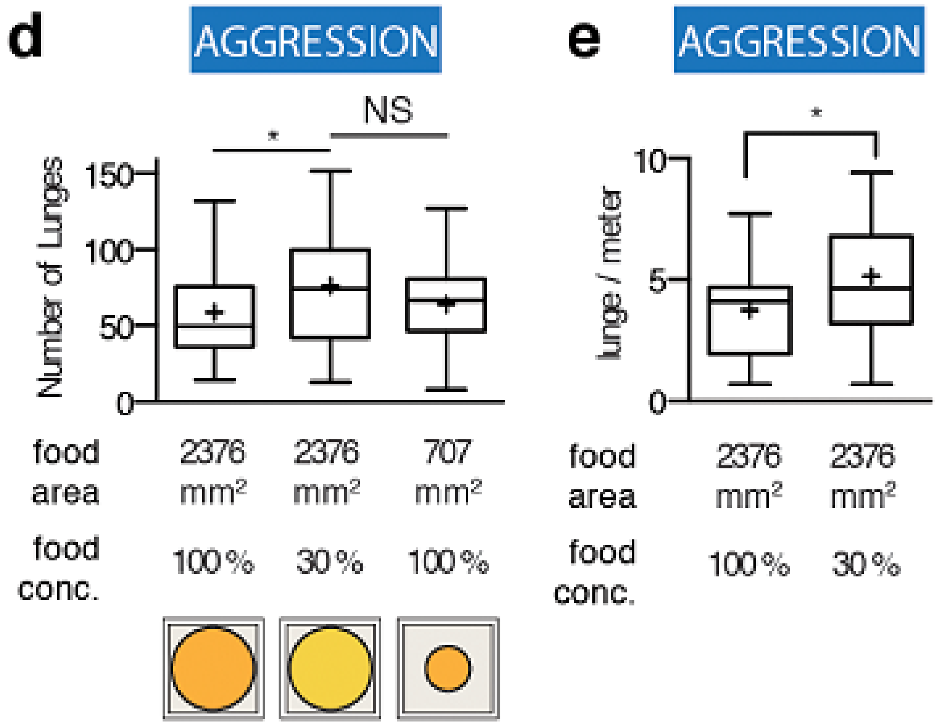


(Lim et al., PLoS One, 2014)

Flies measure the level of total nutrients to increase the level of aggression rather than the area of food

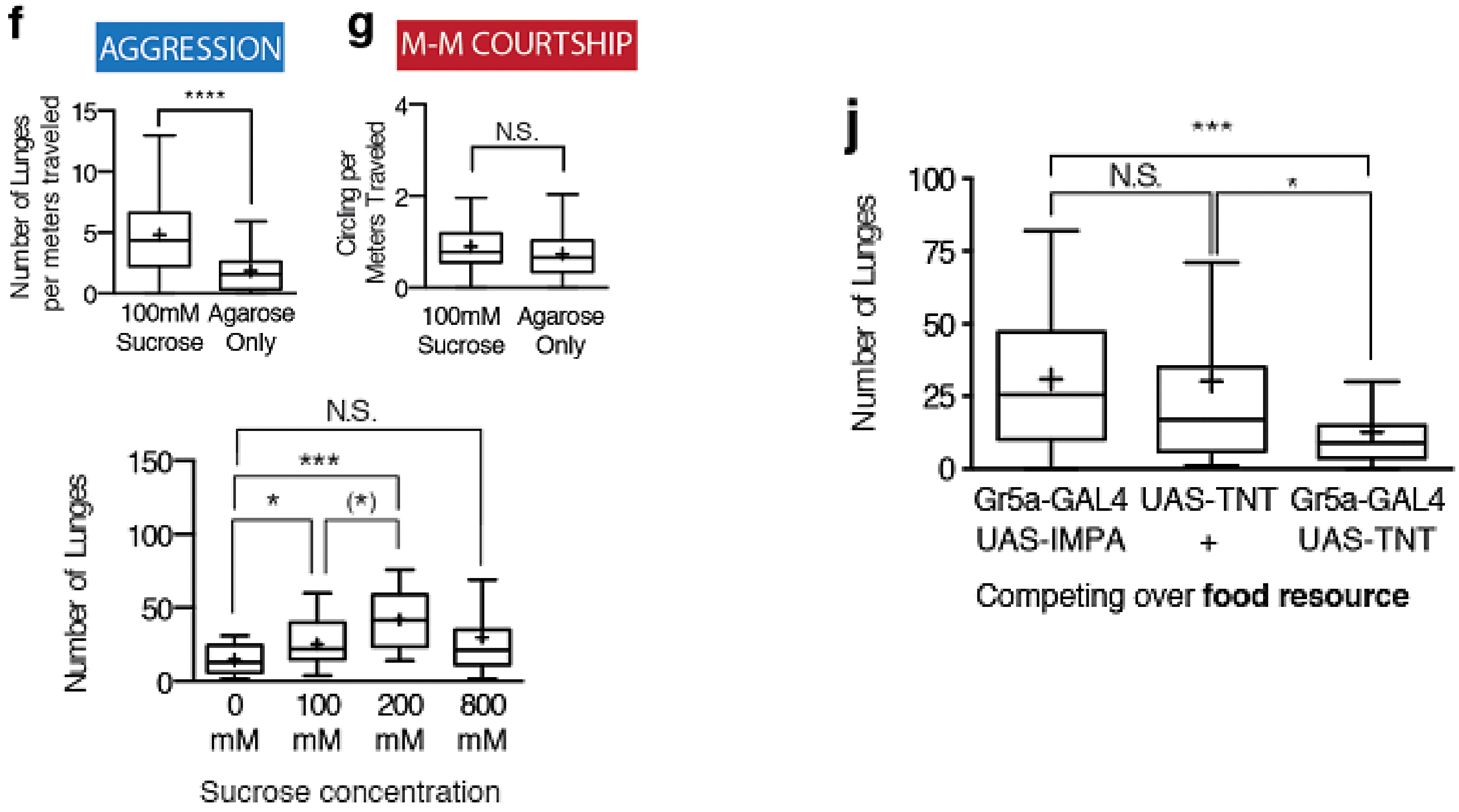


Note: Left and right bars (e.g. 1:235 diluted and 3 mm^2) are calorically matched)



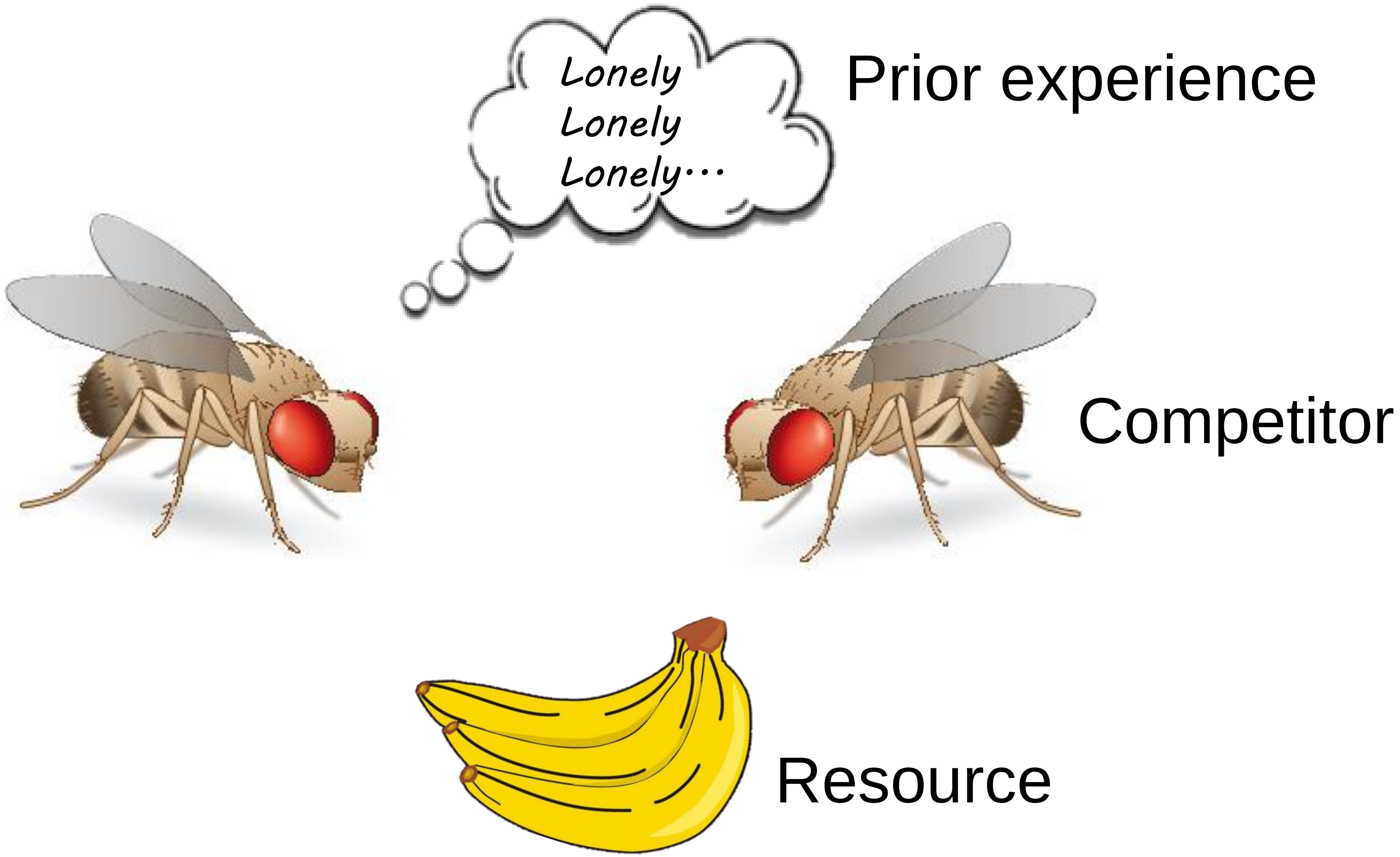
(Lim et al., PLoS One, 2014)

Flies use sweet-sensing Gr5a+ GRNs to detect the concentration of sucrose in the food and tune the level of aggression accordingly

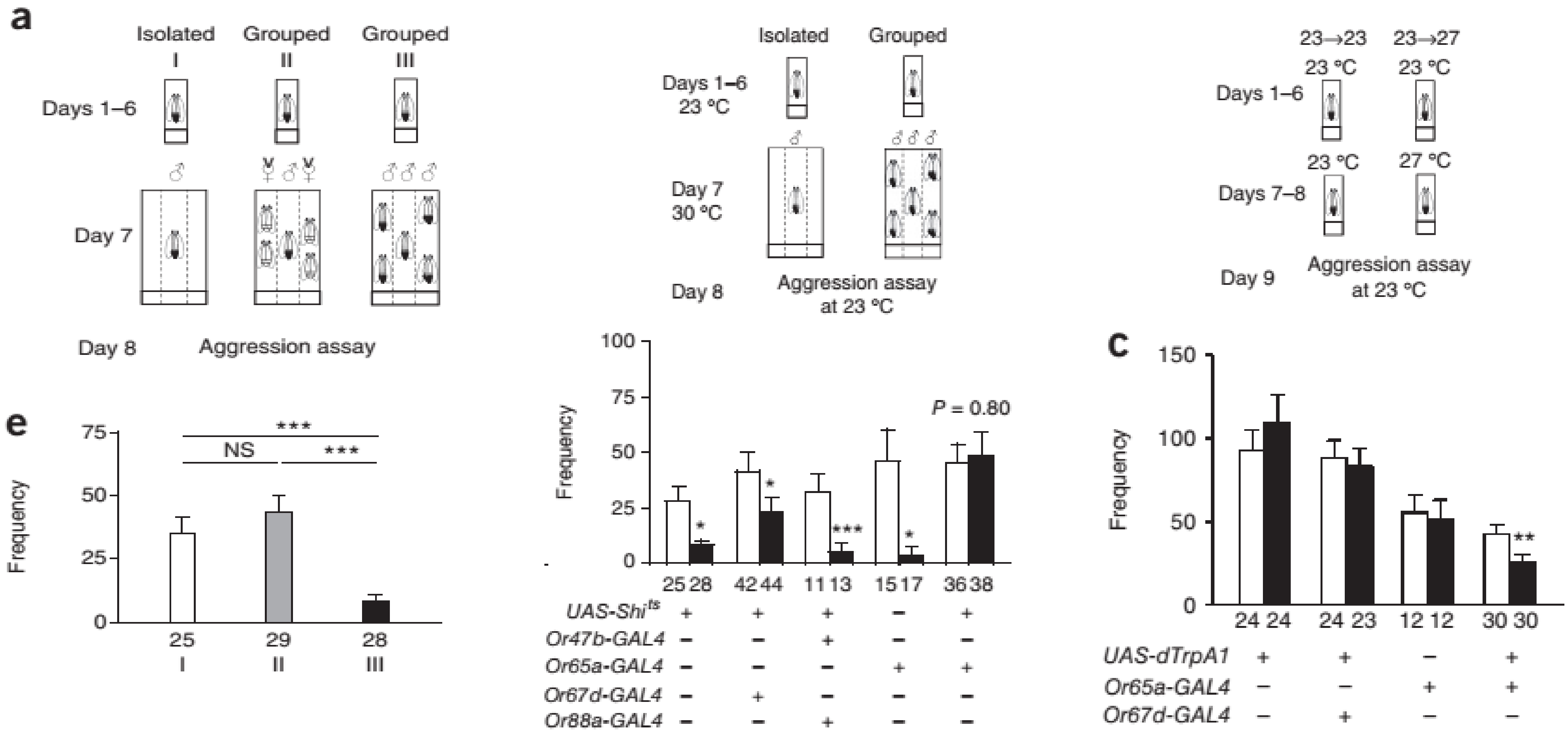


(Lim et al., PLoS One, 2014)

Influence of prior experience on aggression

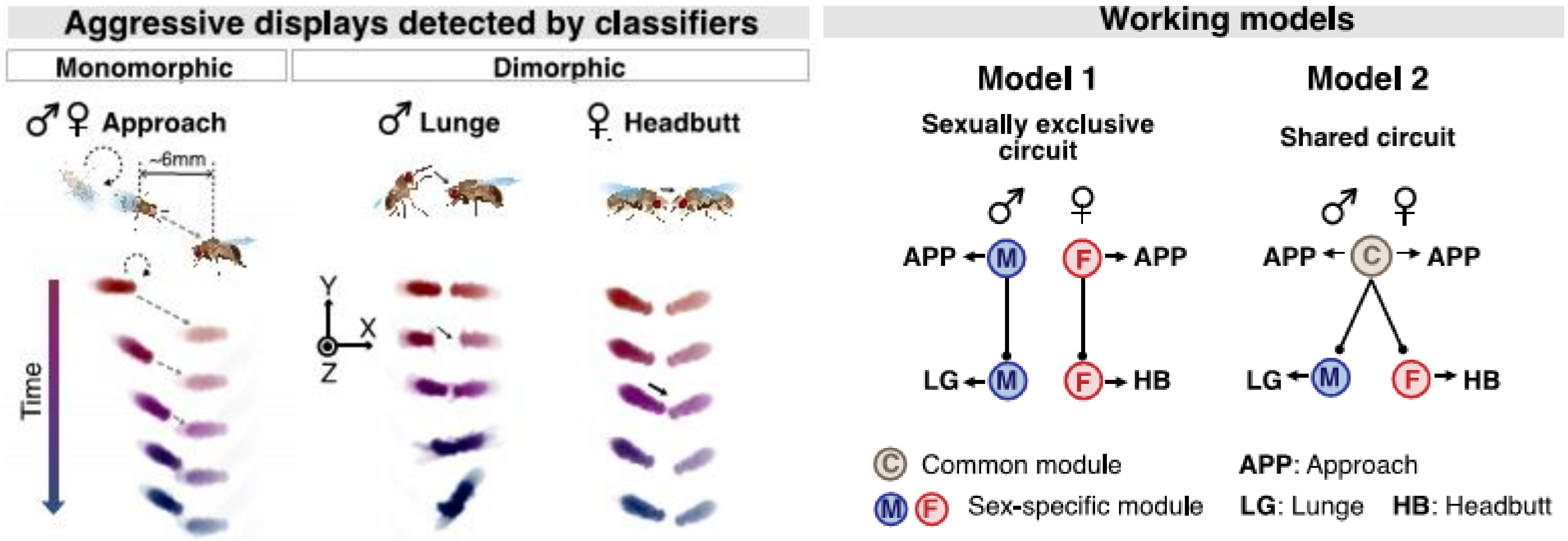


Group flies are exposured to chronic cVA which reduced aggression through Or65a ORNs



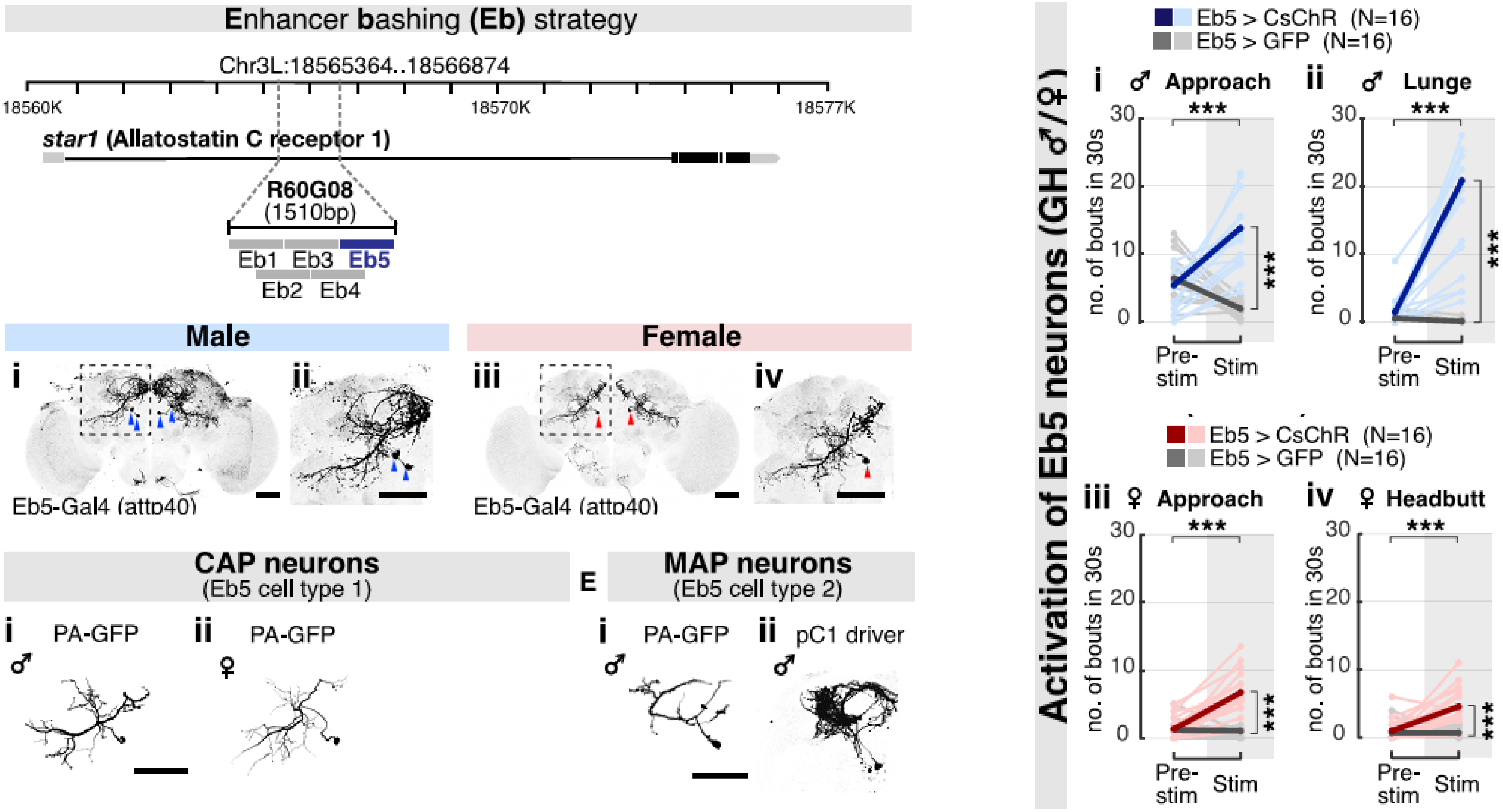
(Liu et al., Nat Neurosci, 2011)

Sexually monomorphic and dimorphic aggressive actions in males and females



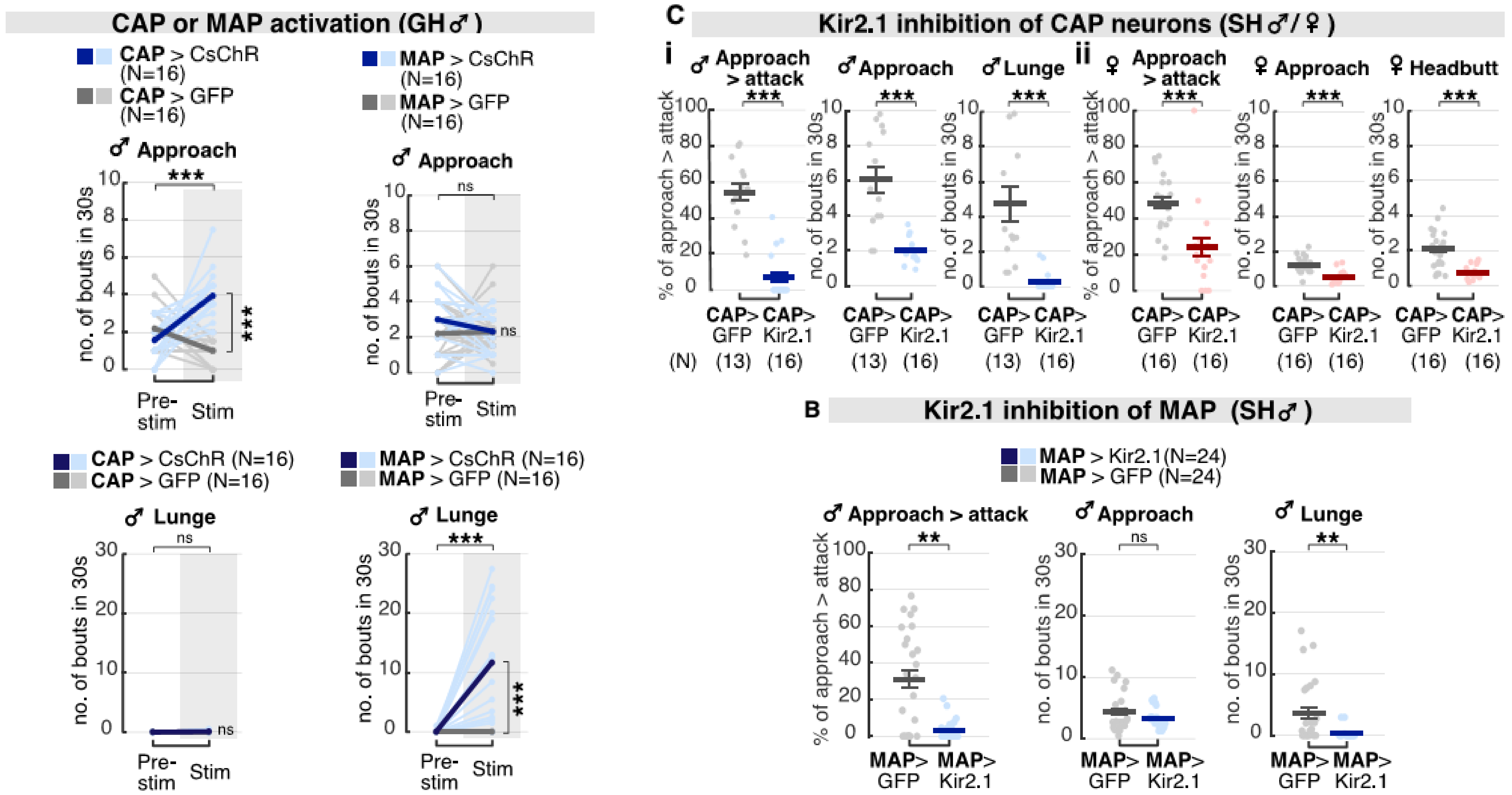
(Chiu et al., Cell, 2020)

Identification of sexually monomorphic and dimorphic aggression-promoting cell types



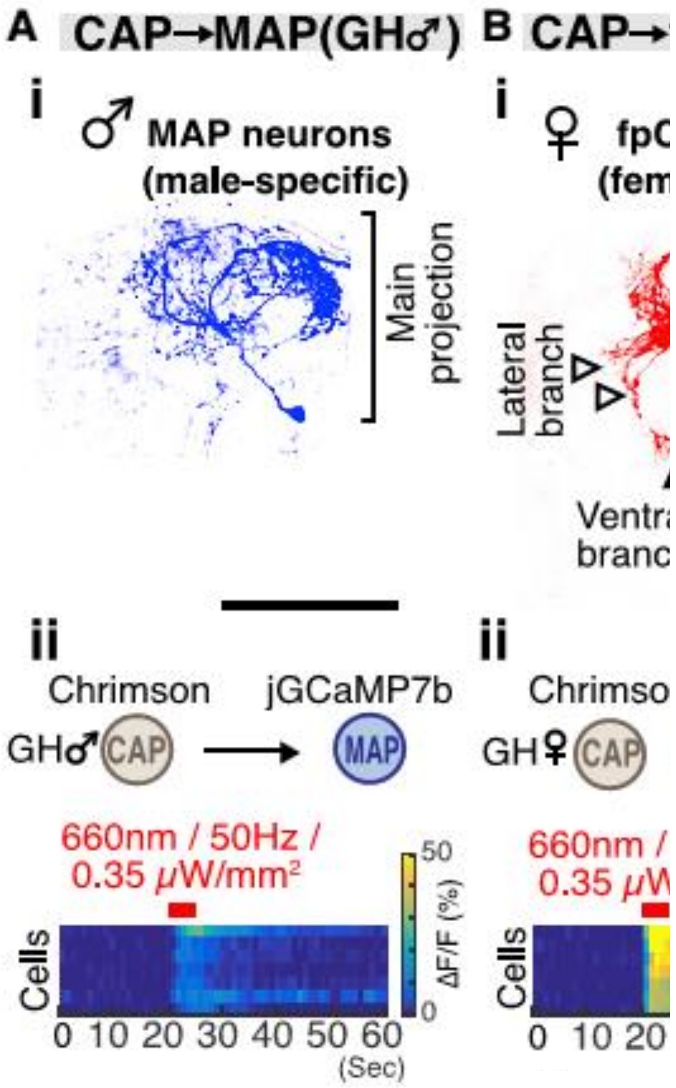
(Chiu et al., Cell, 2020)

MAP stimulation elicits dimorphic attacks in males

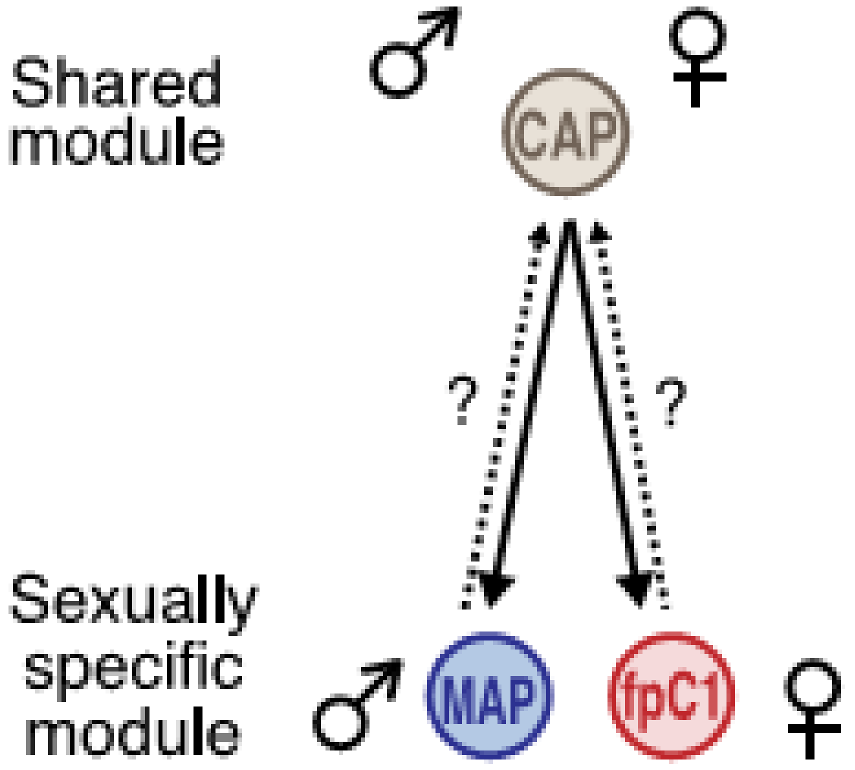


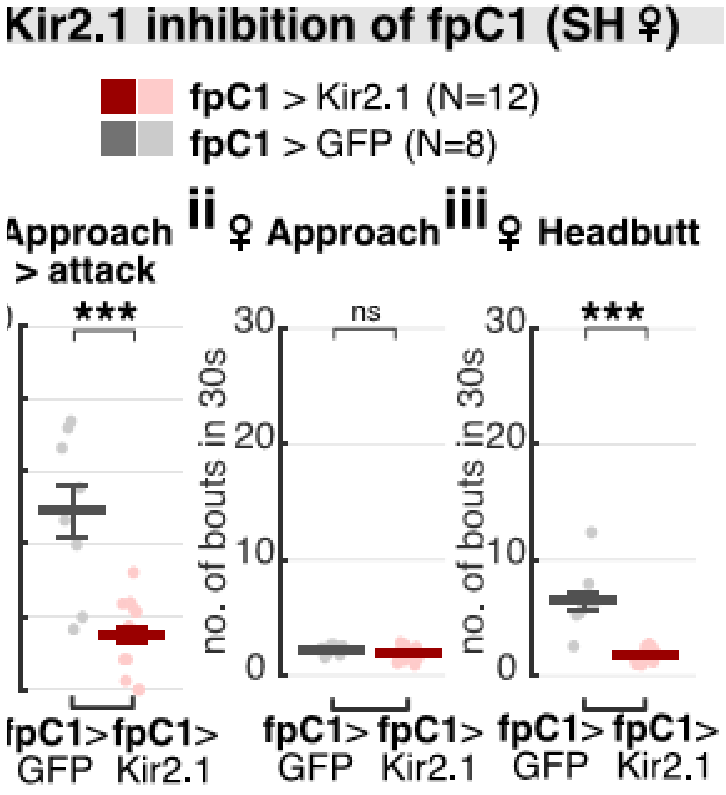
(Chiu et al., Cell, 2020)

Functional connectivity between monomorphic and dimorphic circuit modules



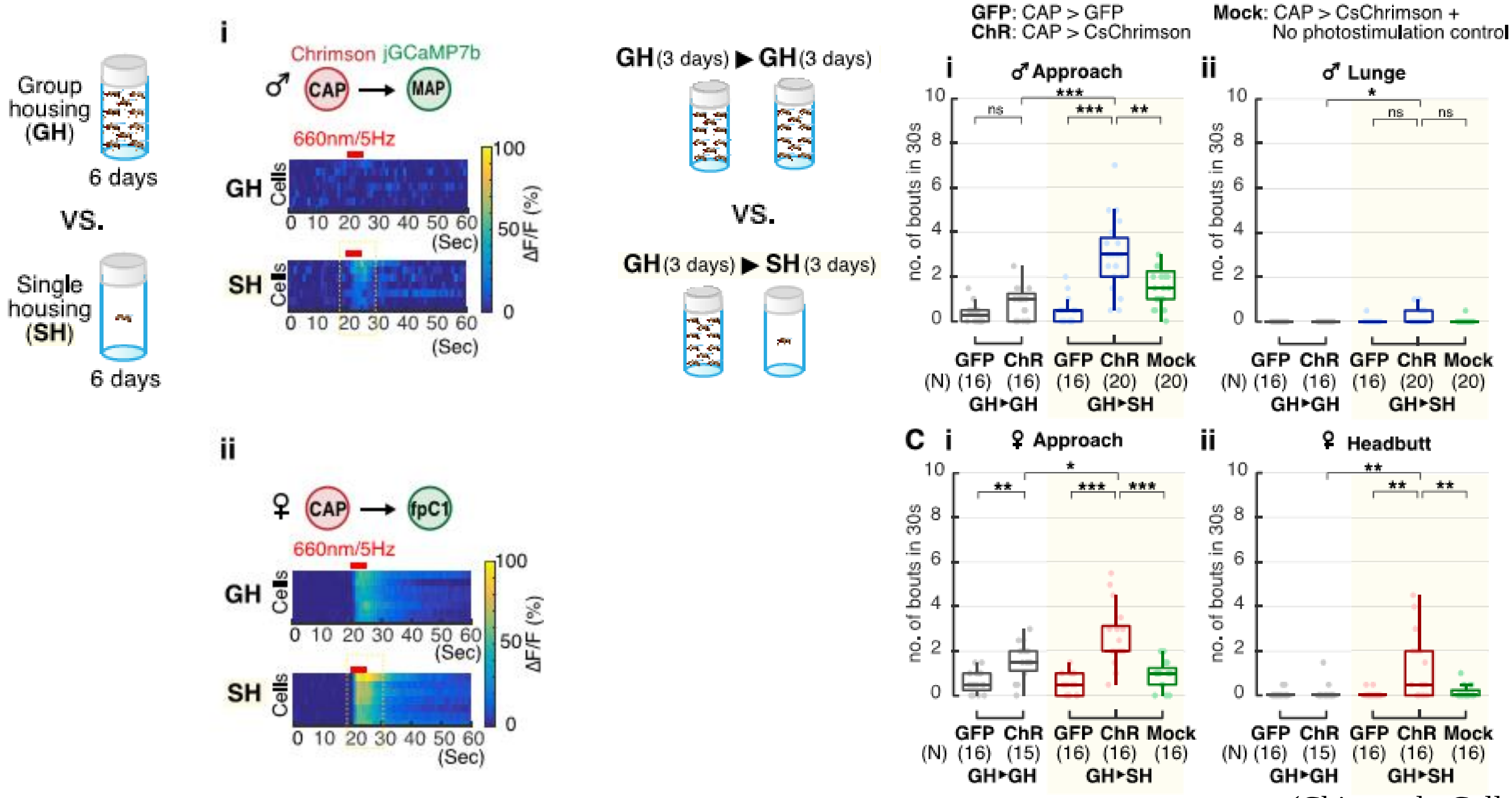
Working model





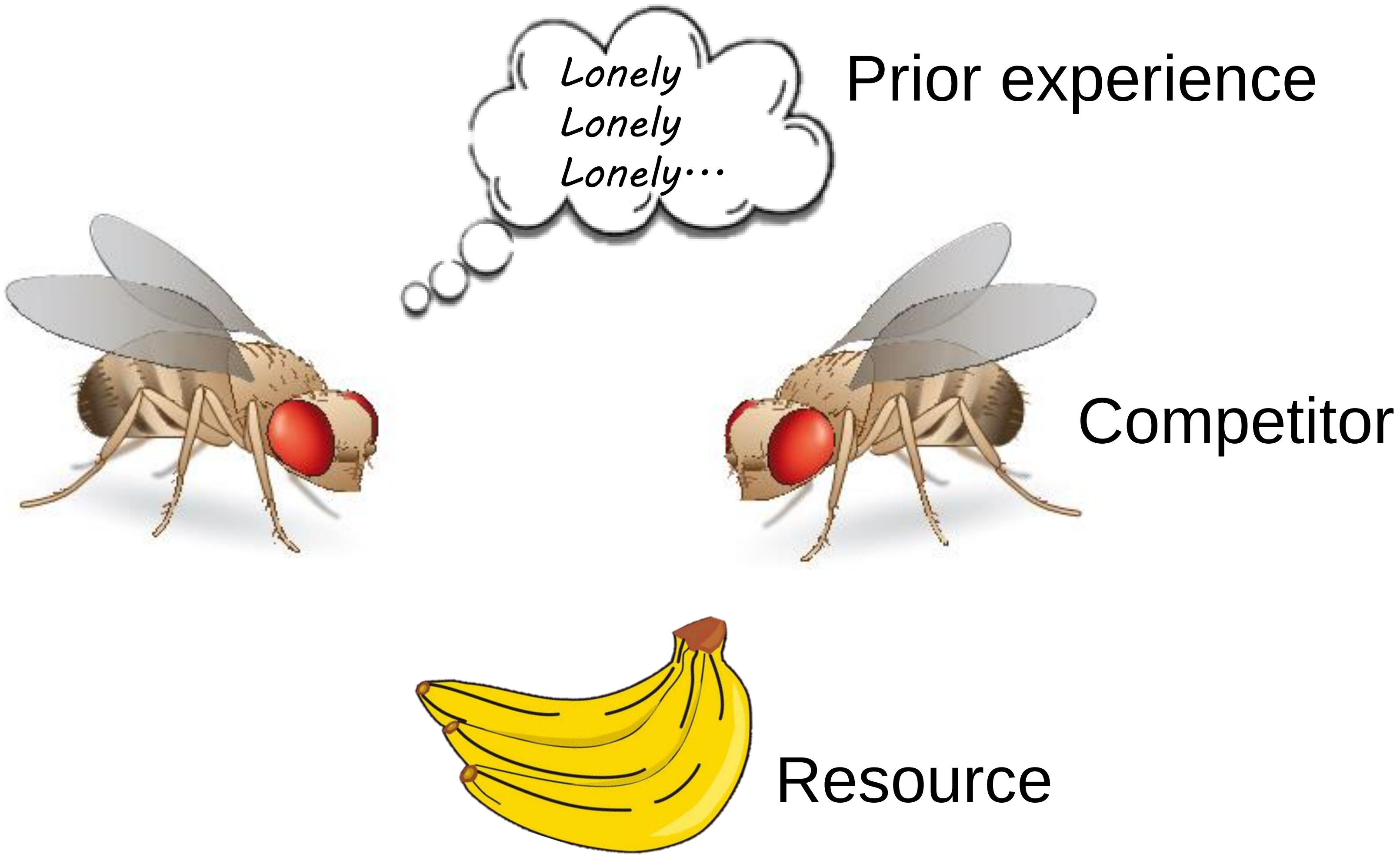
(Chiu et al., Cell, 2020)

Social isolation enhances aggressiveness by strengthening circuit functional connectivity



(Chiu et al., Cell, 2020)

To fight or not to fight

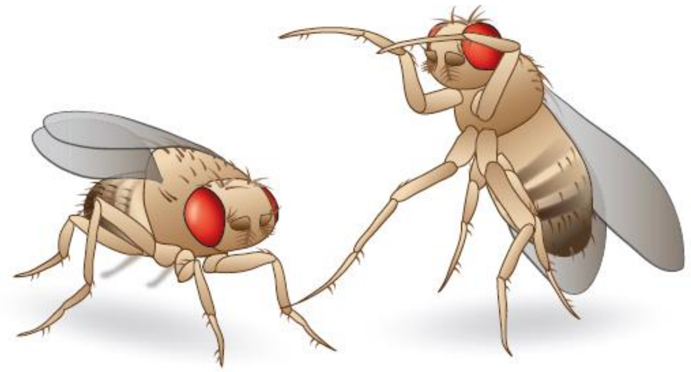


The winner and loser effect in *Drosophila*

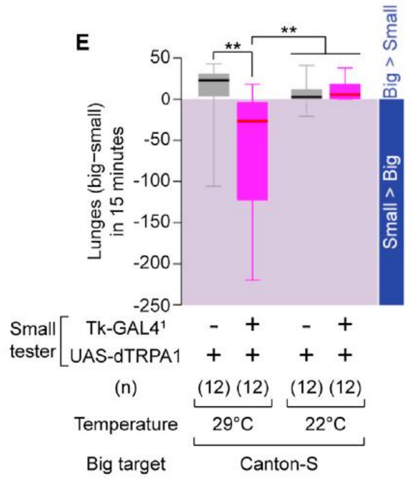
Han Caihong

What sets the odds of winning and losing?

To win or to lose?

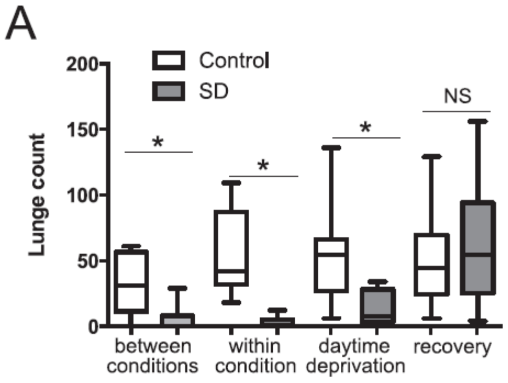


• Body size difference?



Asahina, K., et al. Cell (2014).

• Influence of other behaviors?

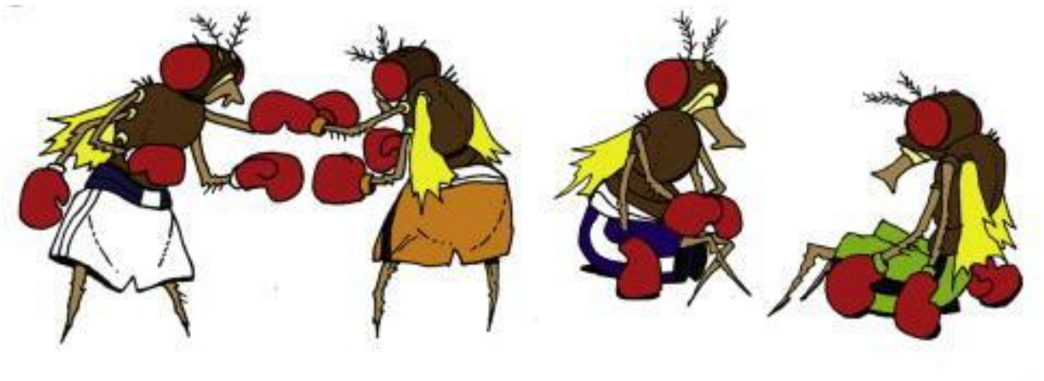


Kayser, M. S., et al. Elife (2015).

• Previous outcome of a fight?

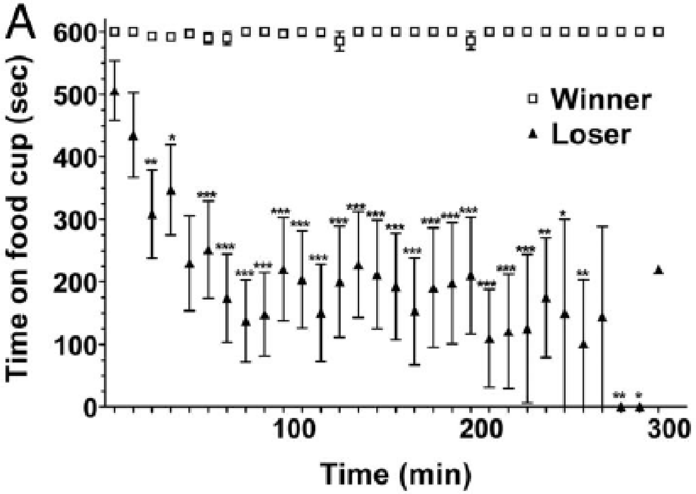
Winner effect and loser effect

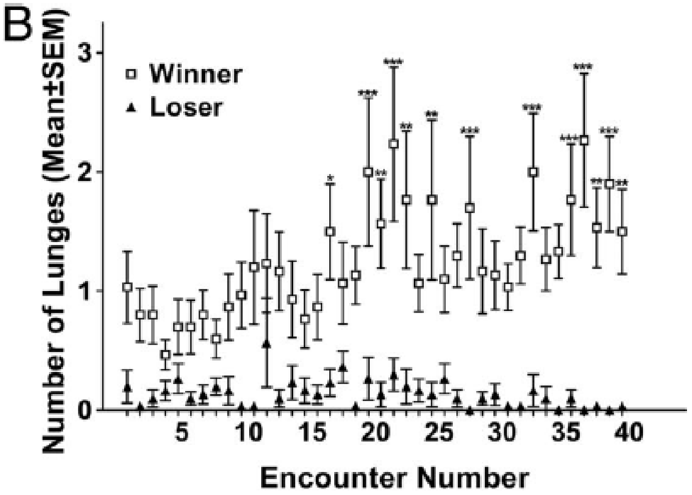
winner effect:
the winners are more likely to win again.
loser effect:
the losers more likely to lose again.

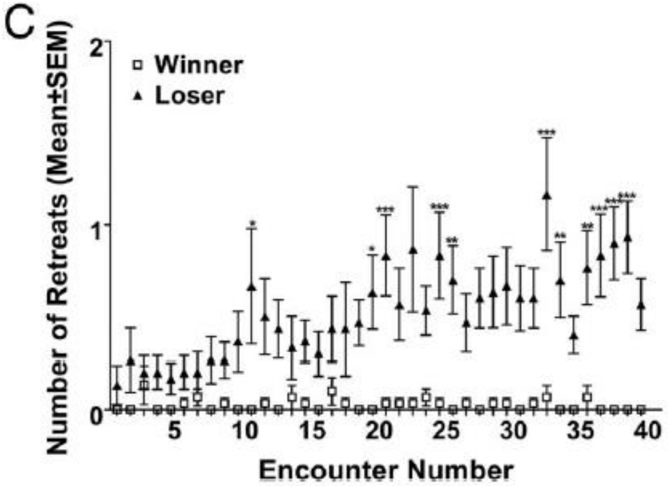


Such effects have been observed in many species, including fish, birds, and mammals.

Indicators of dominant and subordinate status







Yurkovic, A., et al. (2006).

Persistence of dominance relationship and individual recognition

how long flies fight;

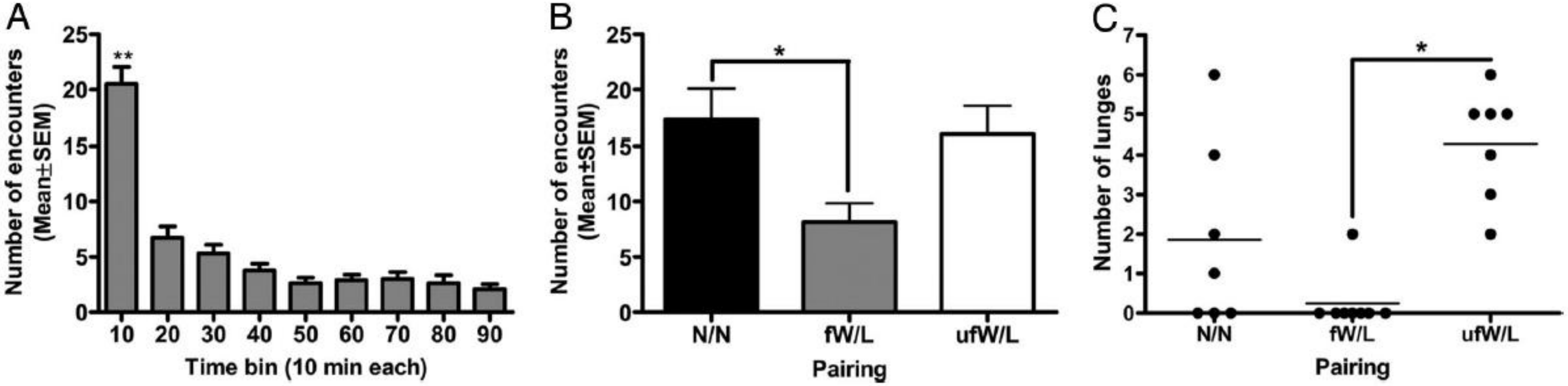


Table 1. Outcomes of second fights and control fights

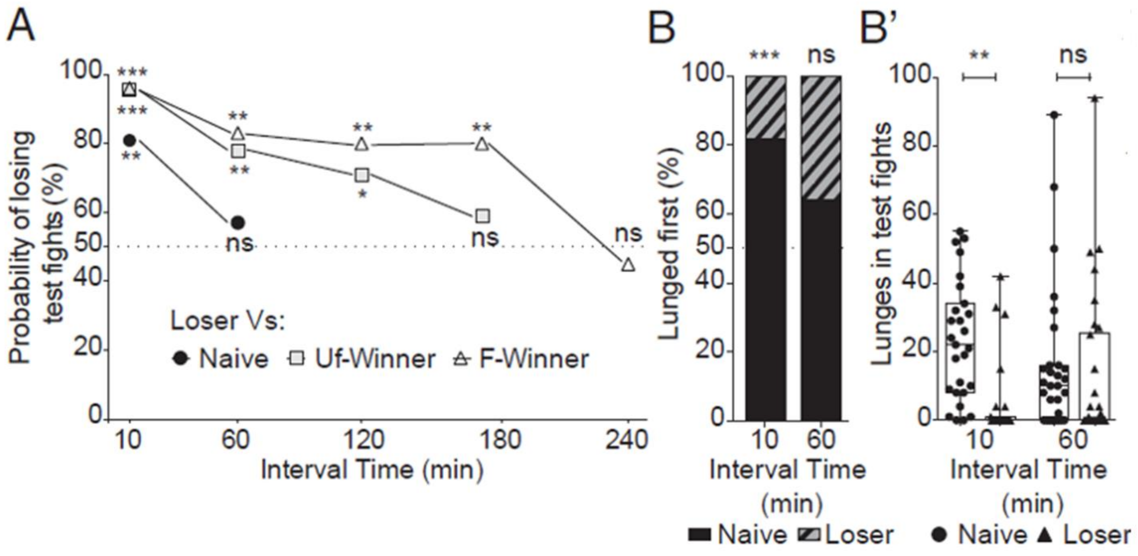
	Winner					Loser					Naive			
vs.	W	fL	ufL	N	Total	L	fW	ufW	N	Total	N	W	L	Total
Win	1	5	6	4	16	3	0	0	0	3	7	5	6	18
Loss	1	0	0	5	6	3	5	6	6	20	7	4	0	11
Draw	0	0	1	4	5	2	5	1	6	14	11	4	6	21
Total	2	5	7	13	27	8	10	7	12	37	25	13	12	50

Counts of wins, losses, and draws by experienced winner, experienced loser, and socially naive flies paired with experienced and naive opponents.

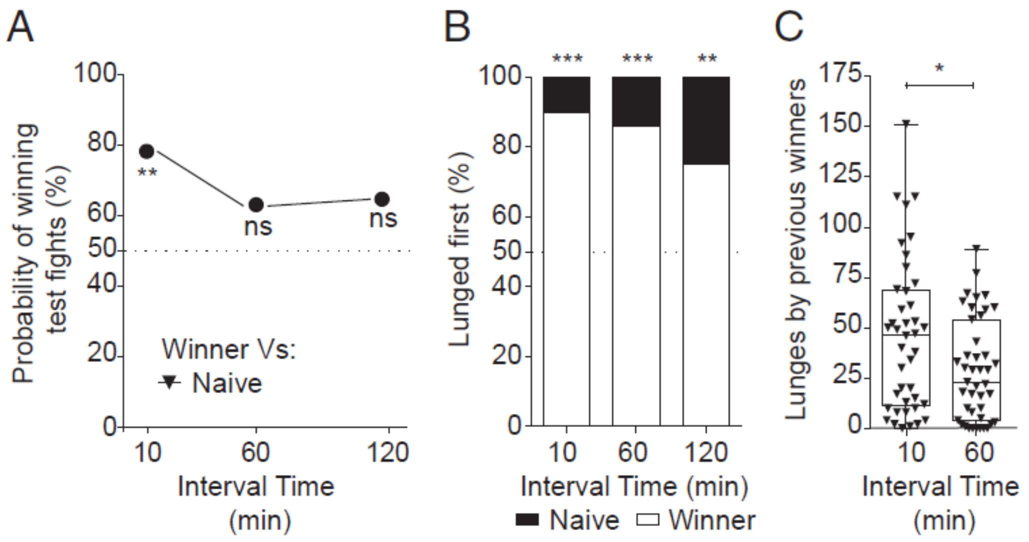
Yurkovic, A., et al. (2006).

Prior experiences induces submissive or aggressive behavior and drives short-term effect formation in loser and winner

in loser flies



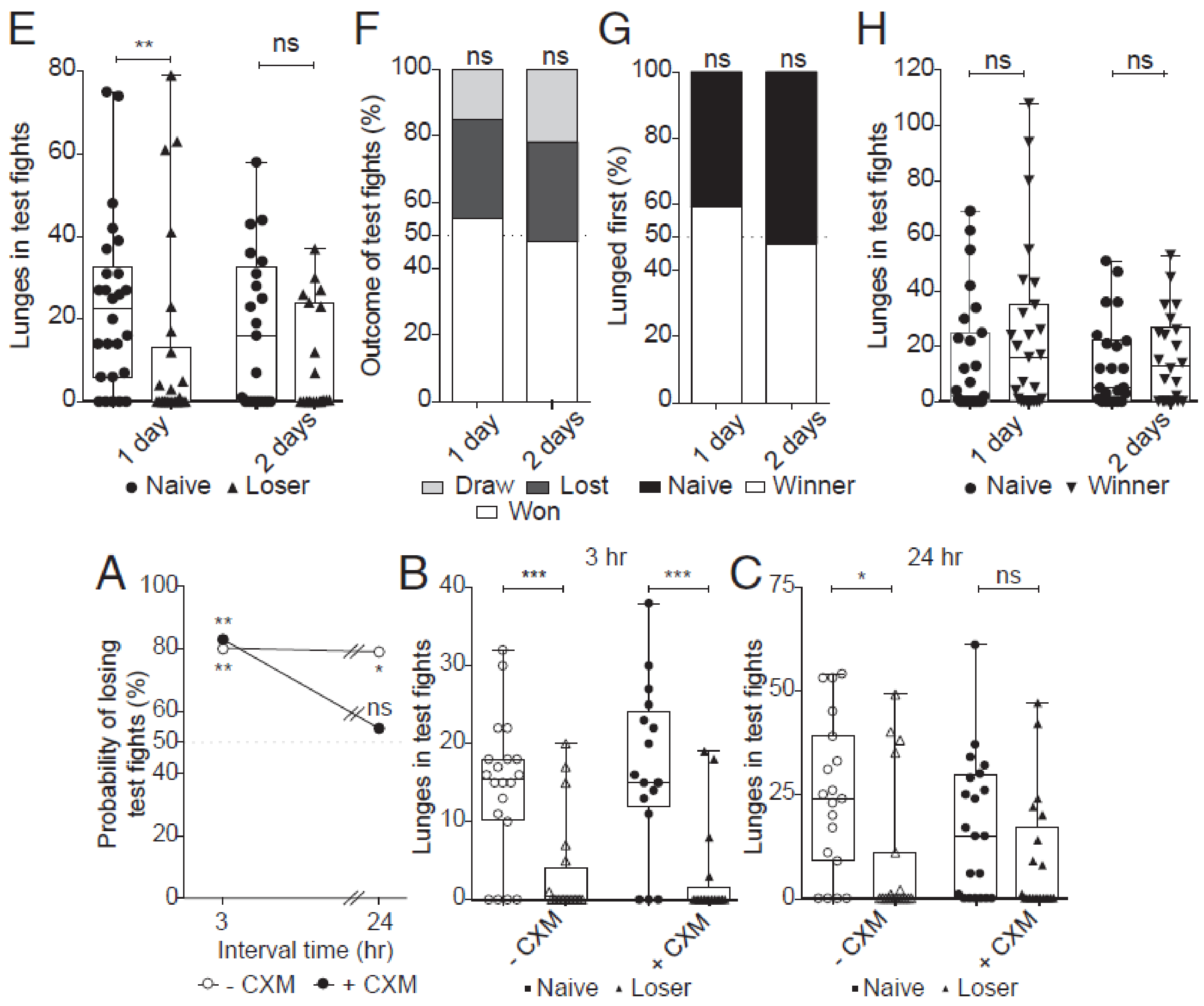
in winner flies



Both winners and losers show short-term memory of the results of previous bouts.

Trannoy, S., et al. (2016).

Repeated defeats lead to long-lasting consequences and the 24-h loser effect requires de novo protein synthesis.

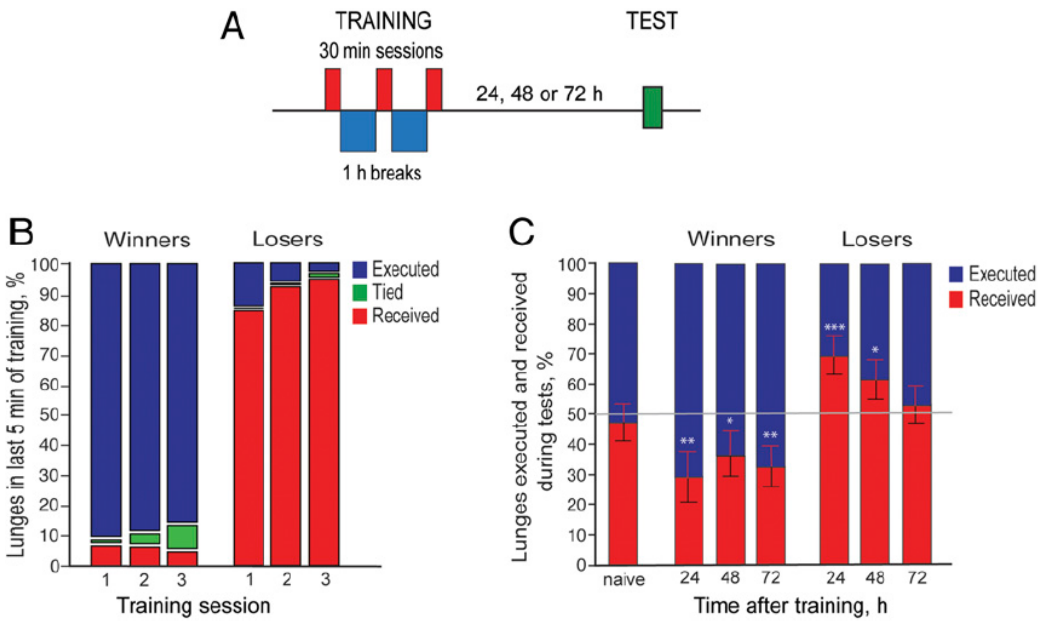


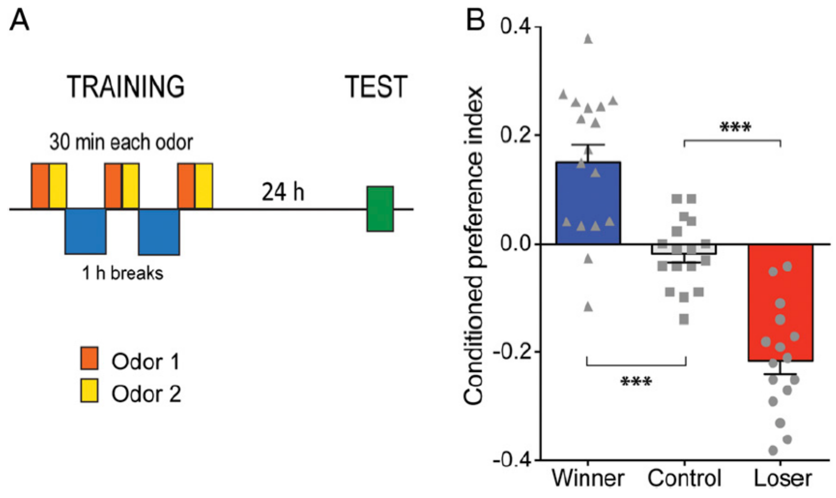
Trannoy, S., et al. (2016).

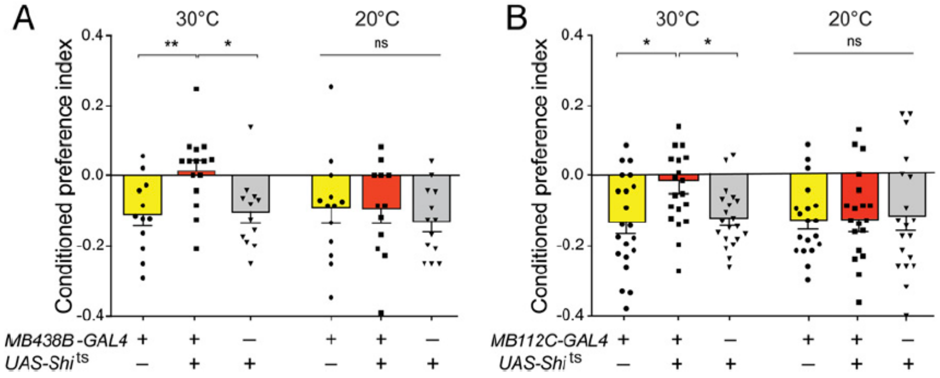
Only losers demonstrate a longer-term memory that requires protein synthesis.

The winning is perceived as rewarding, while losing is perceived as aversive

Generation of a persistent winner and loser effect.



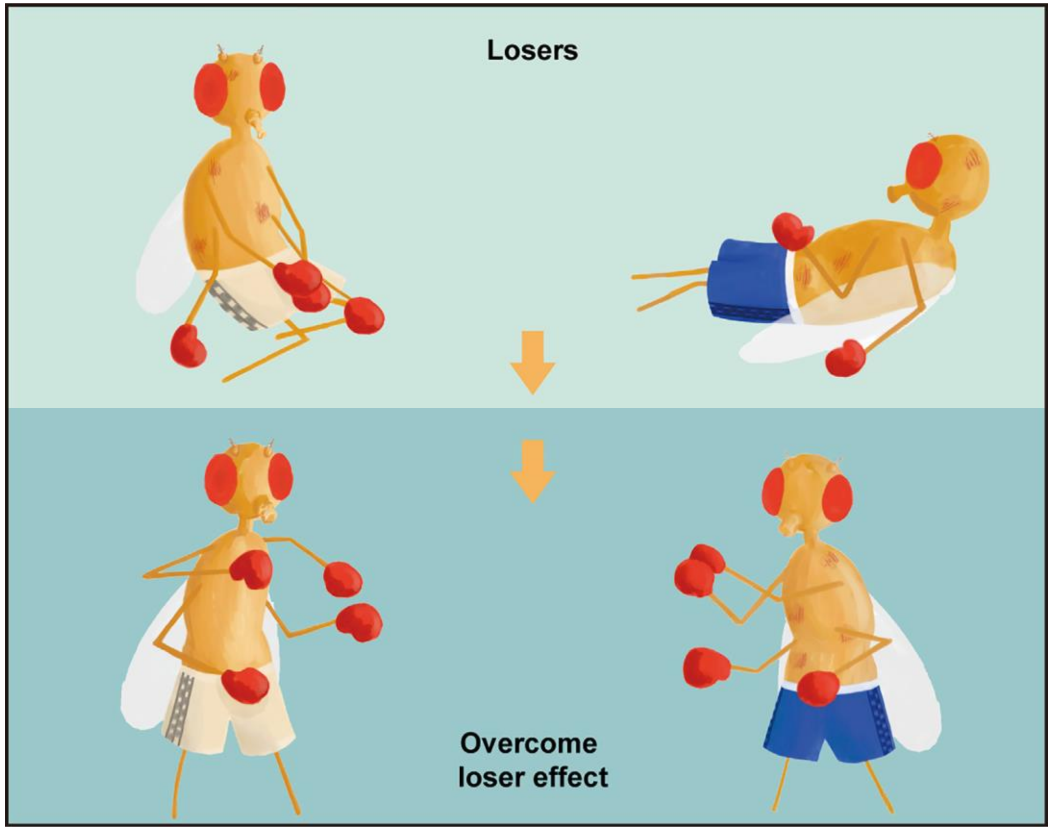




The activities of the PPL1-γ1pedc dopaminergic neuron and the MBON-γ1pedc>α/β mushroom body output neuron are required for aversion to an olfactory cue associated with losing fights.

Kim, Y. K., et al. (2018).

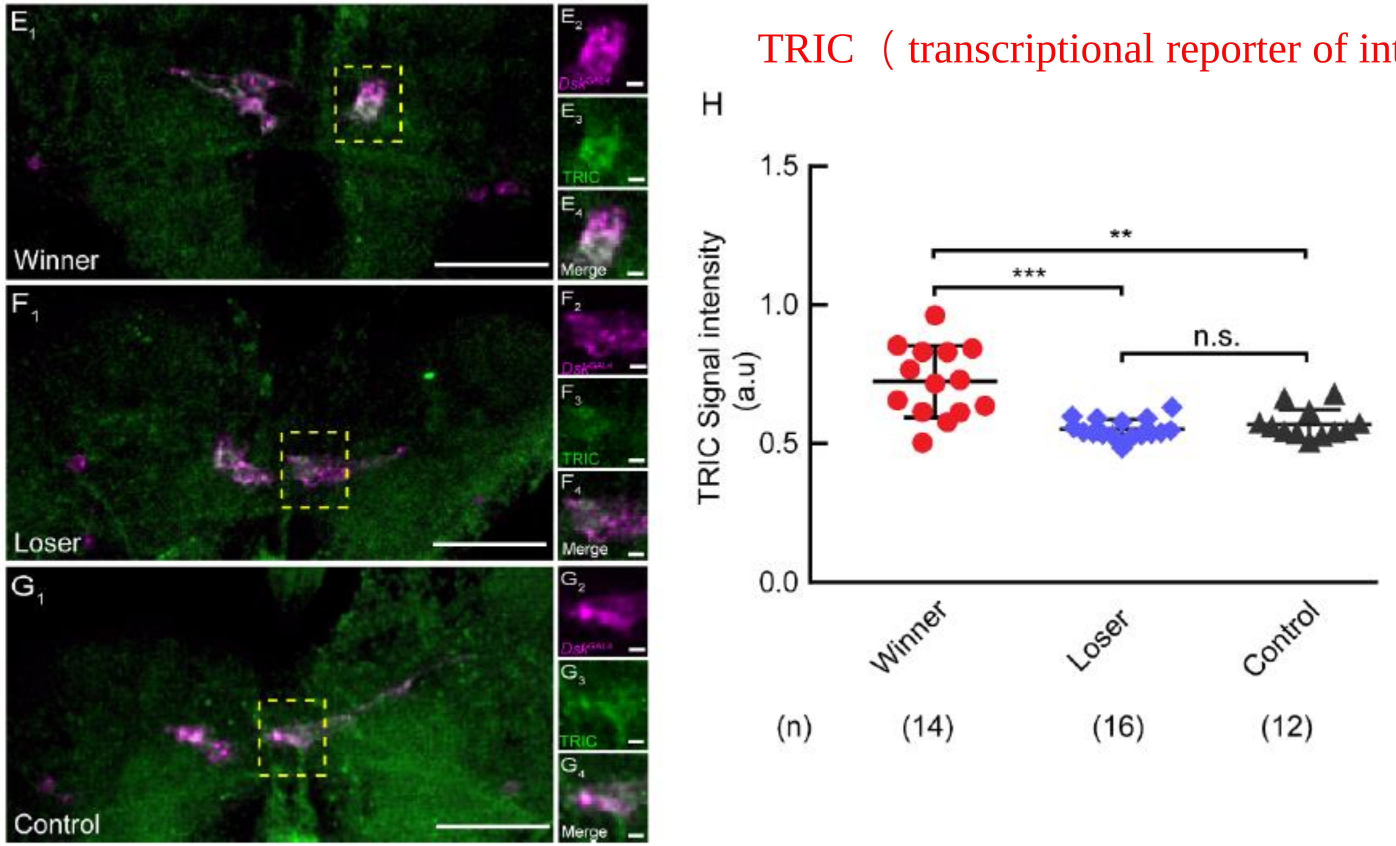
How to reverse the loser effect?



Multiple neurotransmitters and neuropeptides, including octopamine, dopamine, 5-HT, dsk, neuropeptide F, and tachykinin (Tk), are involved in aggression in *Drosophila*.

The winners show increased calcium activity in Dsk- expressing neurons

TRIC （transcriptional reporter of intracellular Ca^{2+}）

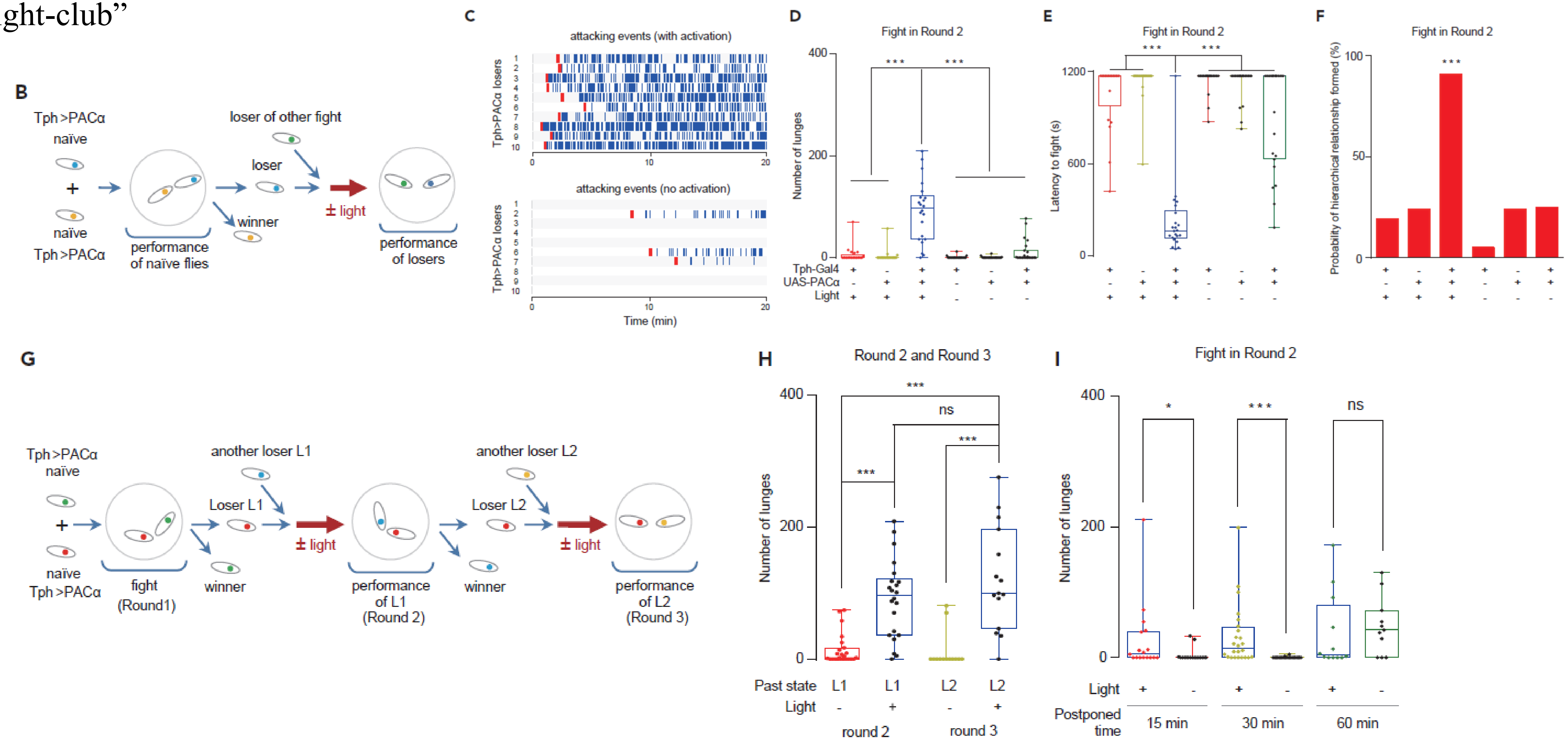


Conditional overexpression of DSK promotes winner effect and winner show increased calcium activity of DSK Neurons.

Wu, F., et al. Elife (2020).

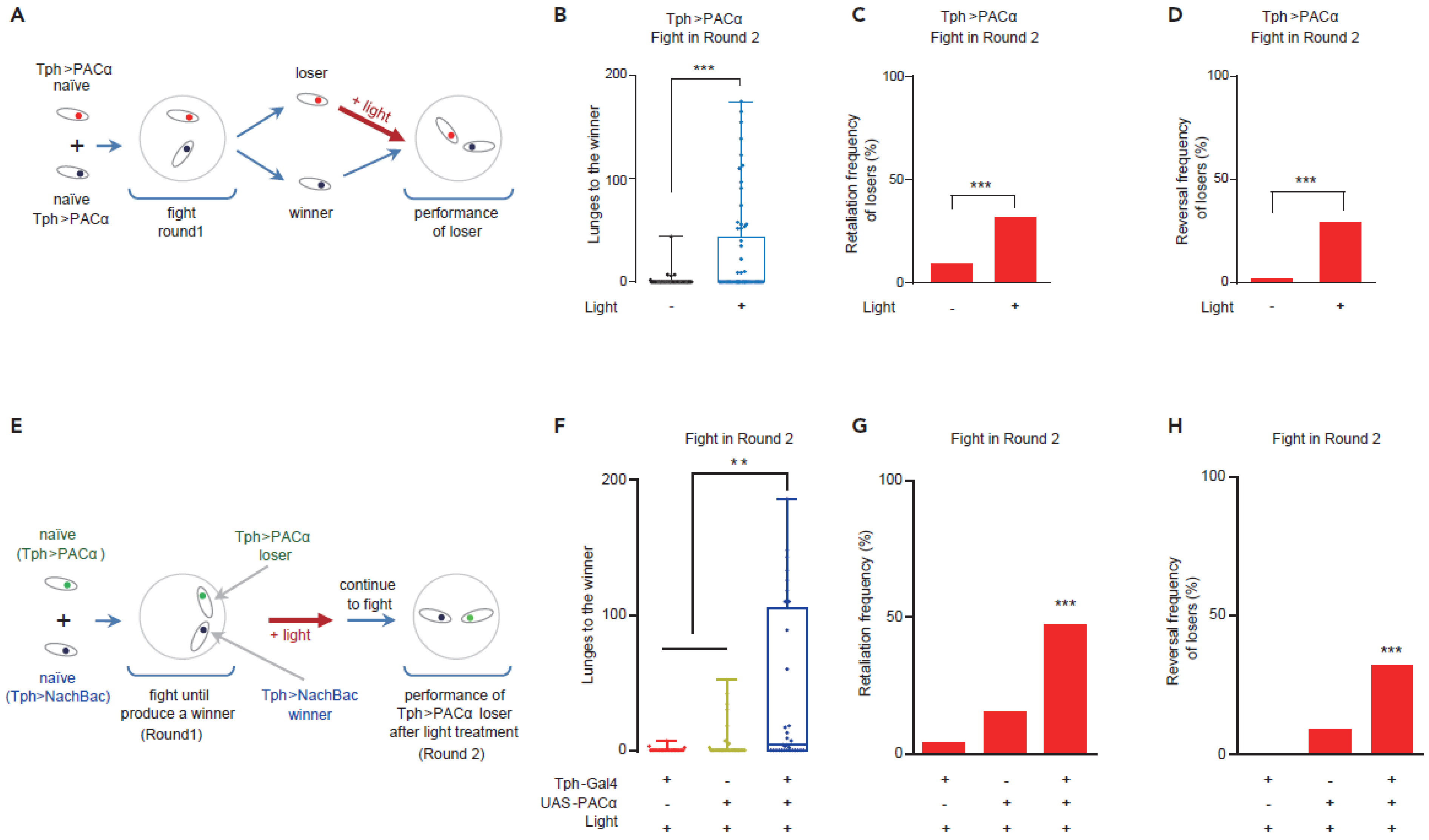
Activation of 5-HT Neurons Promotes Losers to Re-engage in a Fight

“fight-club”



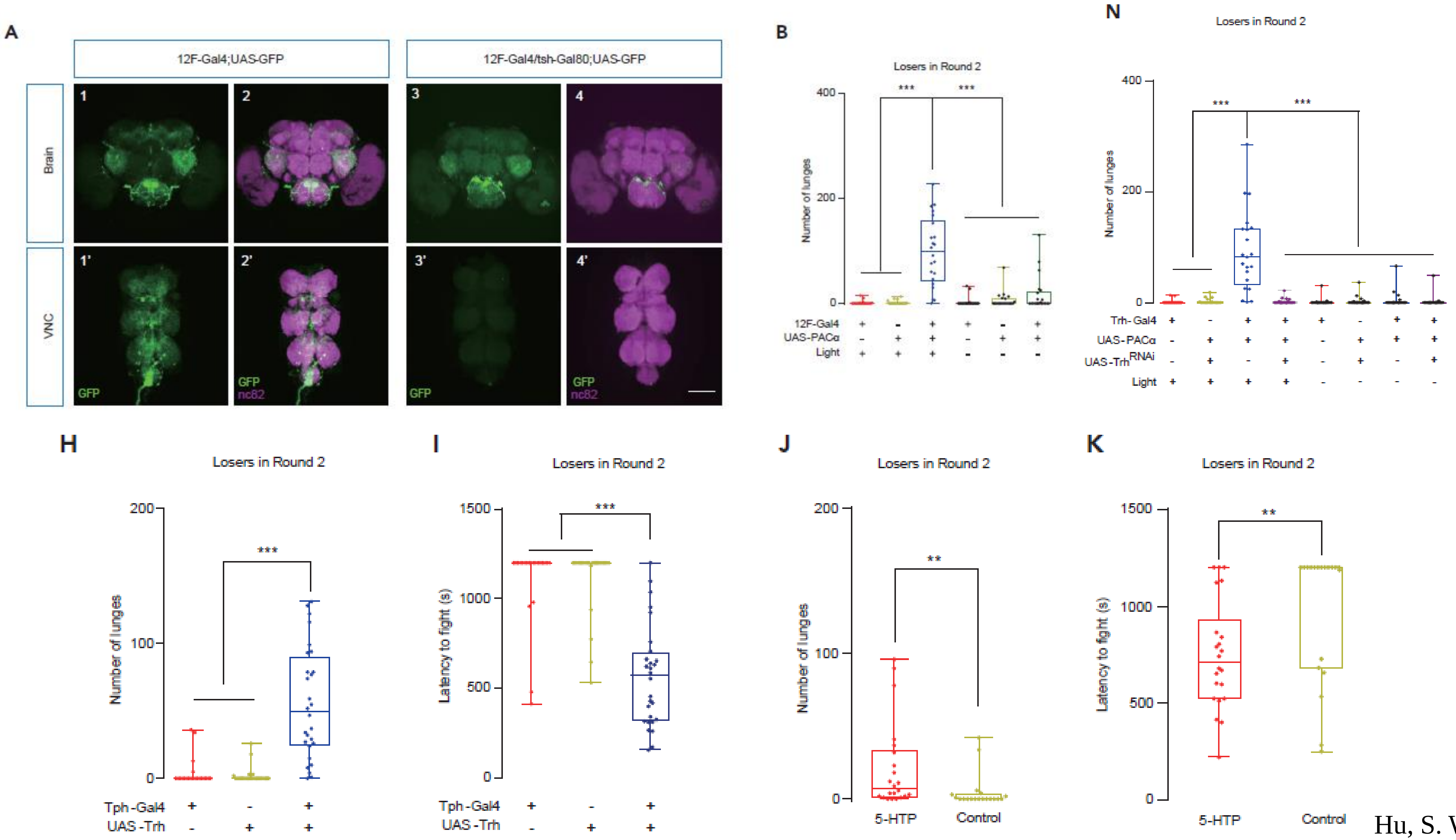
Hu, S. W., et al. (2020).

Activation of 5-HT Neurons Promotes Fighting of Losers Against Winners



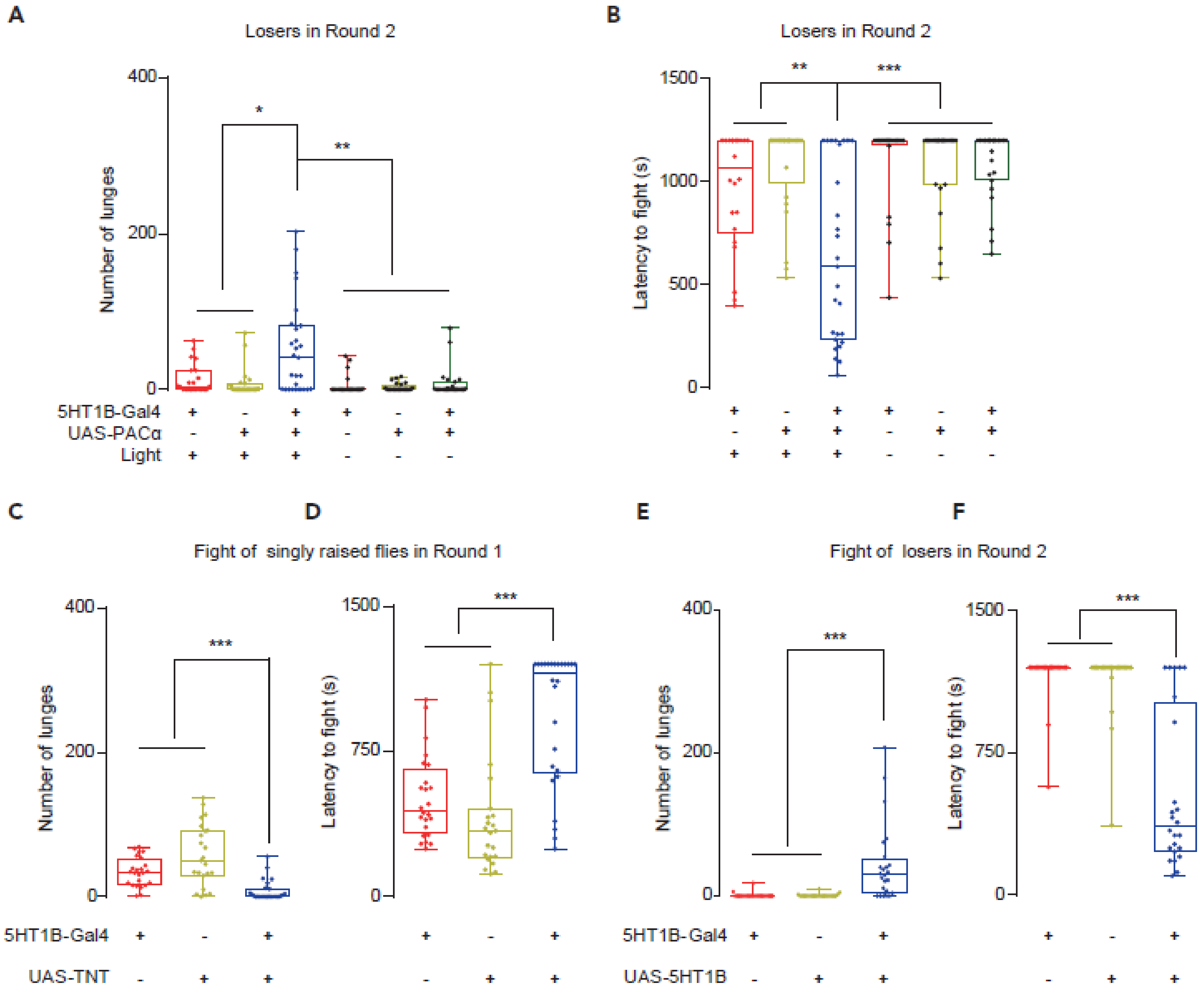
Hu, S. W., et al. (2020).

Serotonin is necessary and sufficient for overcoming the loser effect



Hu, S. W., et al. (2020).

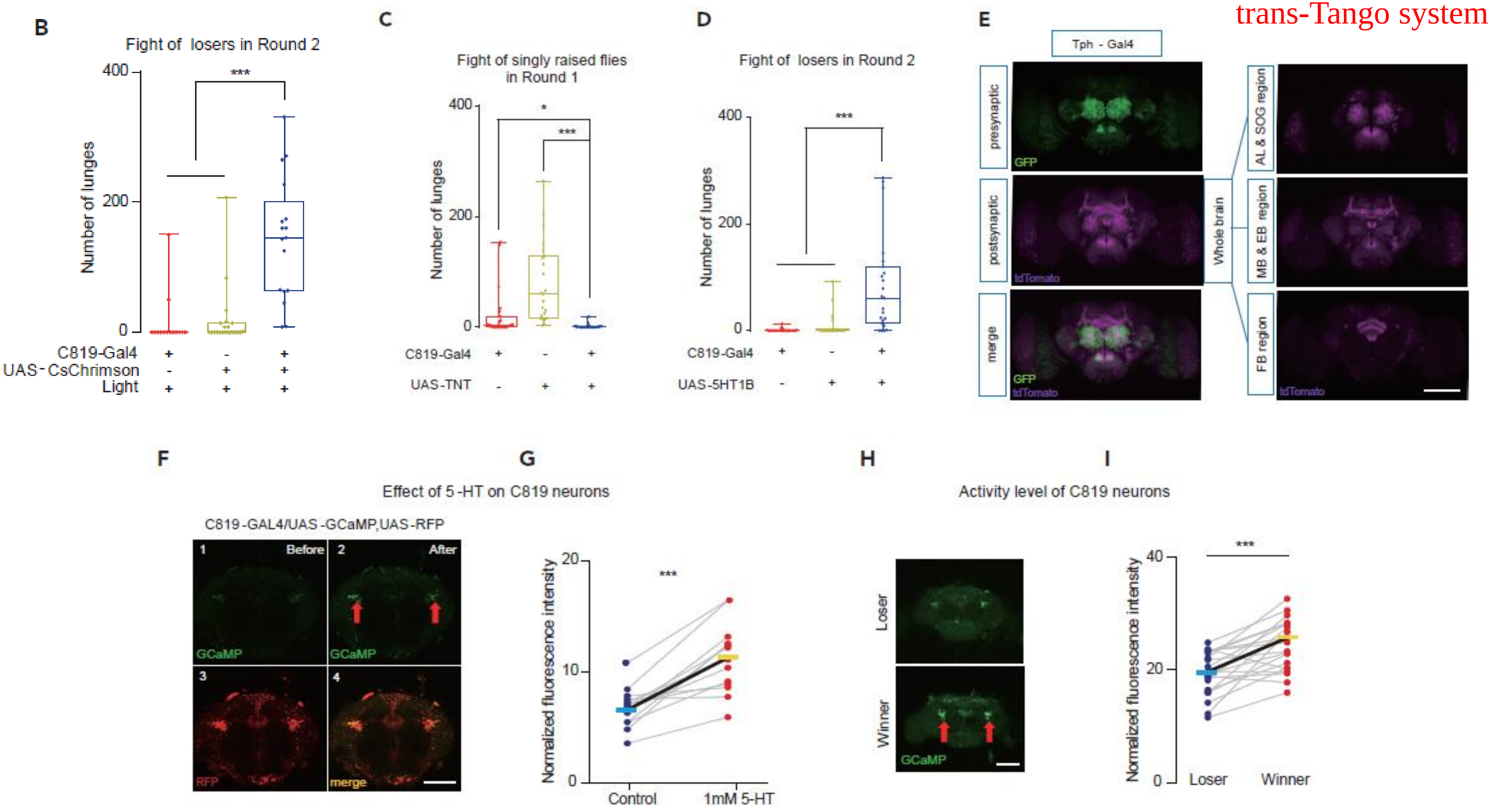
5-HT1B receptors are responsible for restoring aggression in losers



Hu, S. W., et al. (2020).

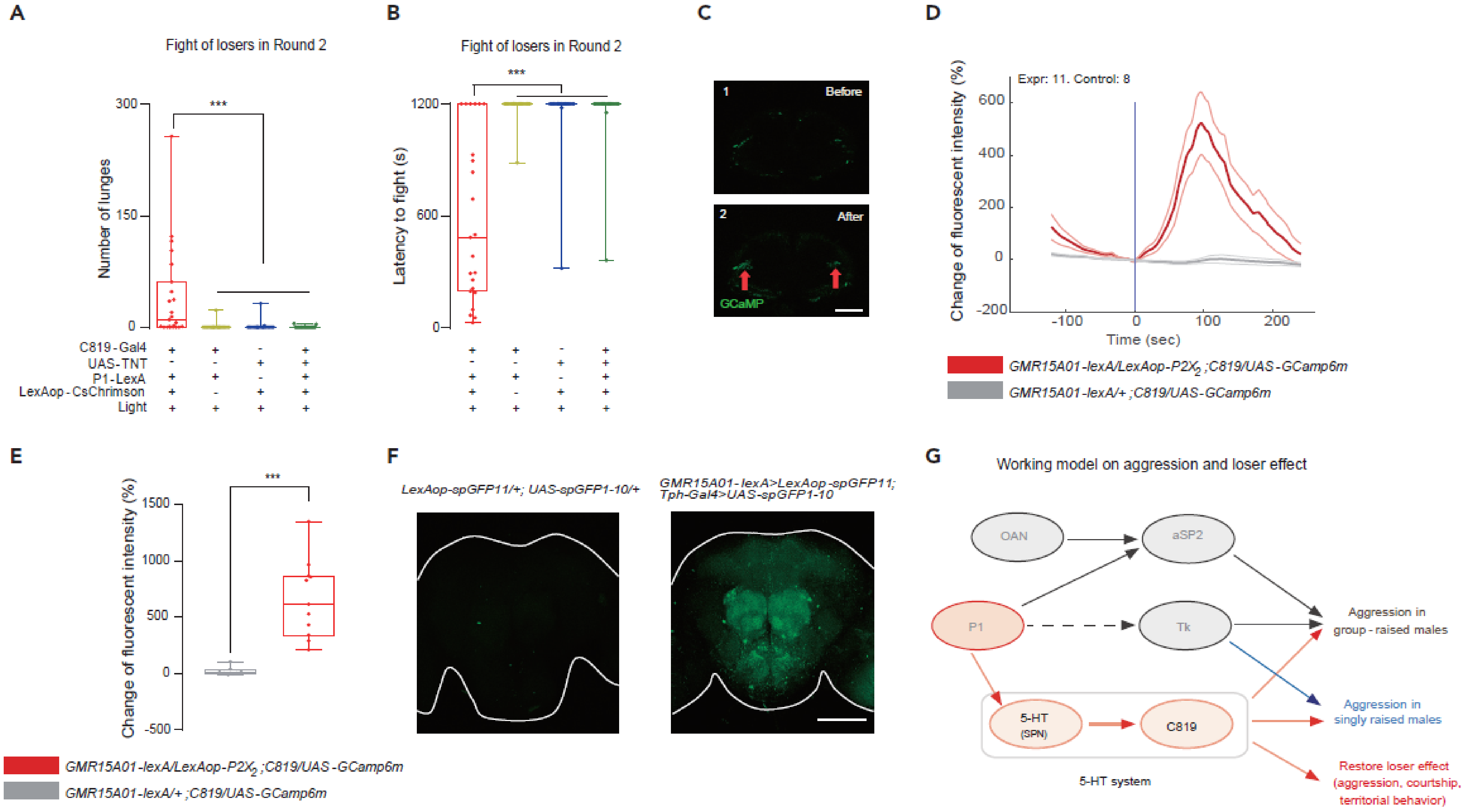
R2/R4m neurons in the Ellipsoid Body are responsible for overcoming the loser effect

trans-Tango system



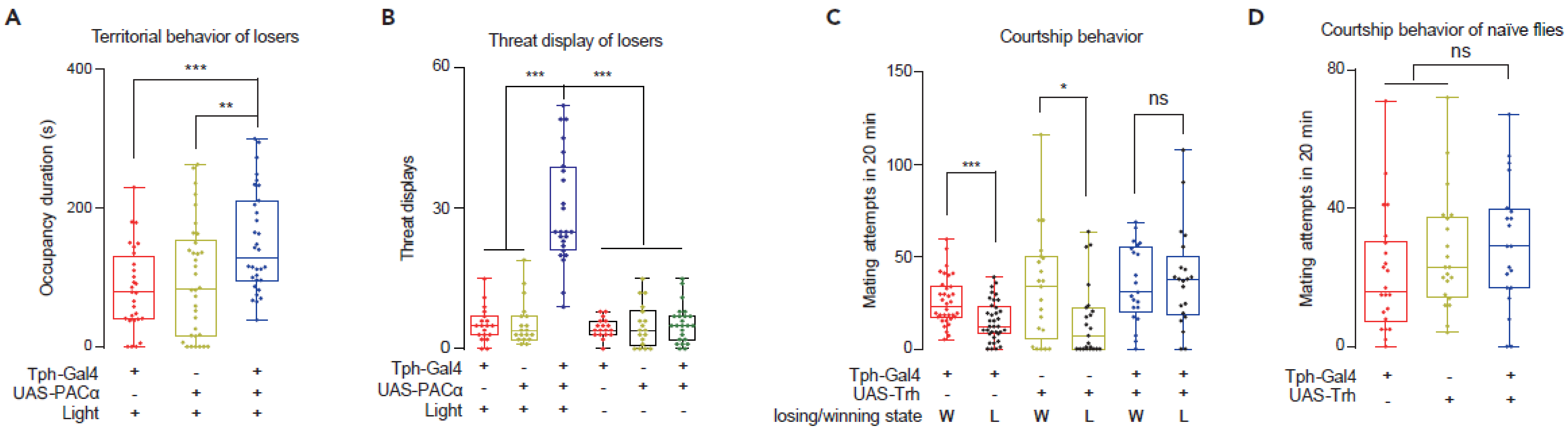
Hu, S. W., et al. (2020).

P1 neurons act upstream of 5-HT signaling



Hu, S. W., et al. (2020).

Suppressive loser mentality is effectively removed by increasing serotonin signaling



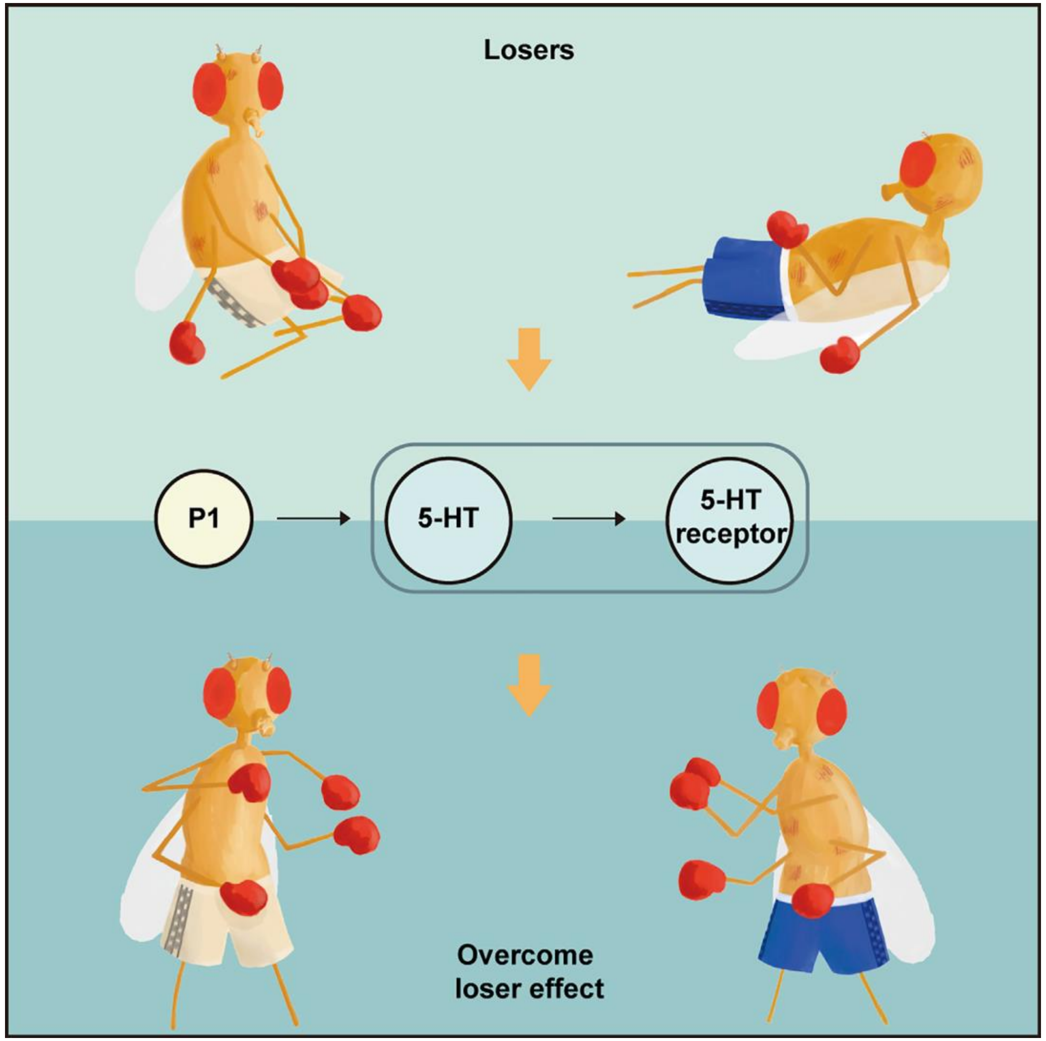
Hu, S. W., et al. (2020).

Article

iScience

2020

Serotonin Signals Overcome Loser Mentality in *Drosophila*



HIGHLIGHTS

Activating a small subset of serotonin neurons promotes losers to fight.

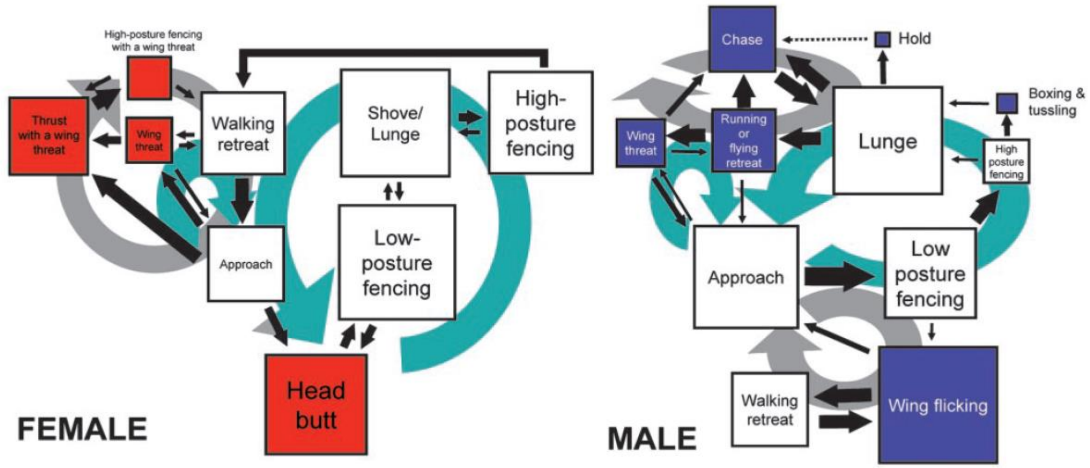
Serotonin is necessary and sufficient for modulating aggression in losers.

The neural circuit for motivating losers includes P1, 5-HT, and 5-HT1B neurons.

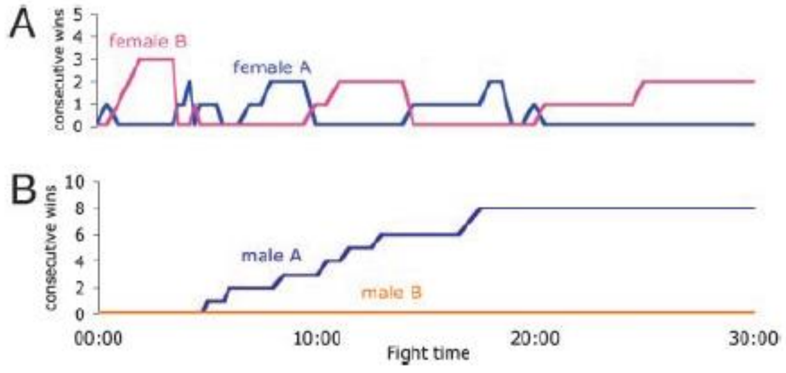
Elevating 5-HT signaling overcomes the depressive behavioral state in losers.

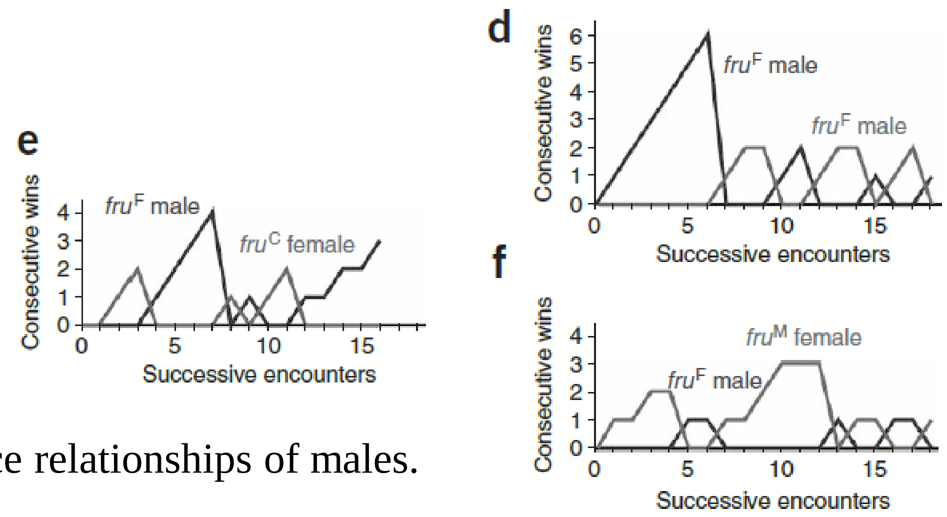
No strong dominance relationships were formed in fights between females

Behavioral patterns and transitions seen in fights between pairs of male and pairs of female *D. melanogaster.*



The Absence of Dominance Relationships in Female Fights.





fru plays a critical role in establishing dominance relationships of males.

Take home message

- Encounters between flies were frequent during the first 10 min of pairing and then dropped significantly.
- Both winners and losers show short-term memory of the results of previous bouts and only losers demonstrate a longer-term memory that requires protein synthesis.
- The winning is perceived as rewarding, while losing is perceived as aversive.
- The activities of the dopaminergic neuron and mushroom body output neuron are required for aversion to an olfactory cue associated with losing fights.
- Serotonin is necessary and sufficient for modulating aggression in losers and the neural circuit for motivating losers includes P1, 5-HT, and 5-HT1B neurons.
- Female have no dominance relationships were formed in fighting.

question

- An increasing aggression is not identical to reversal of the loser effect, the neural mechanisms of overcoming the loser effect is unclear.
- The underlying neural mechanisms of negative social experiences (sexual rejection and fighting loser) modulate multiple behaviors.
- Whether aggression in flies, like most complex behaviors in most organisms, comprises both innate and learned components.

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