The good, the bad, and the ugly: neural coding of upshifted, downshifted and blocked cues in the orbitofrontal cortex

Geoffrey Schoenbaum, MD, PhD
Branch Chief and Senior Investigator
National Institute on Drug Abuse
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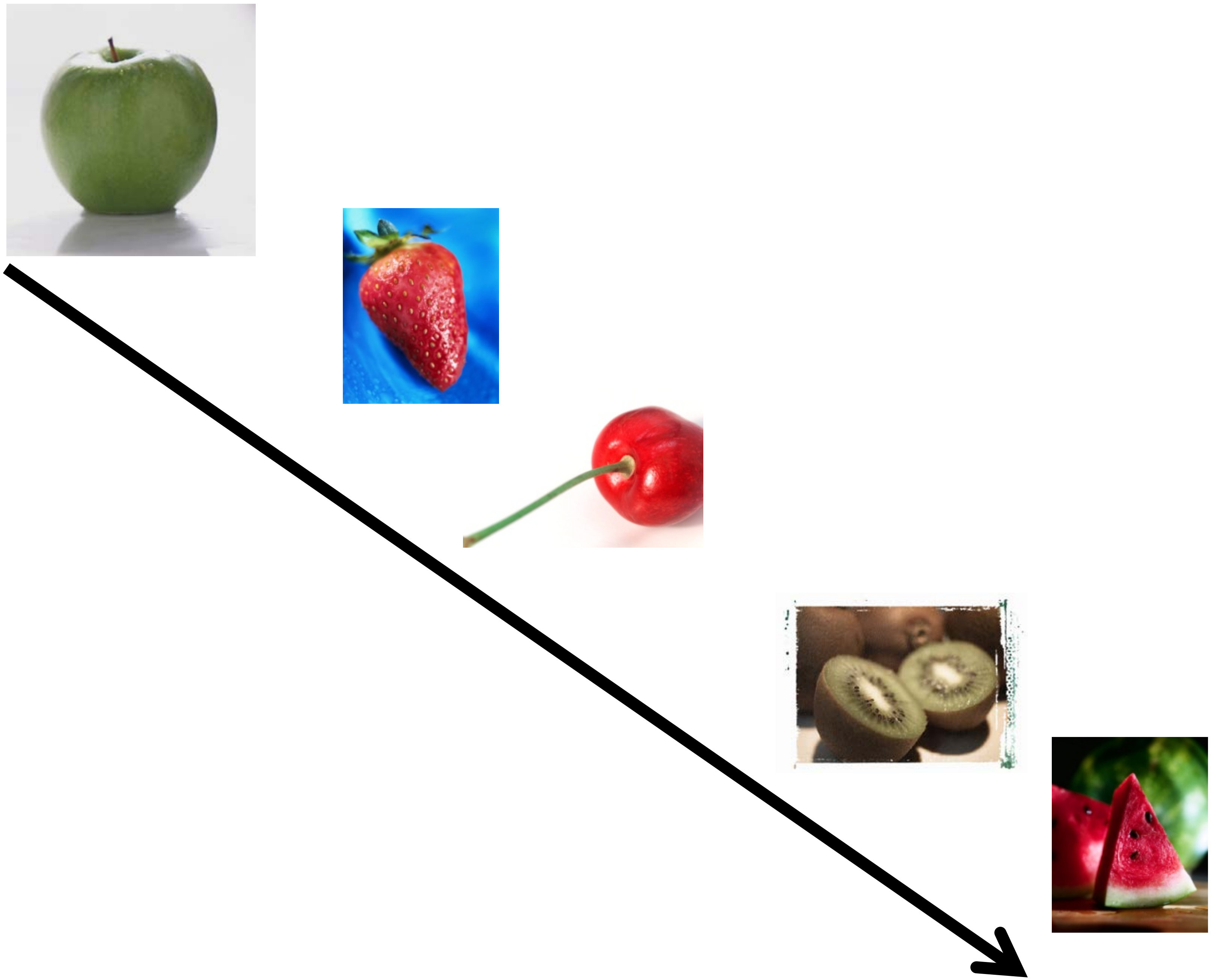
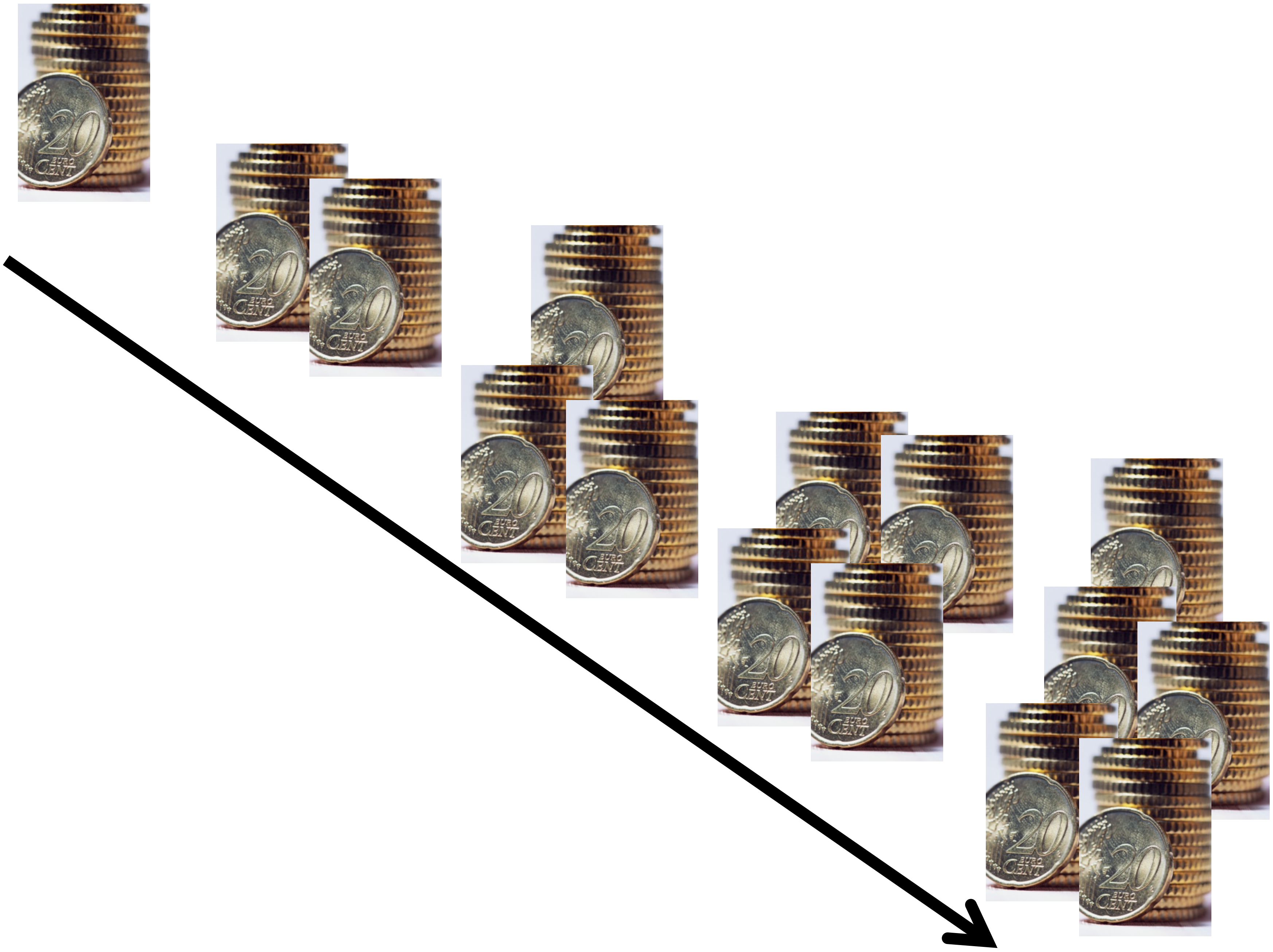
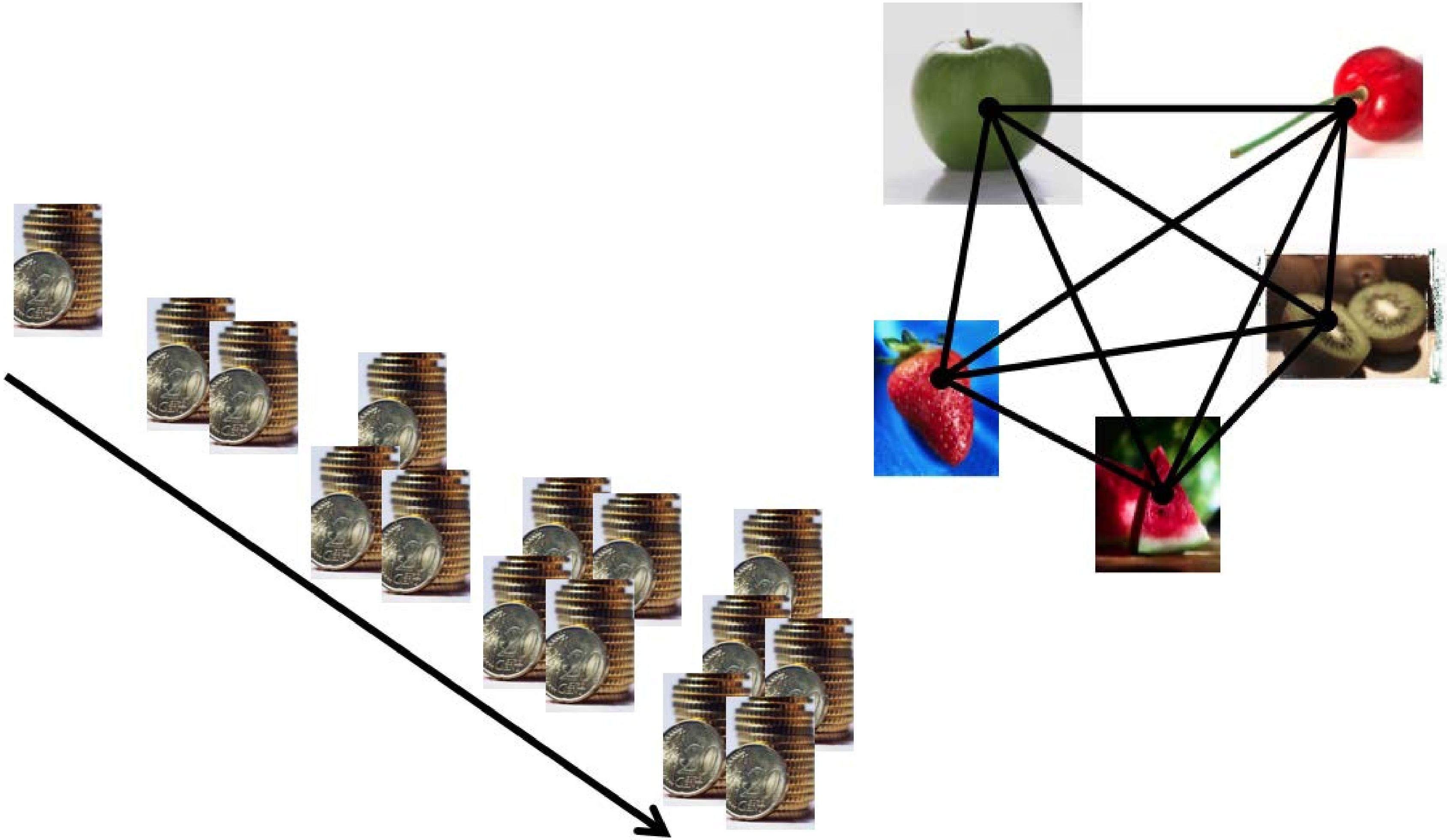
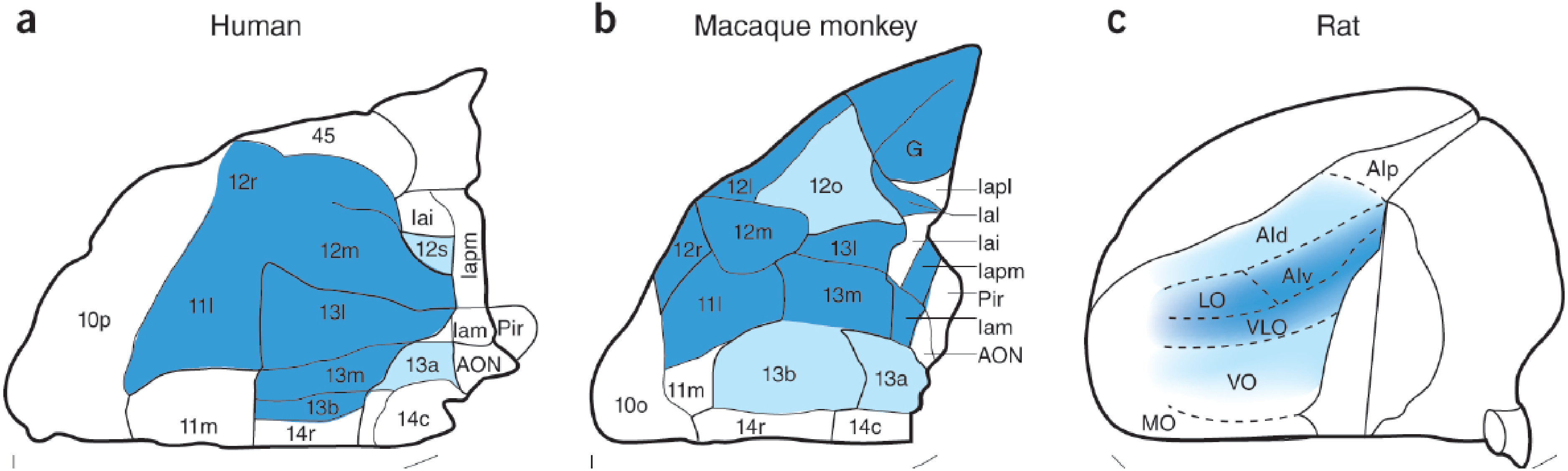
Baltimore, MD





So type of information does the orbitofrontal cortex contribute?




a
Human
45
12r
lai
12m
12s
lapm
10p
11l
13l
lam
Pir
13m
13a
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13b
11m
14r
14c
b
Macaque monkey
G
12l
12o
lapl
lal
12m
13l
lai
12r
lapm
11l
13m
Pir
lam
AON
13b
13a
11m
10o
14r
14c
c
Rat
AIp
AId
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VLO
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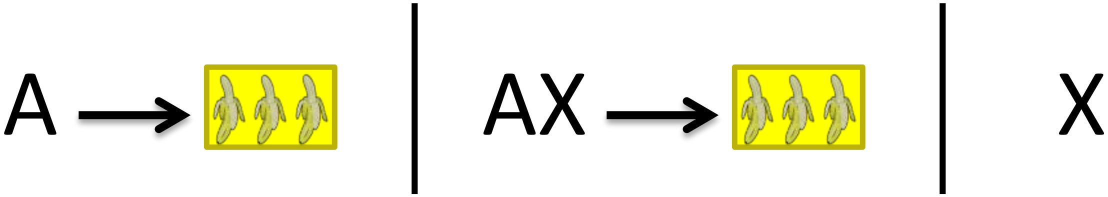
Blocking and Unblocking

McDannald, Lucantonio, Burke, Niv, and Schoenbaum, J Neurosci, 2011

Blocking and Unblocking



A → | AX → | X

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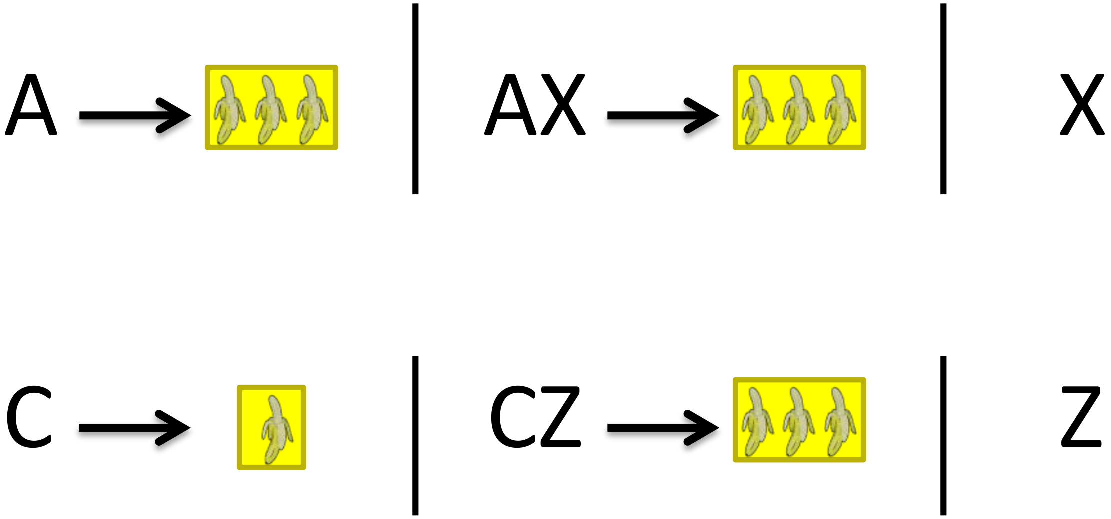

A → | AX → | X

C → | CZ → | Z

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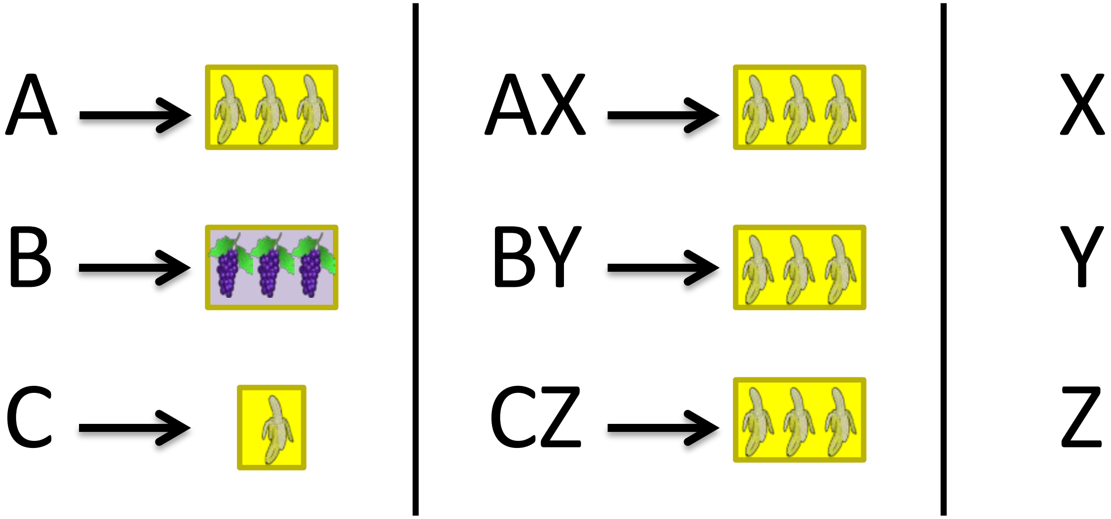

A →

B →

C →

AX →

BY →

CZ →

X

Y

Z

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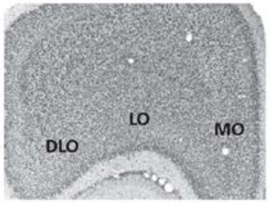
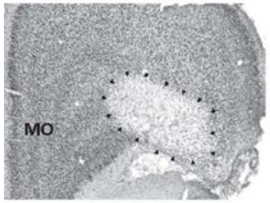
Learning…..

Sham-Lesioned Controls



Orbitofrontal Lesions



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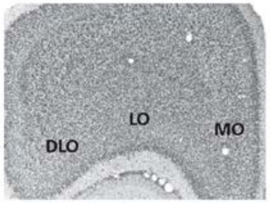

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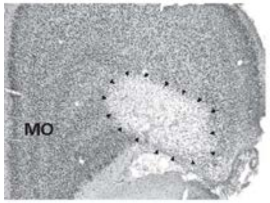

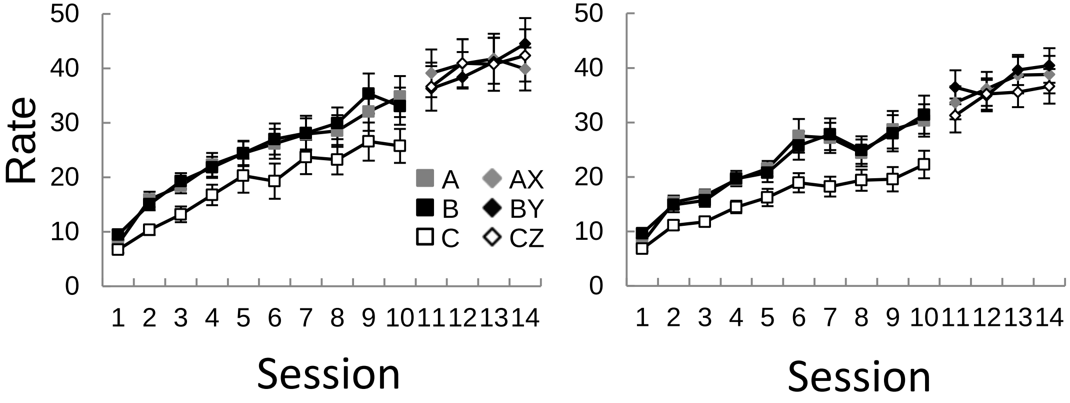

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Probe for value based unblocking….

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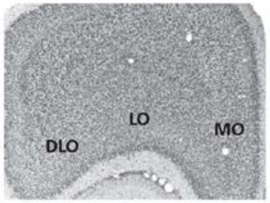

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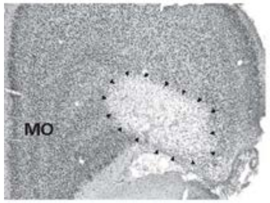

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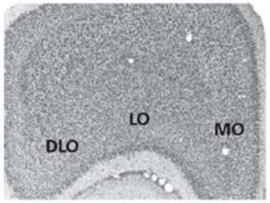

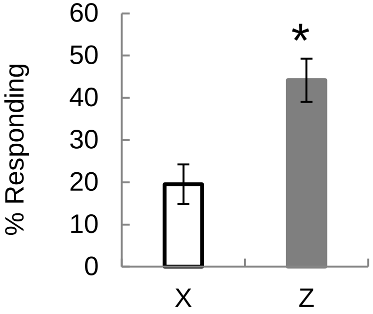

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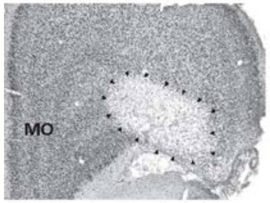

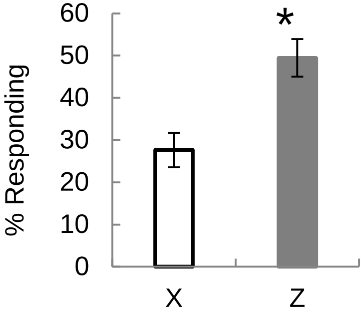

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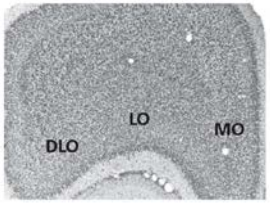

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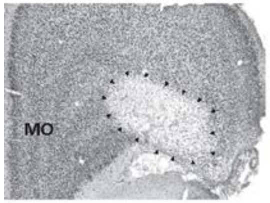

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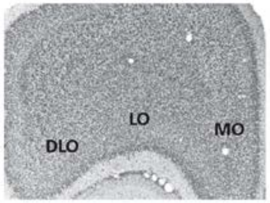

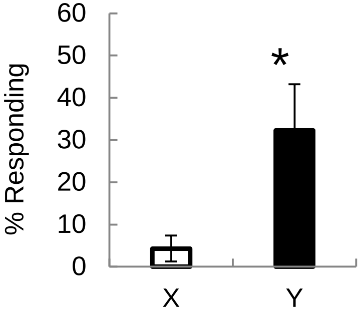

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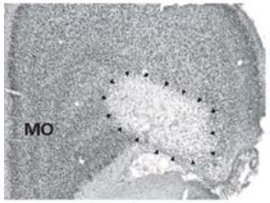

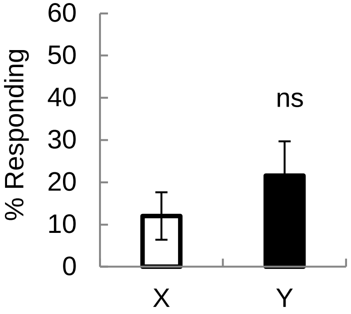

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So is that consistent with correlates in OFC?

Behavioral procedures for recording

McDannald, Esber,et al, eLife, 2014

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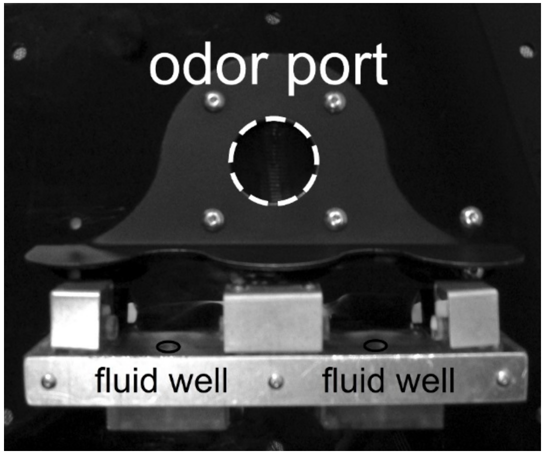
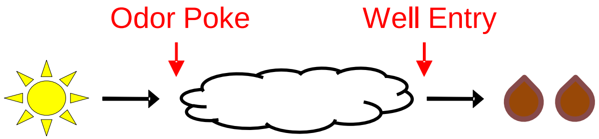
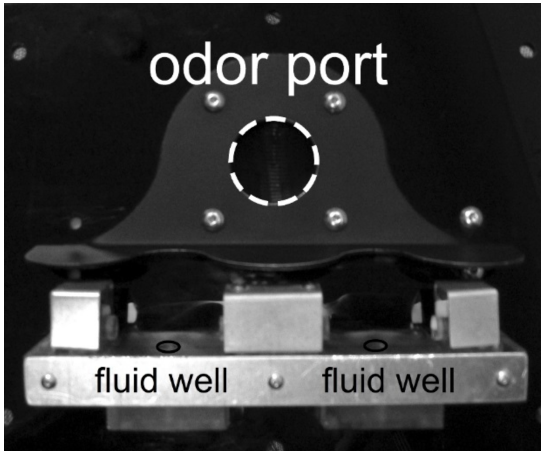

odor port
fluid well
fluid well

McDannald, Esber,et al, eLife, 2014

Behavioral procedures for recording

Initial Training


Odor Poke
Well Entry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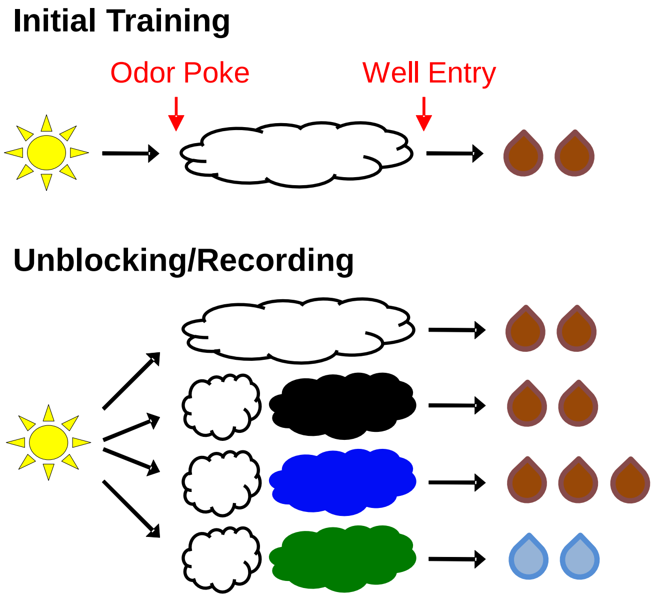
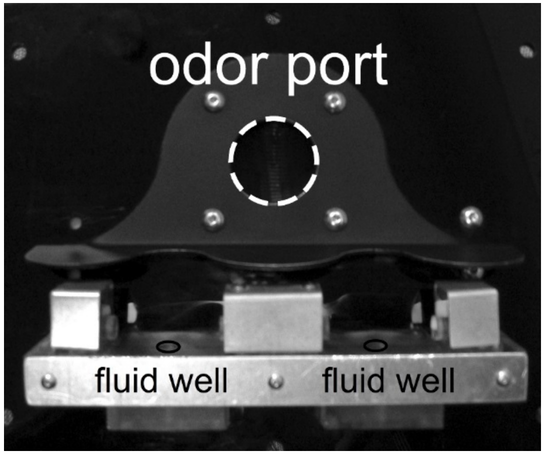


Initial Training

Odor Poke
Well Entry

Unblocking/Recording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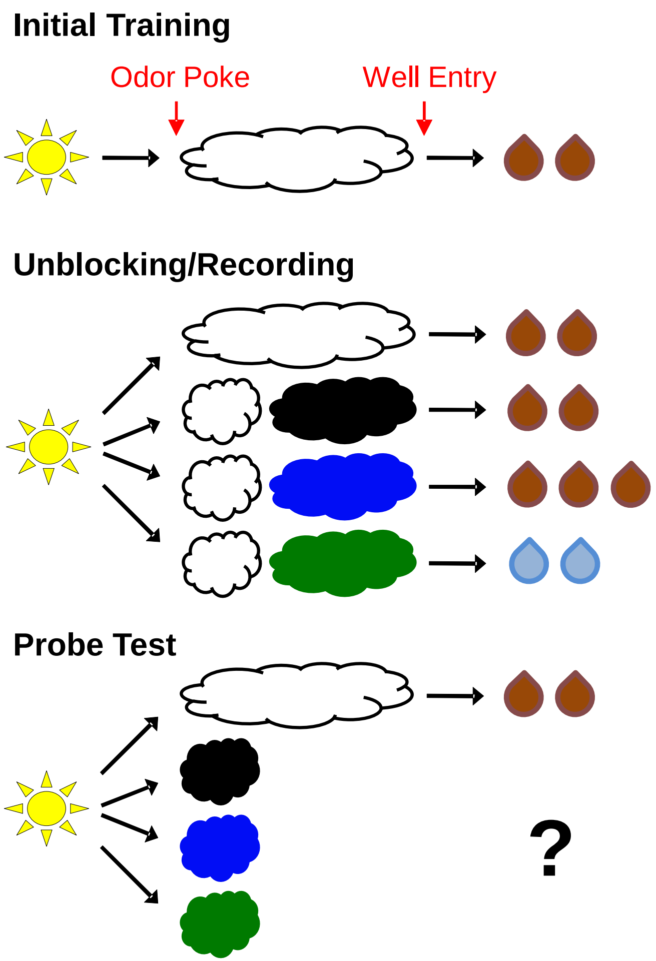
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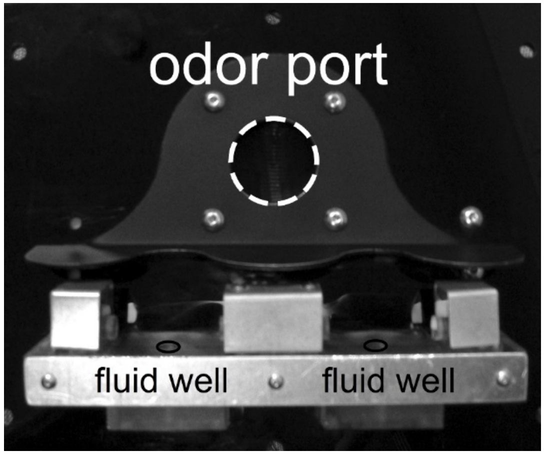
?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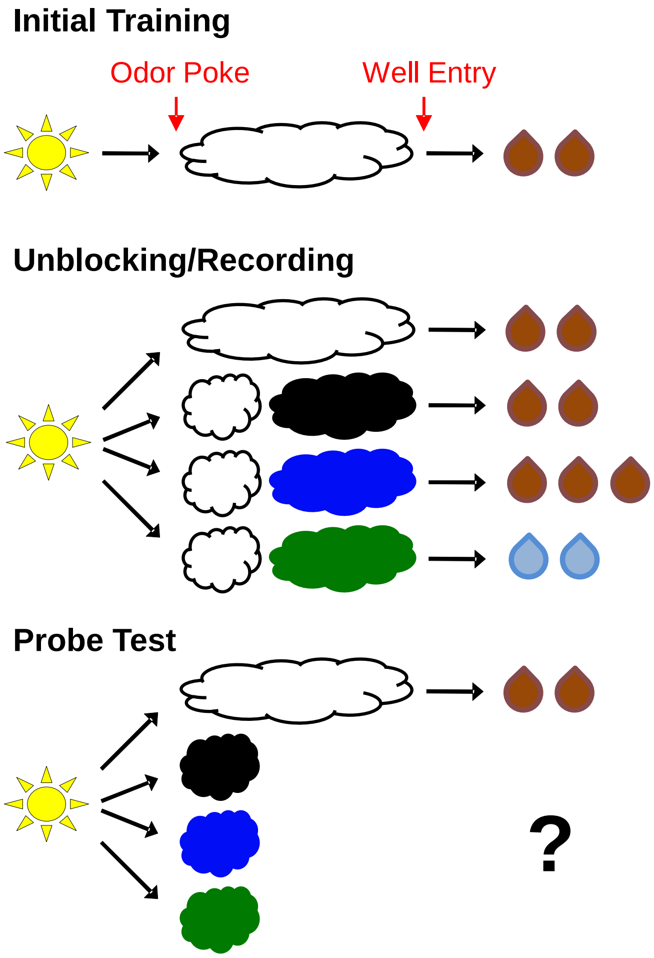

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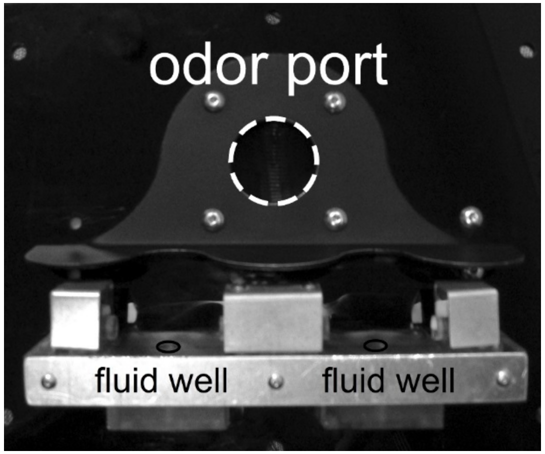

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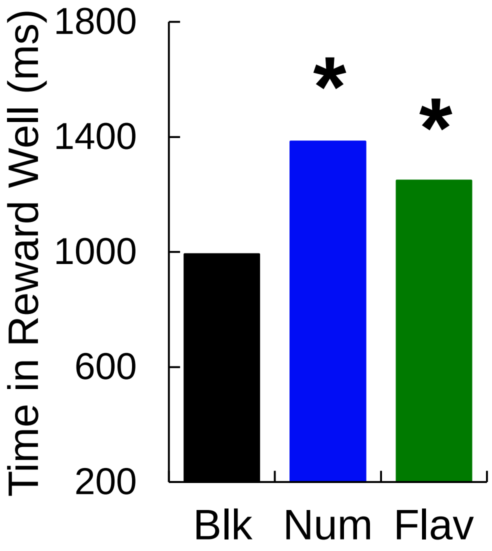

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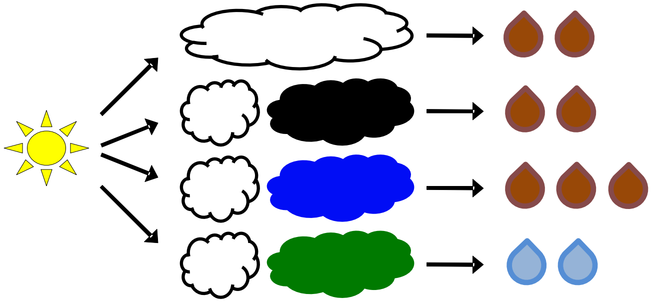
Predictions for odor firing



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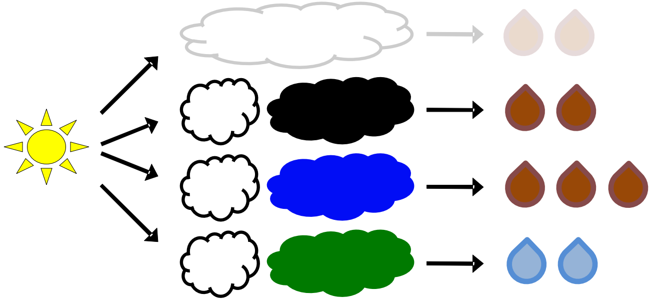

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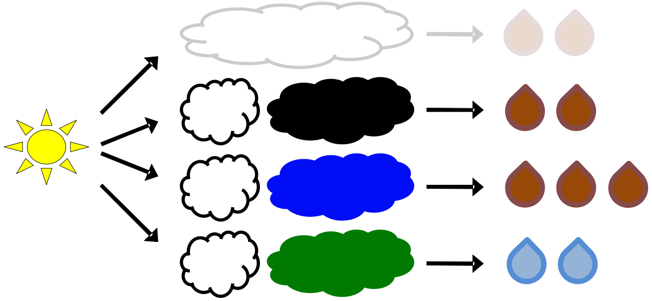
Predictions for odor firing

If OFC activity reflects predicted value



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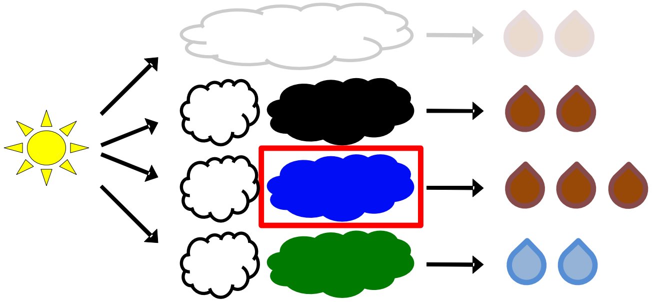
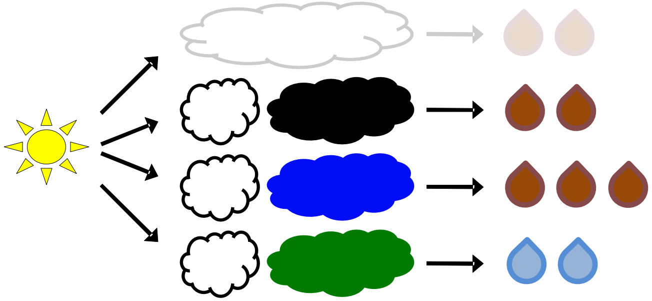


Only an increase in reward number will support odor firing

McDannald, Esber,et al, eLife, 2014

Predictions for odor firing

If OFC activity reflects predicted features



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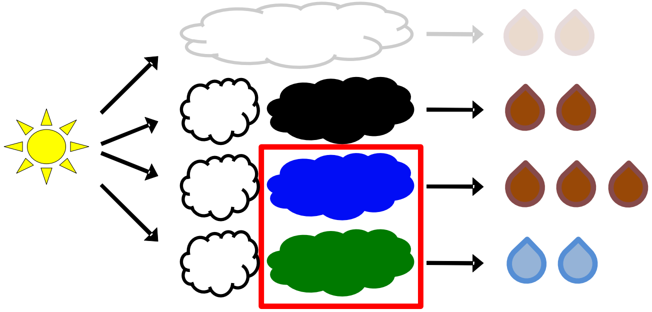

Increase in reward number
or change in flavor
will support odor firing

McDannald, Esber,et al, eLife, 2014

Many OFC neurons (~1/3) fired to the critical odor cues.

McDannald, Esber,et al, eLife, 2014

Many OFC neurons (~1/3) fired to the critical odor cues.

About half of these neurons fired to novel odors generally…..

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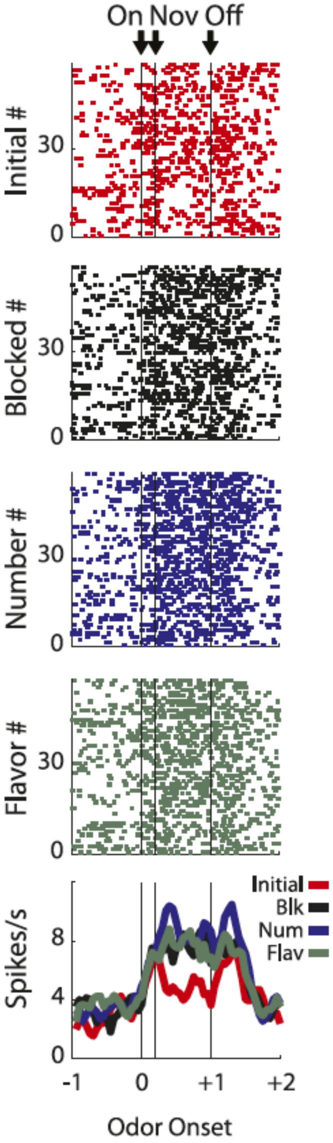

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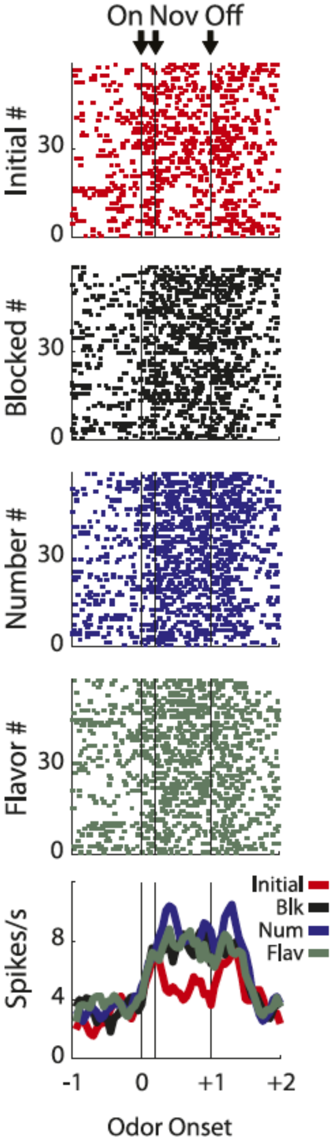

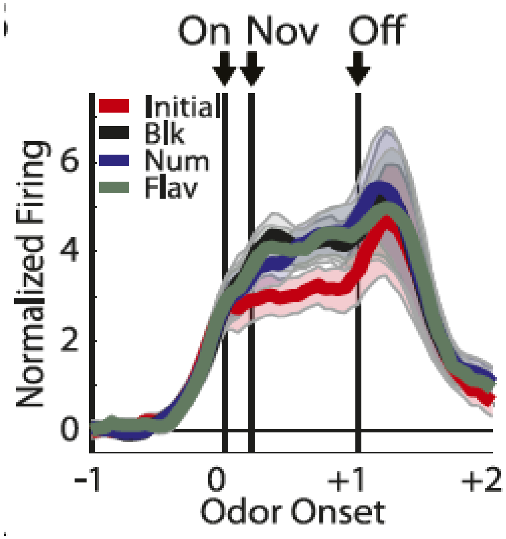

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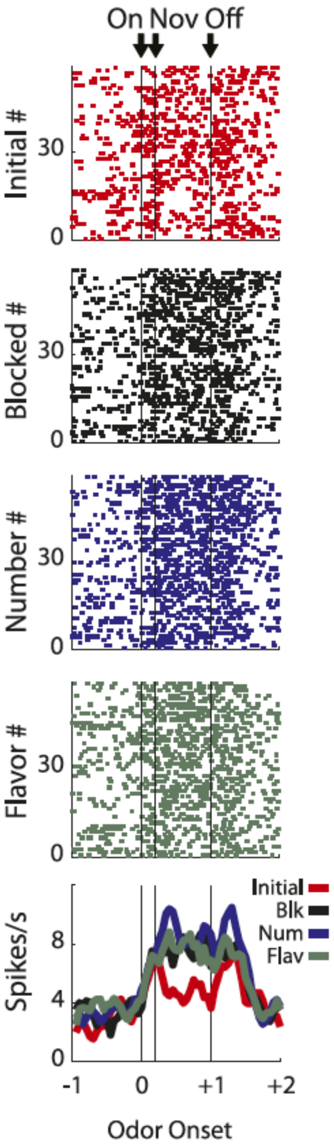

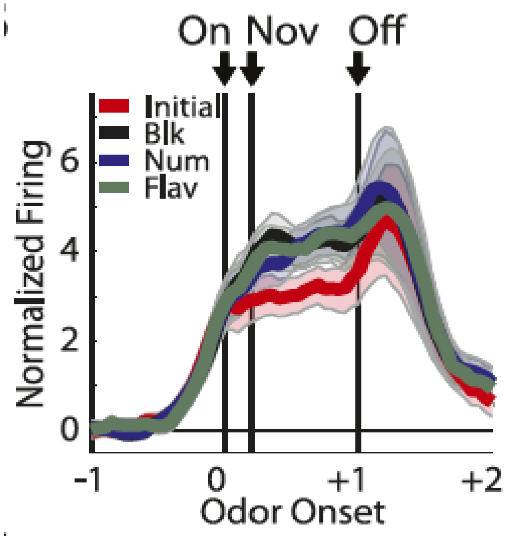

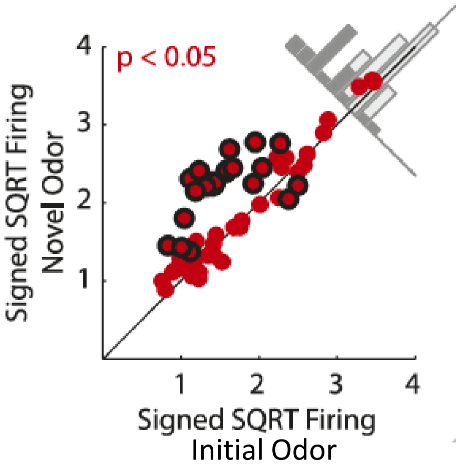

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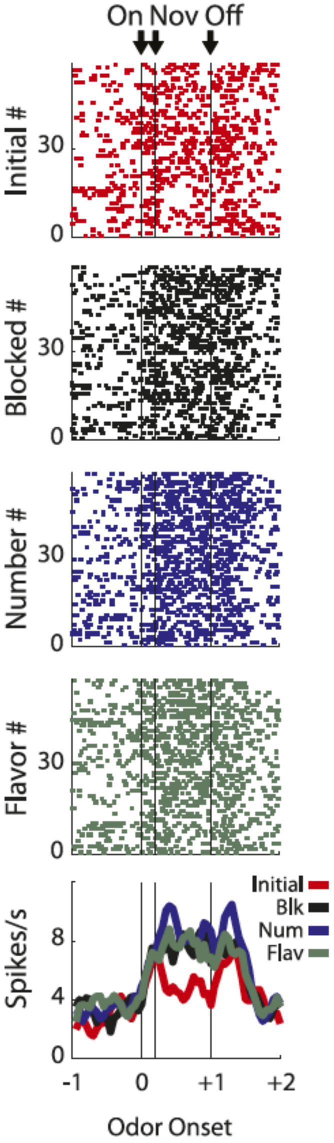

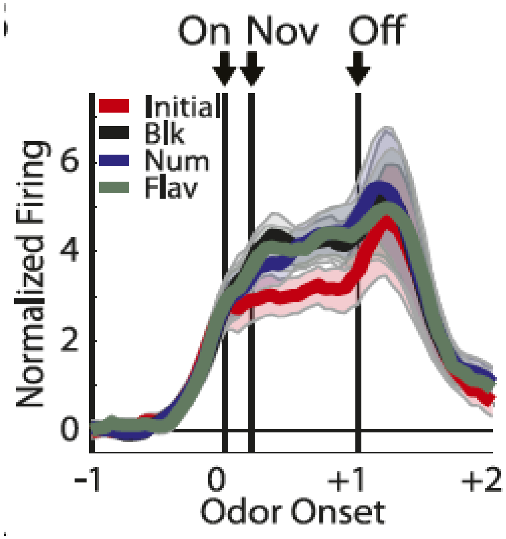

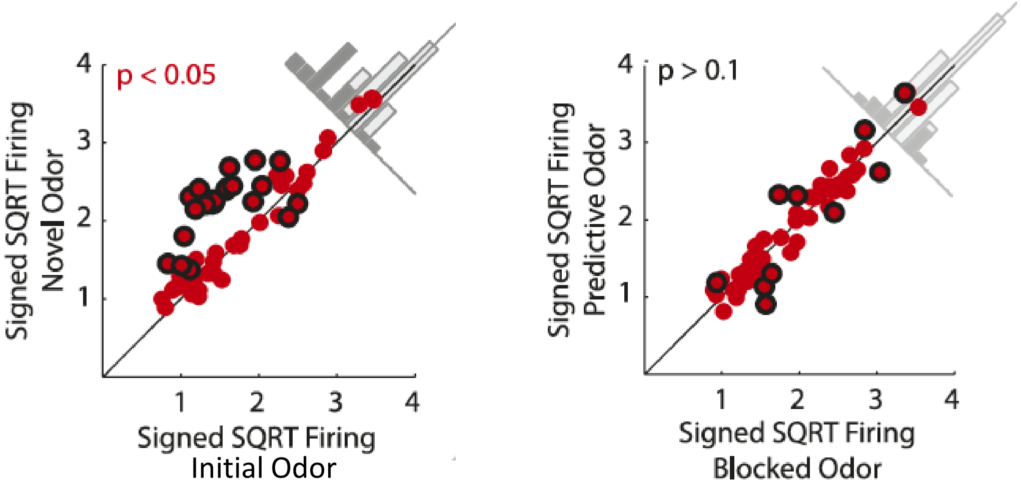

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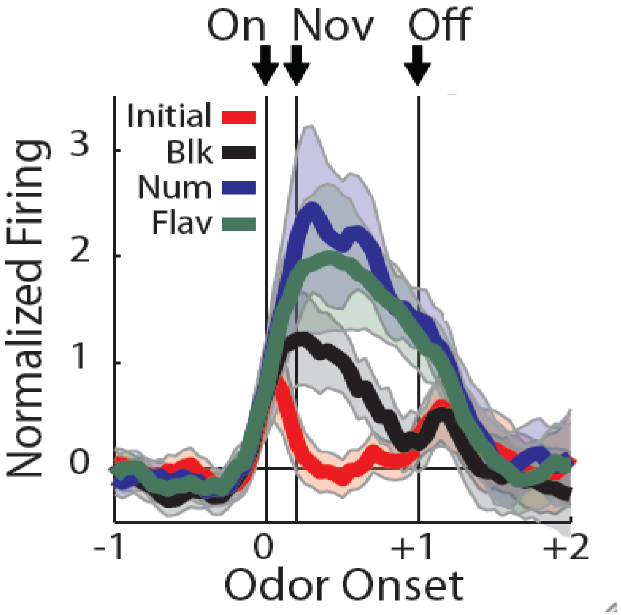

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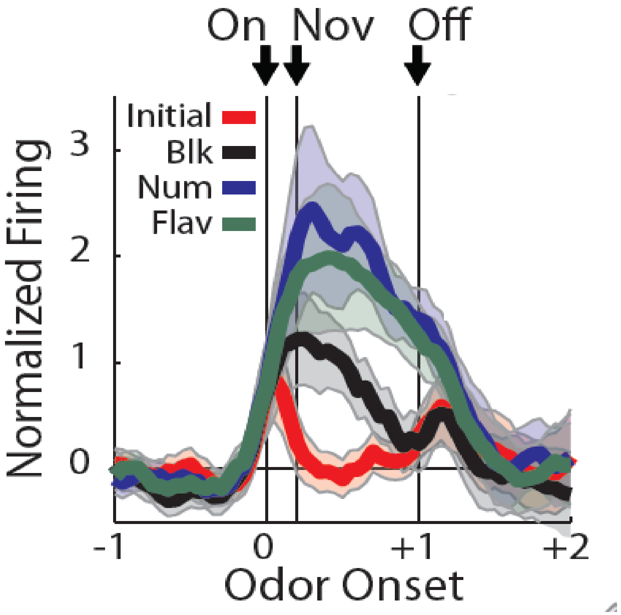

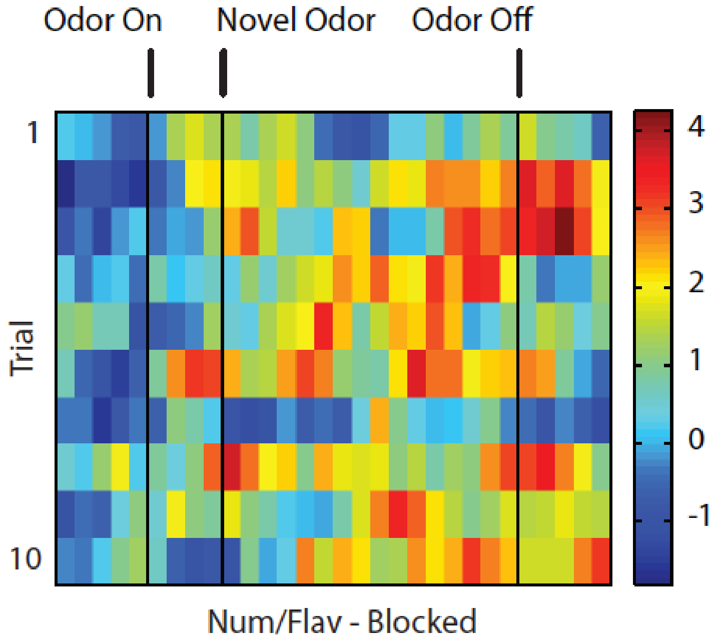

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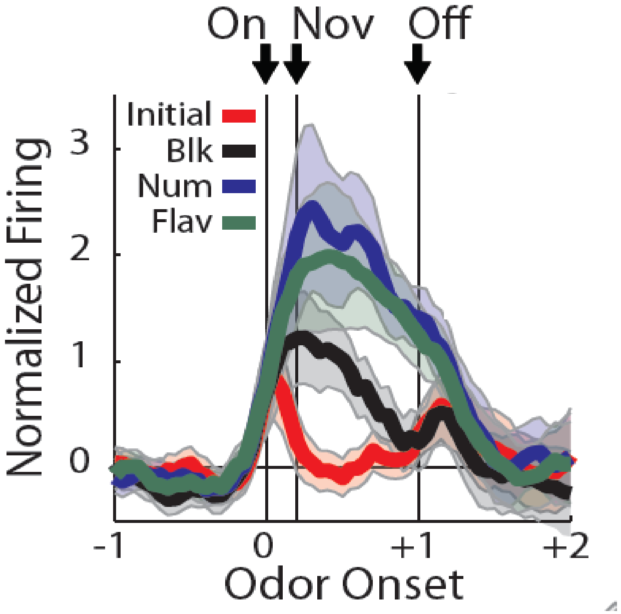

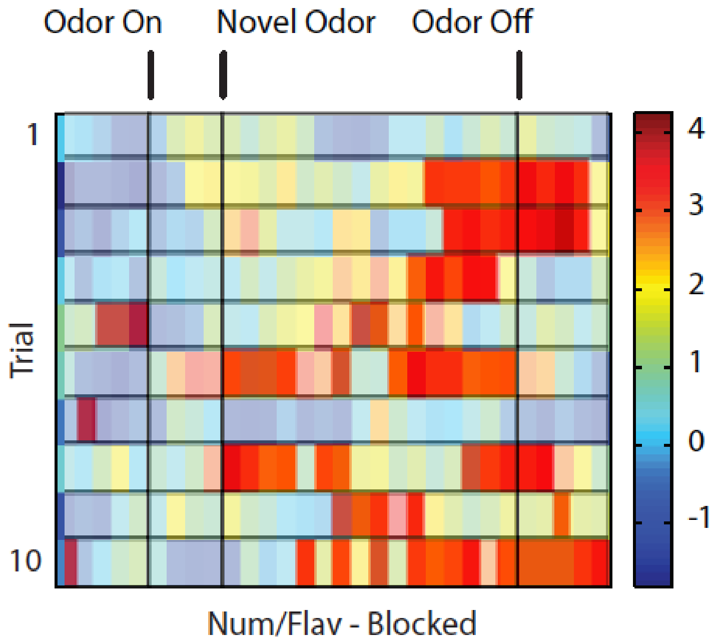

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Activity to valued and value-less cues was similar….

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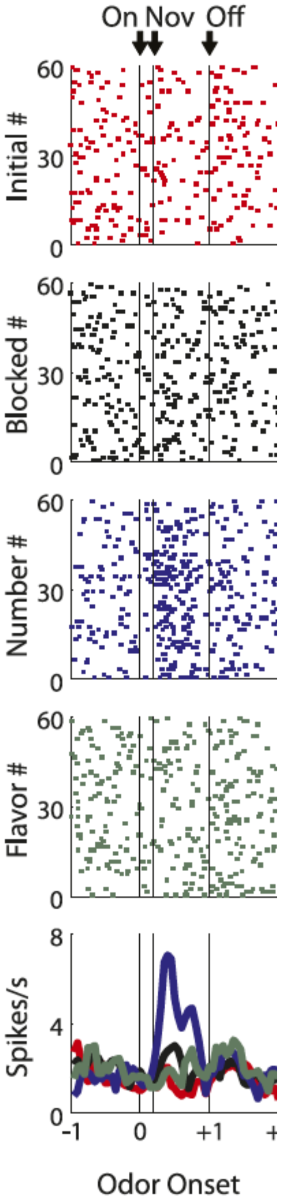

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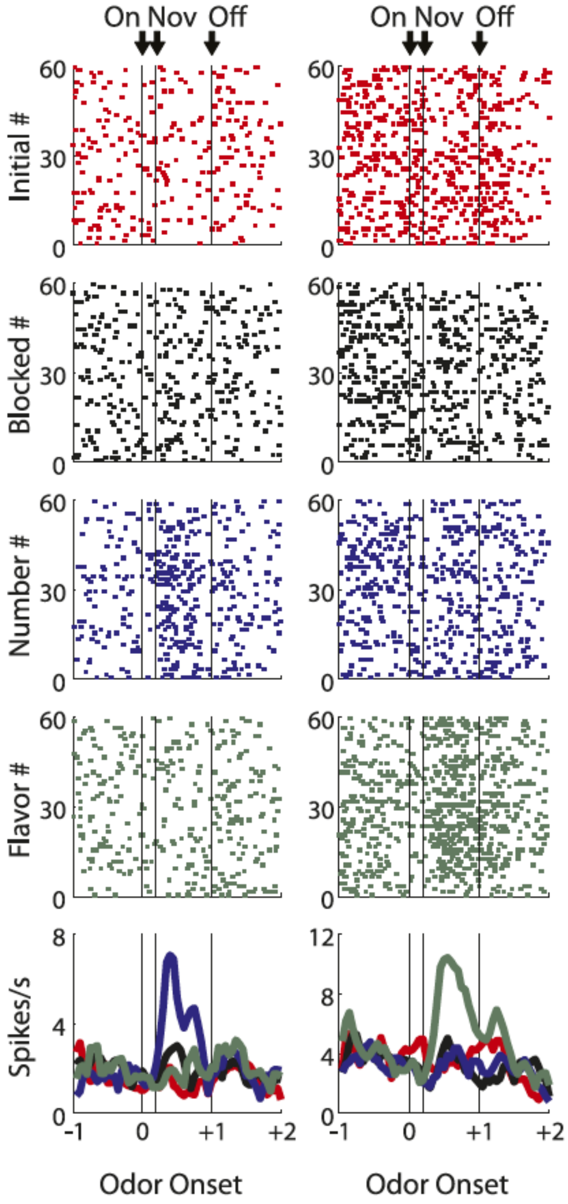

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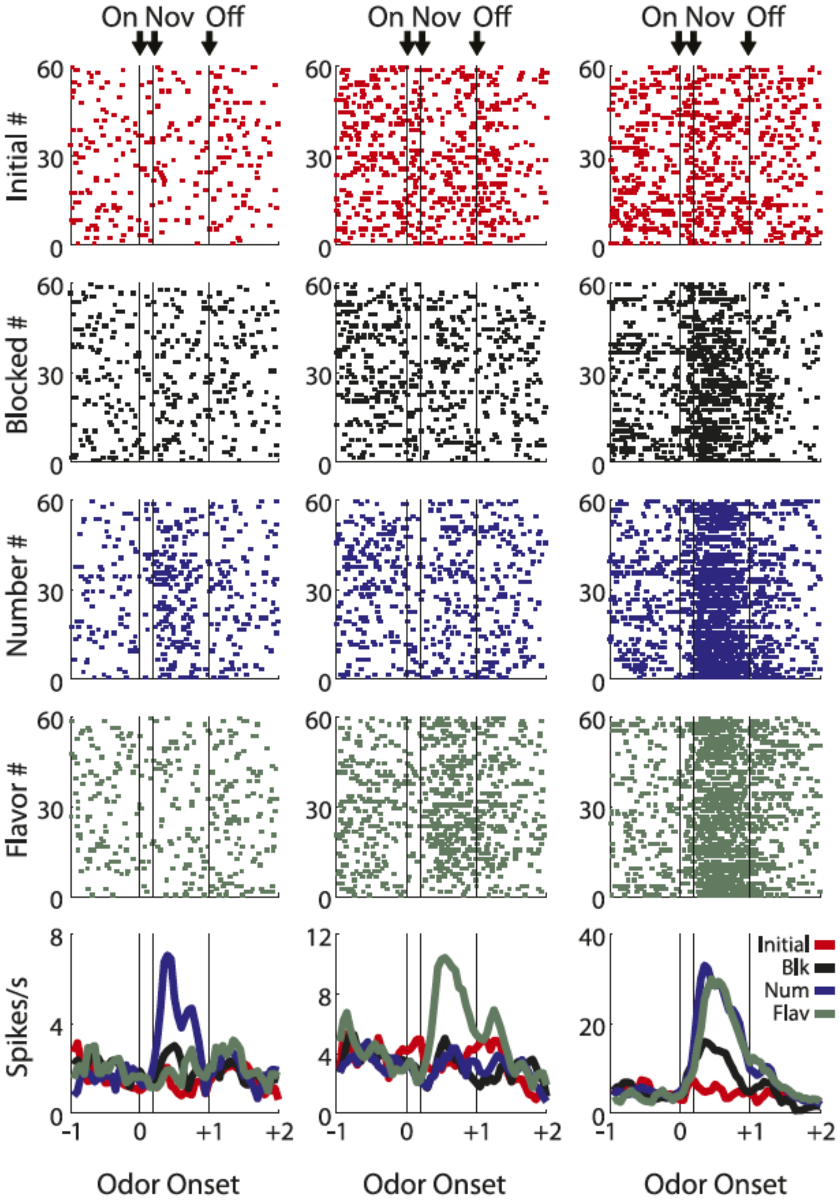

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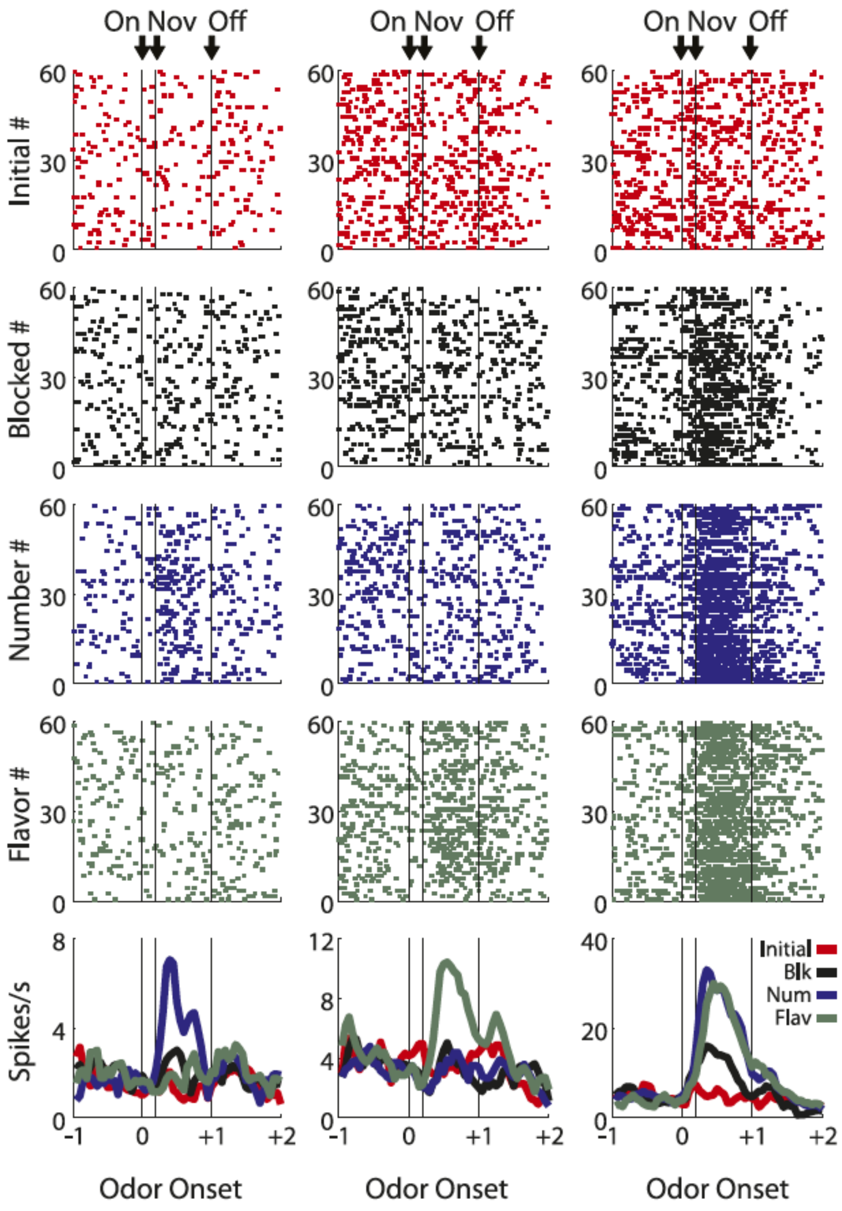

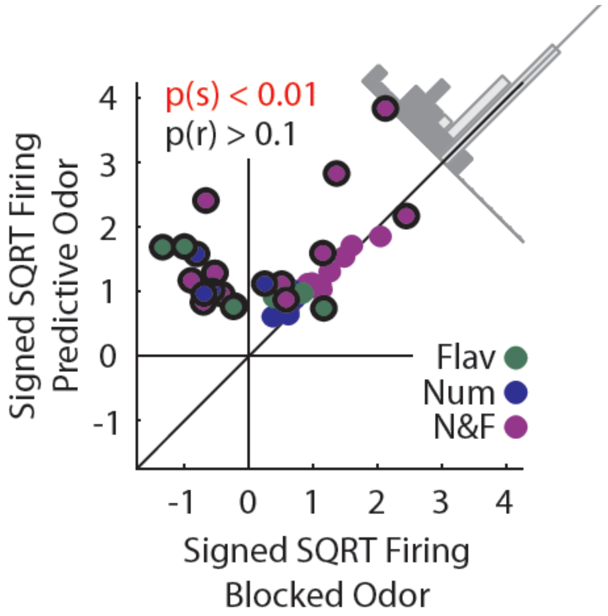

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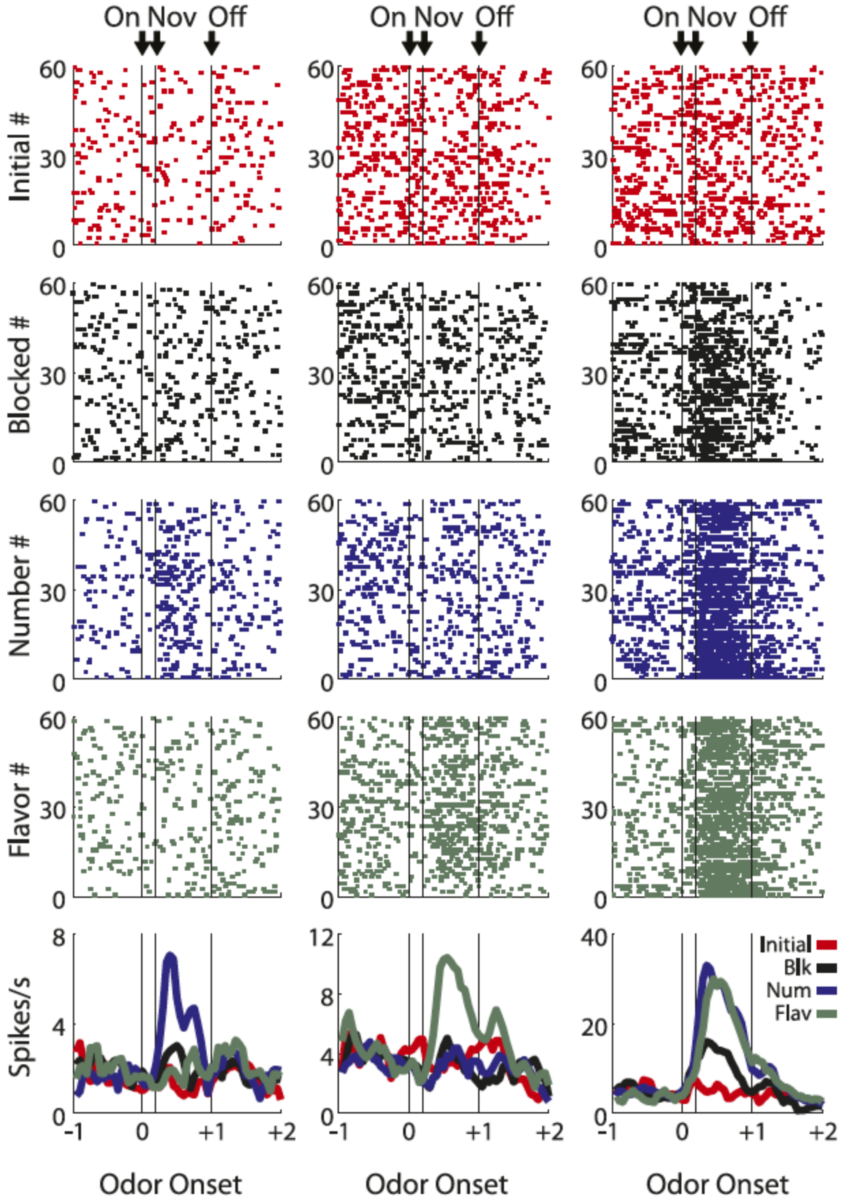

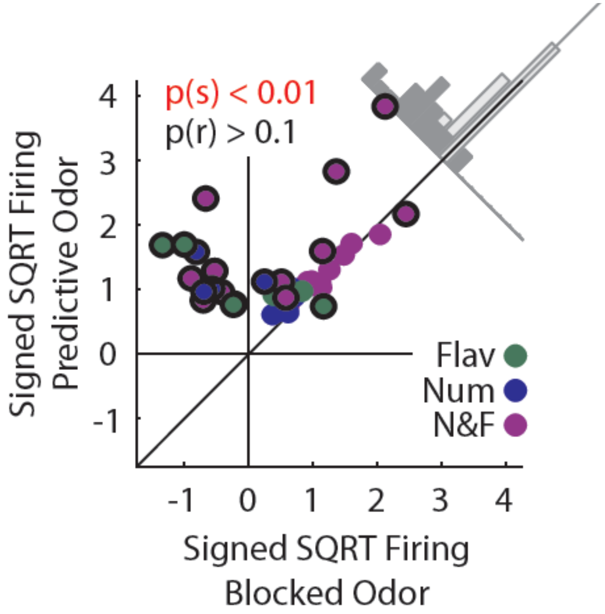

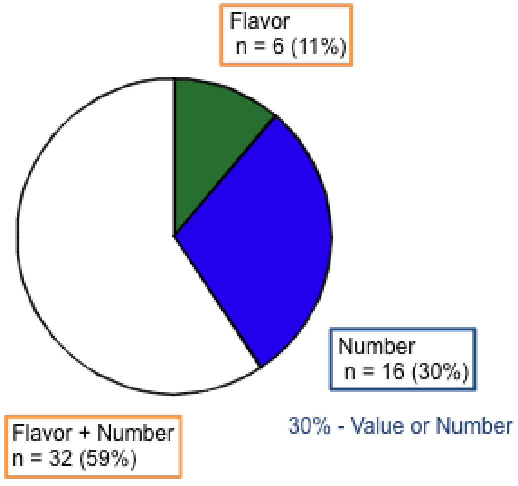

30% - Value or Number

70% - Features

McDannald, Esber,et al, eLife, 2014

OFC neurons acquired activity to the cue predicting new reward features but no change in value.

Activity to this valueless cue was largely similar to activity to a similar cue predicting a more reward.

But is signaling of more reward in OFC during unblocking a value signal or could it be a feature?

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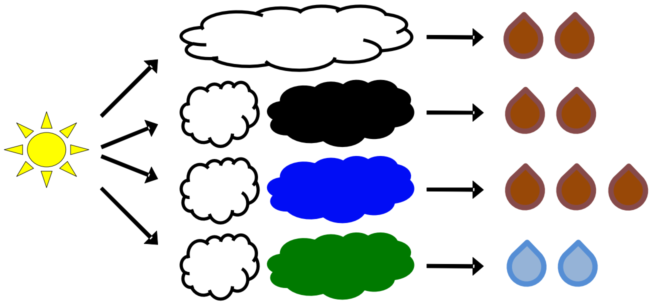

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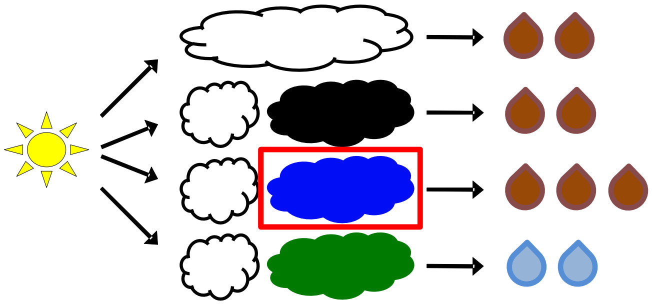

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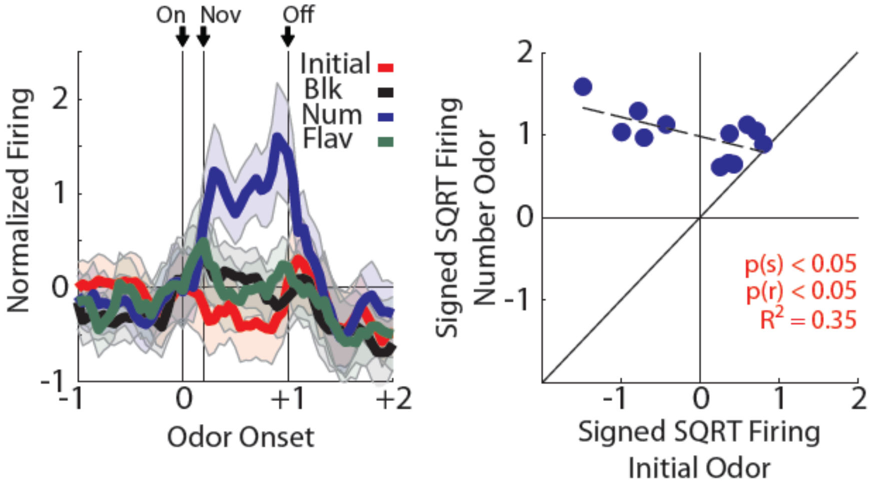
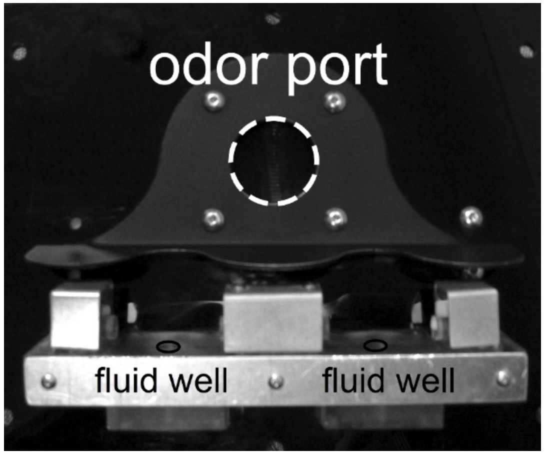


Behavioral procedures for recording

Lopatina, McDannald, et al, in prep

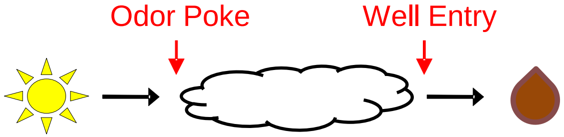
Behavioral procedures for recording

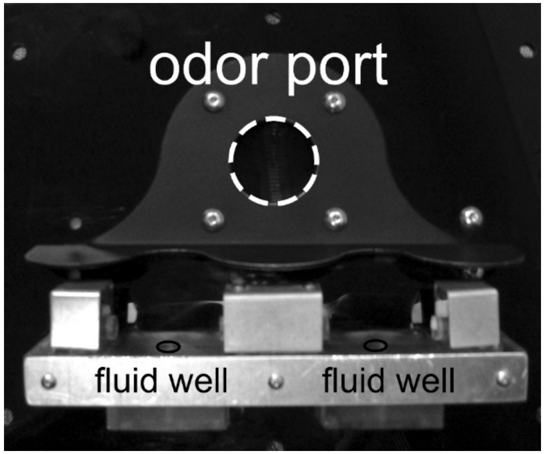

odor port
fluid well
fluid well

Lopatina, McDannald, et al, in prep

Behavioral procedures for recording

Initial Training


Odor Poke
Well Entry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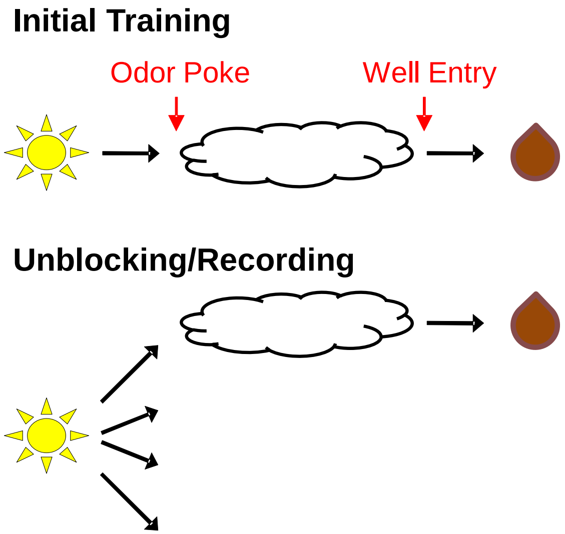
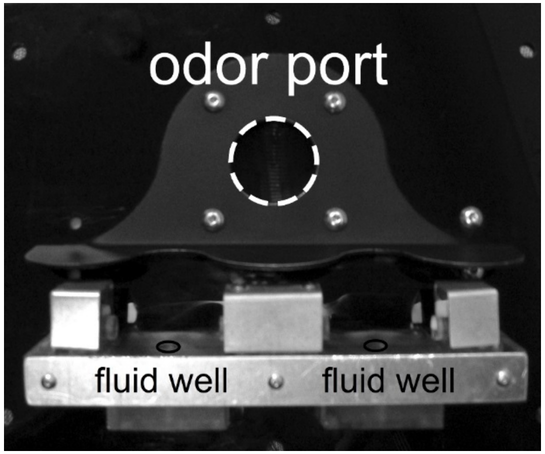


Initial Training

Odor Poke

Well Entry

Unblocking/Recording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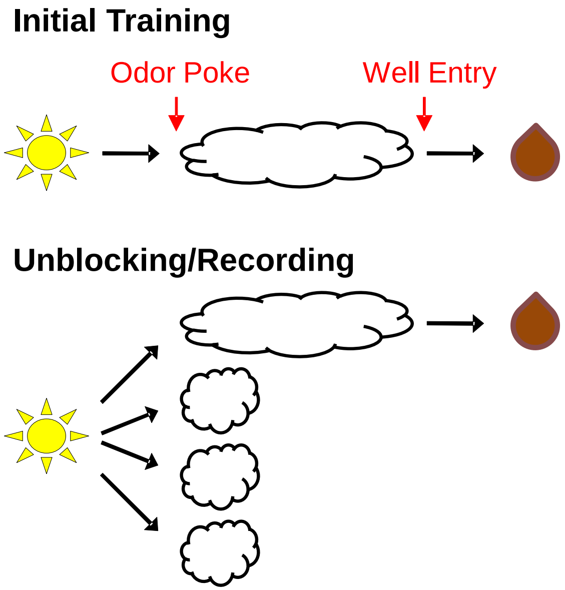

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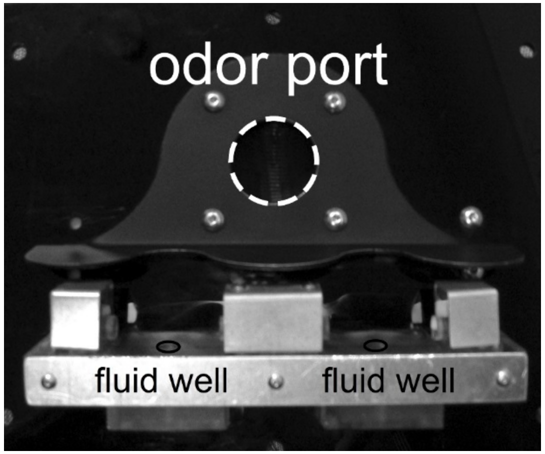
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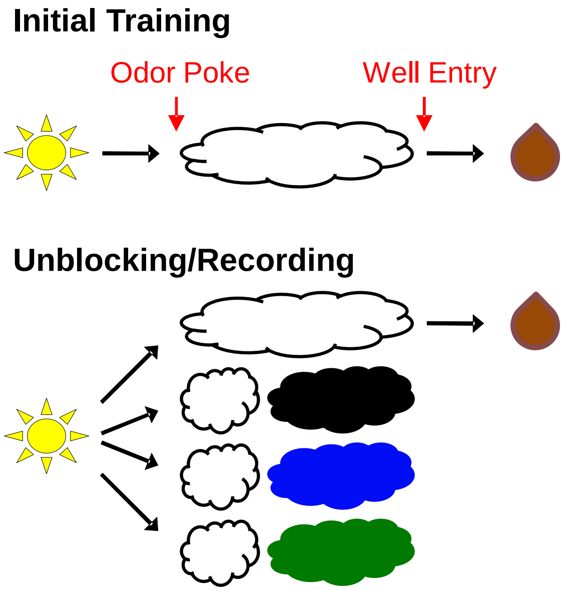

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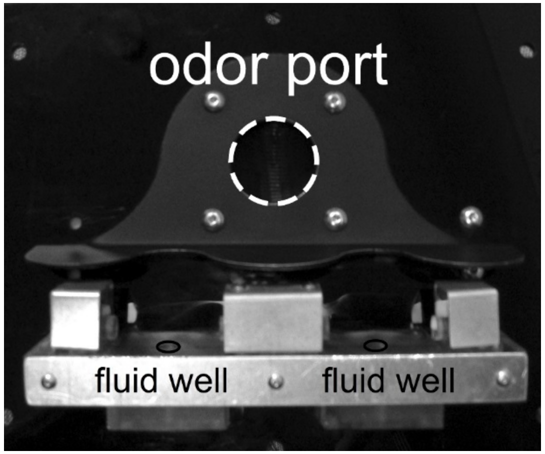
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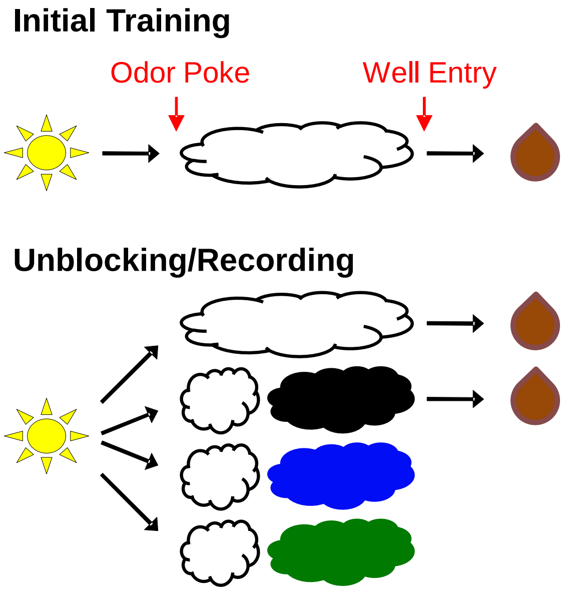
Initial Training
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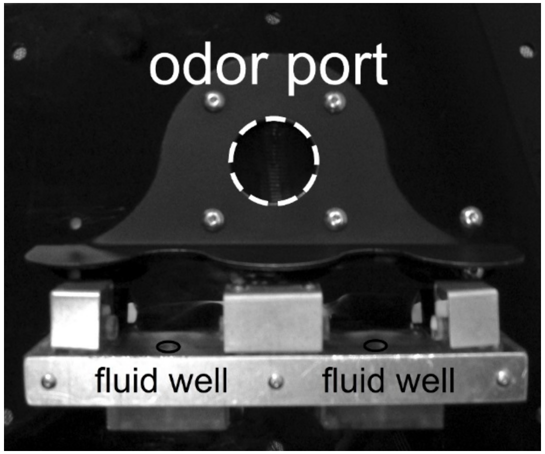
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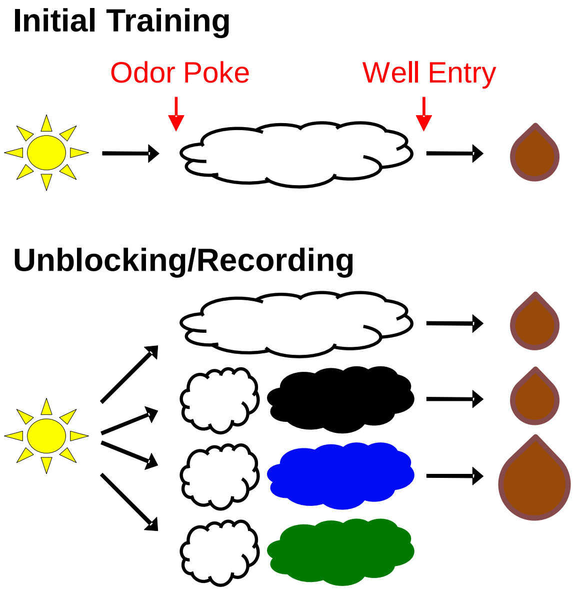
Initial Training
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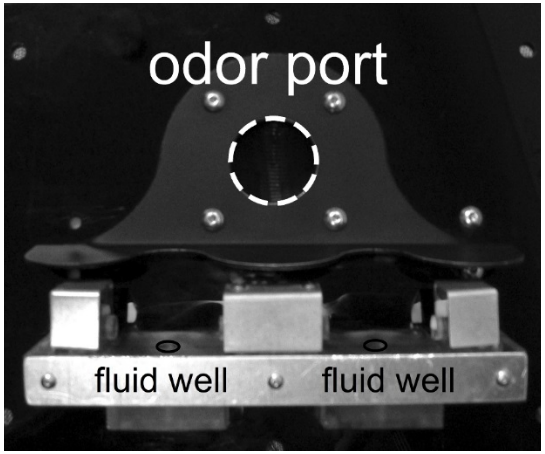
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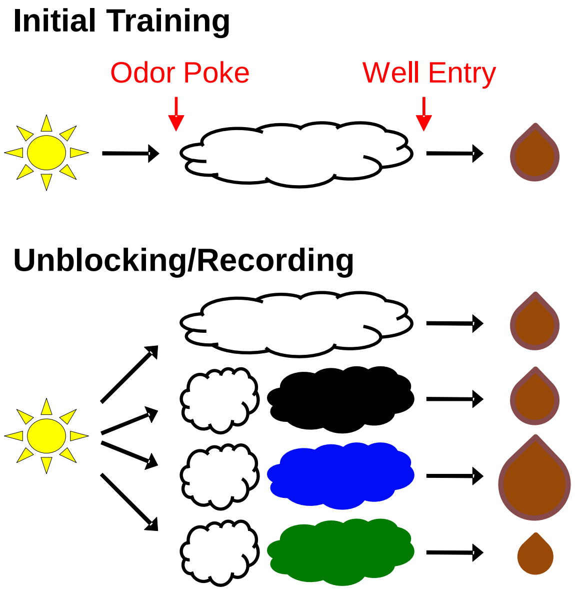

Initial Training

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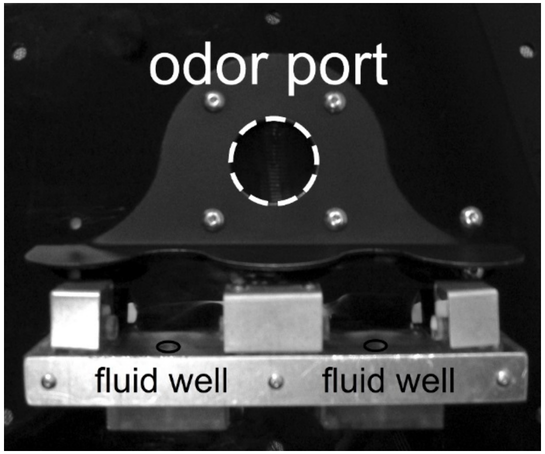
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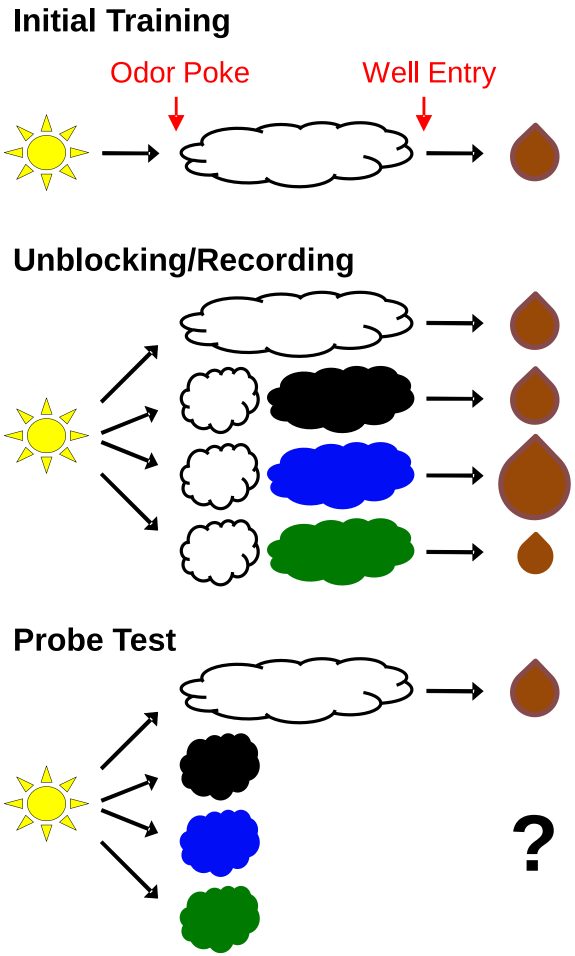


Initial Training

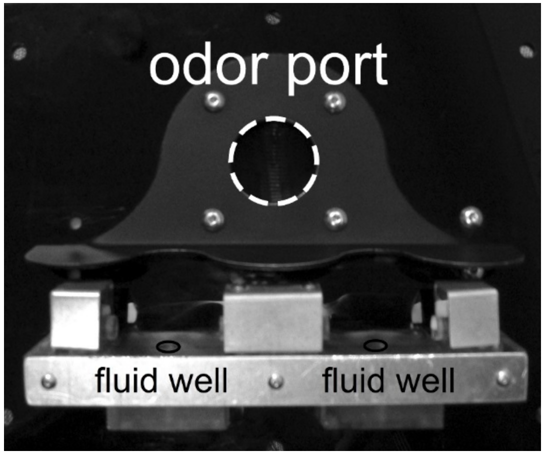
Odor Poke

Well Entry

Unblocking/Recording

Probe Test

?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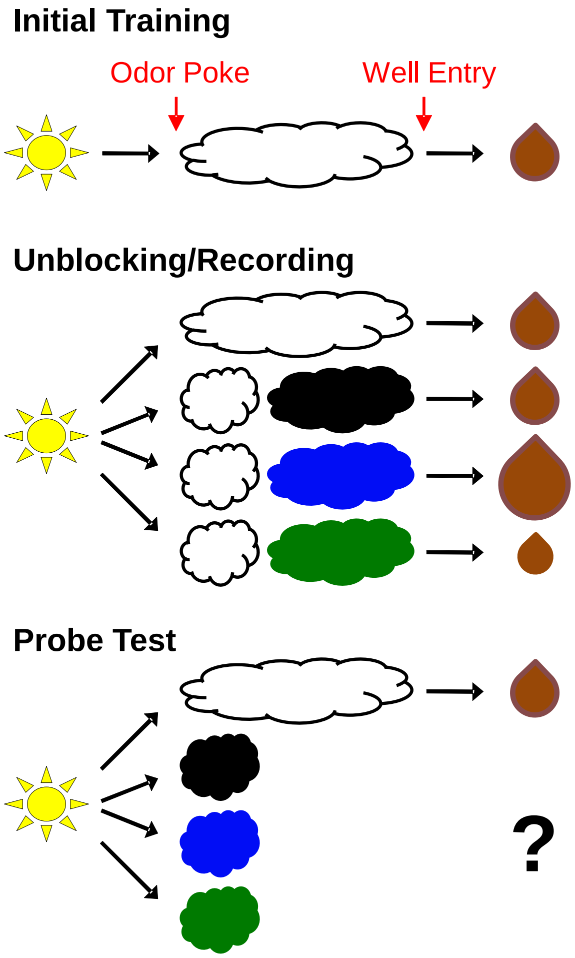

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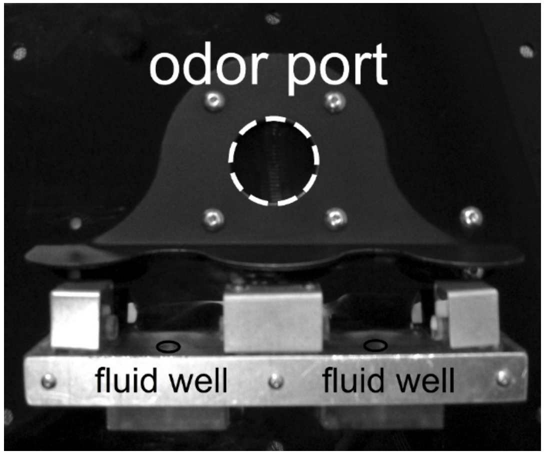
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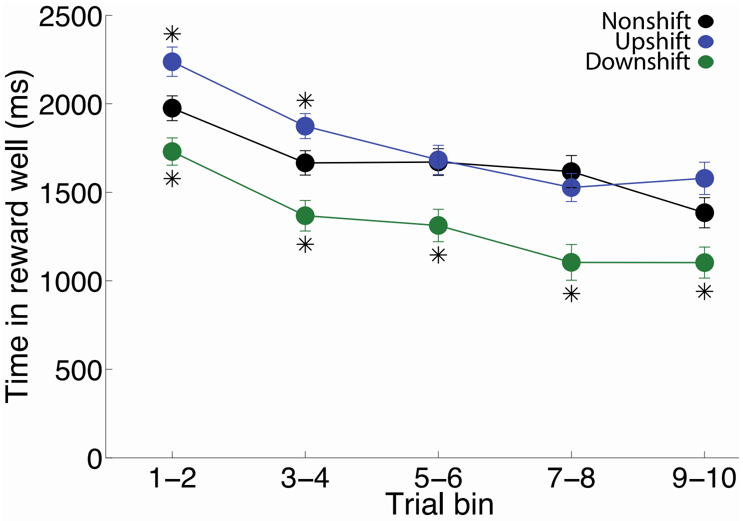

Lopatina, McDannald, et al, in prep

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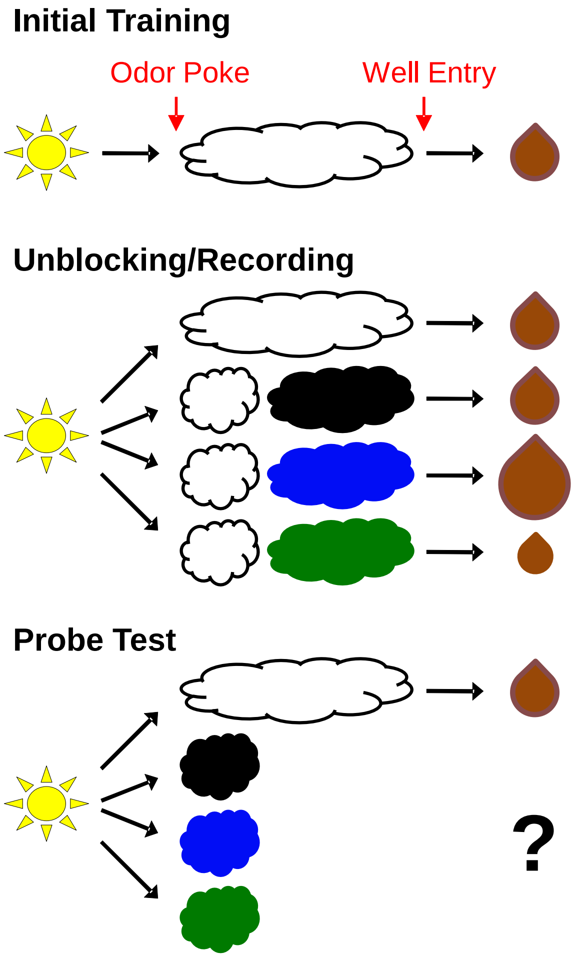

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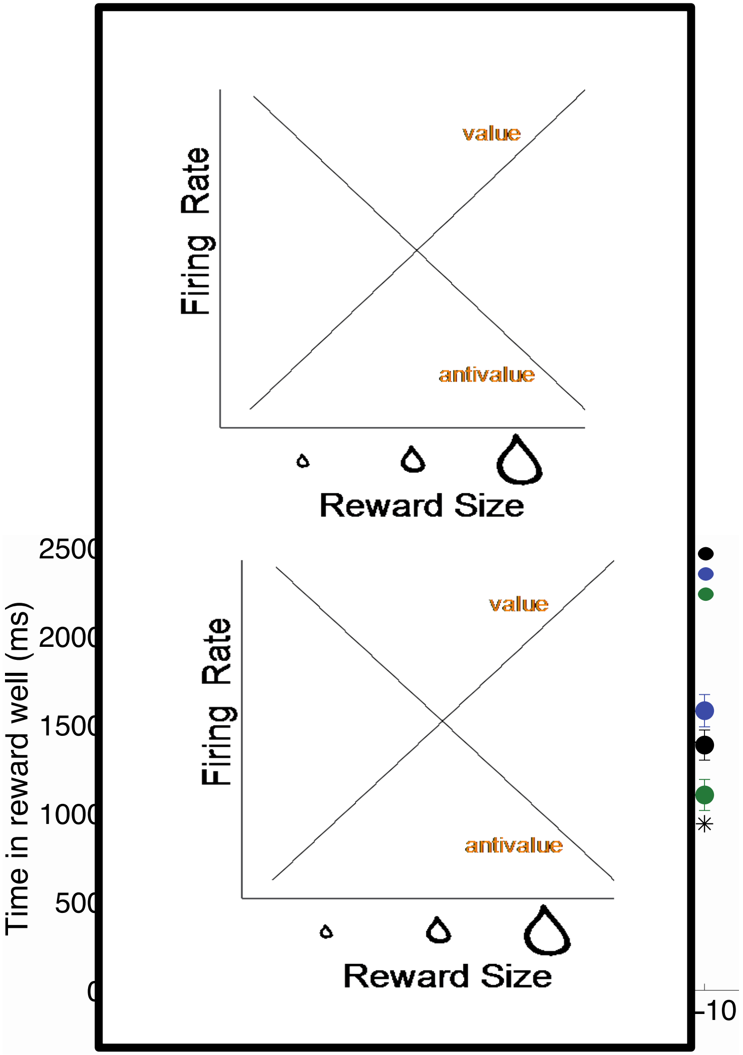
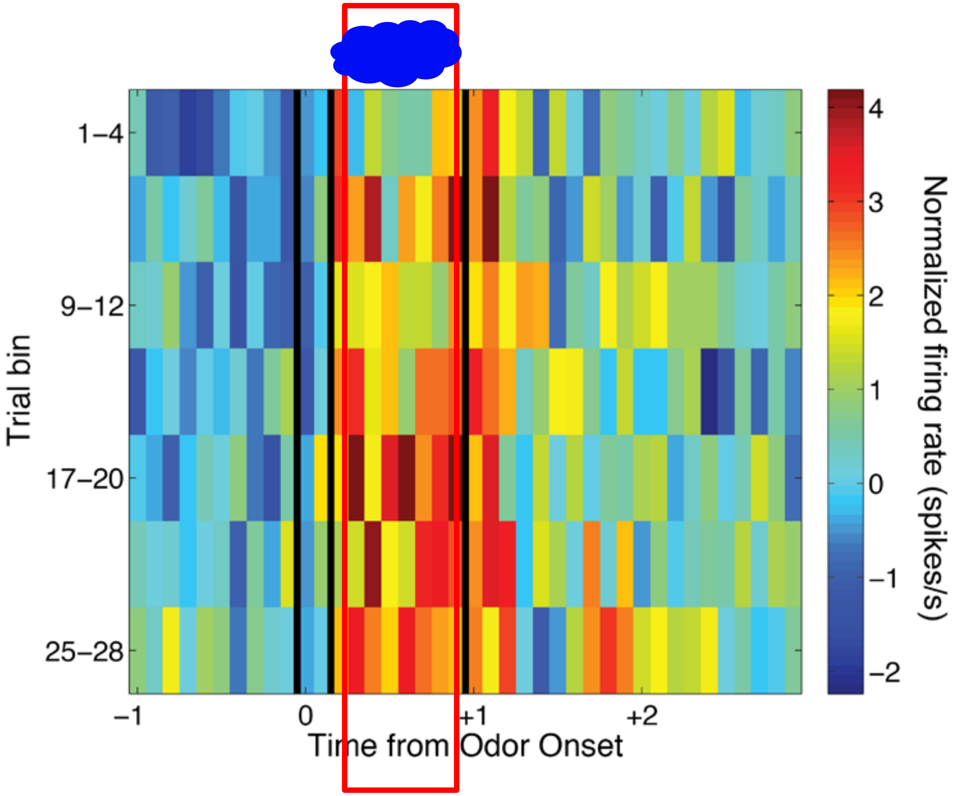


Lopatina, McDannald, et al, in prep

Again many neurons fired to cue predicting more reward,

Again many neurons fired to cue predicting more reward, and this activity developed with training…..



Including some neurons that seem to code value…

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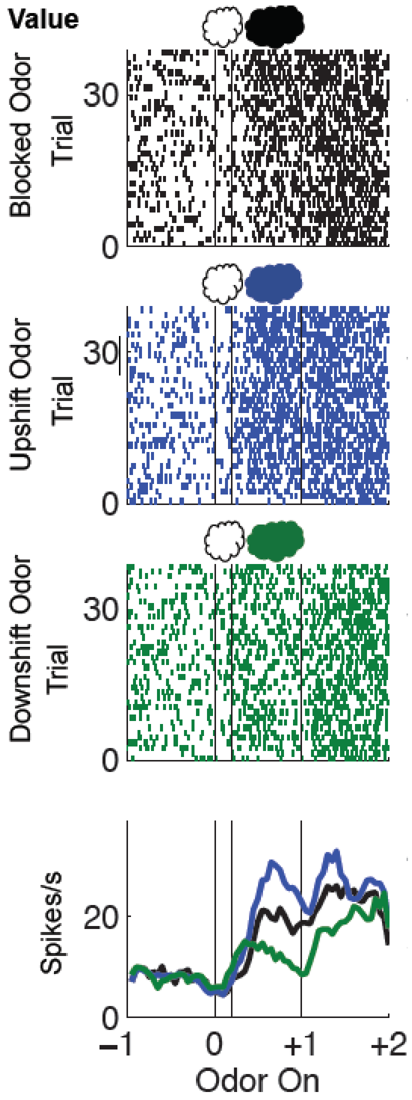

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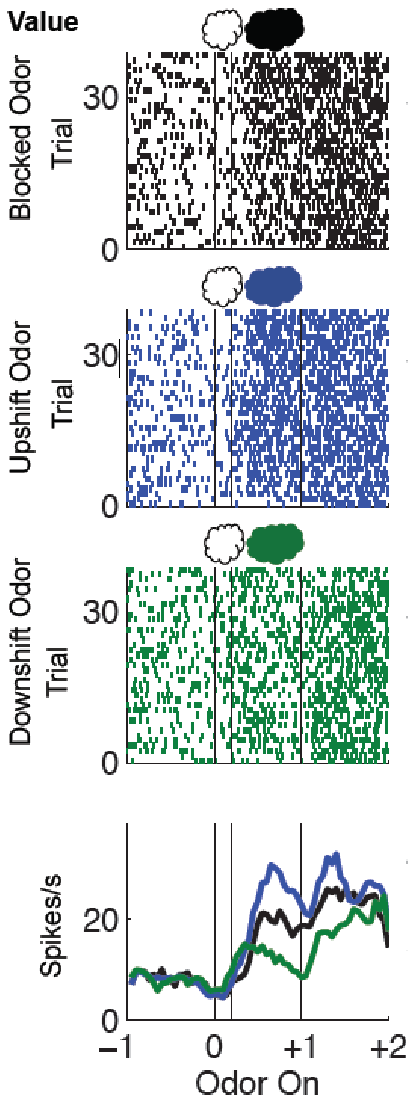

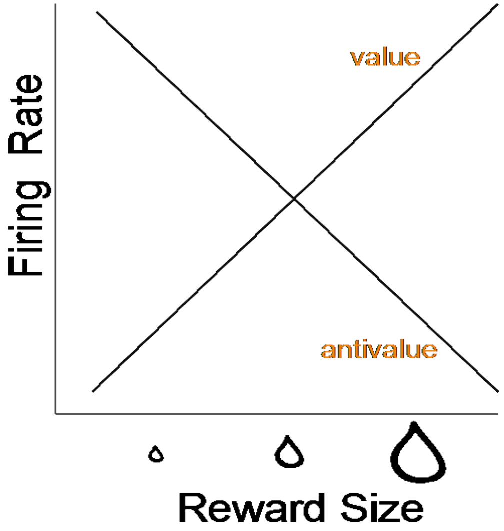

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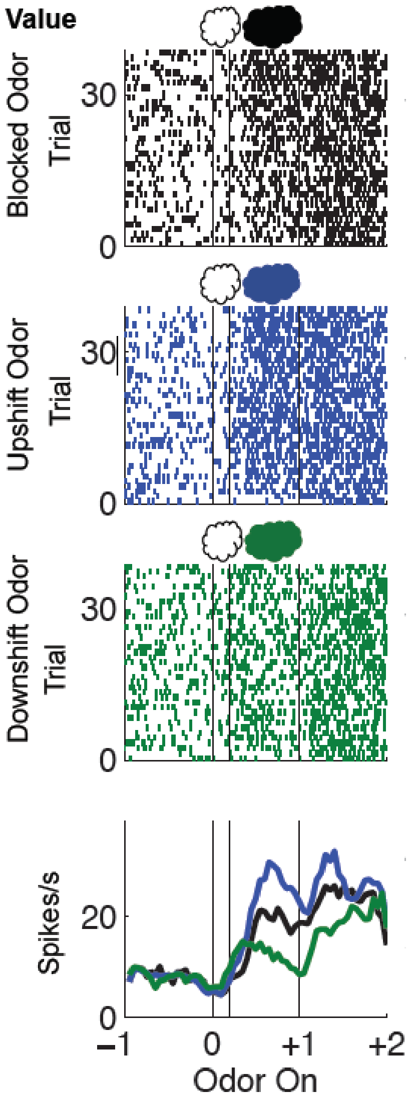
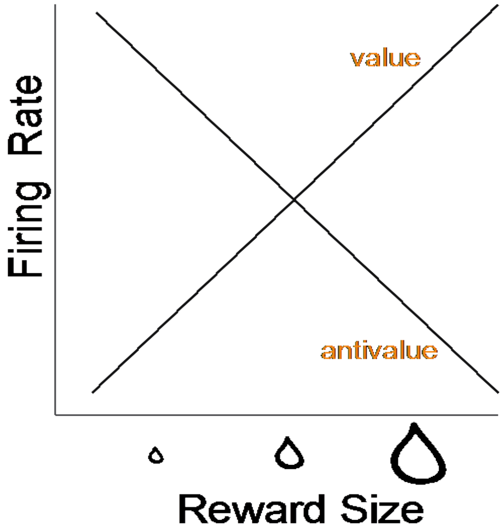
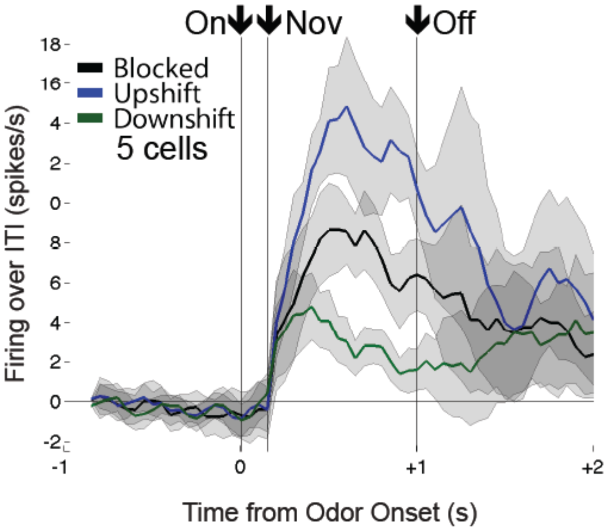



Firing Rate
value
antivalue
Reward Size



Many neurons (half) fired to cue predicting more reward…

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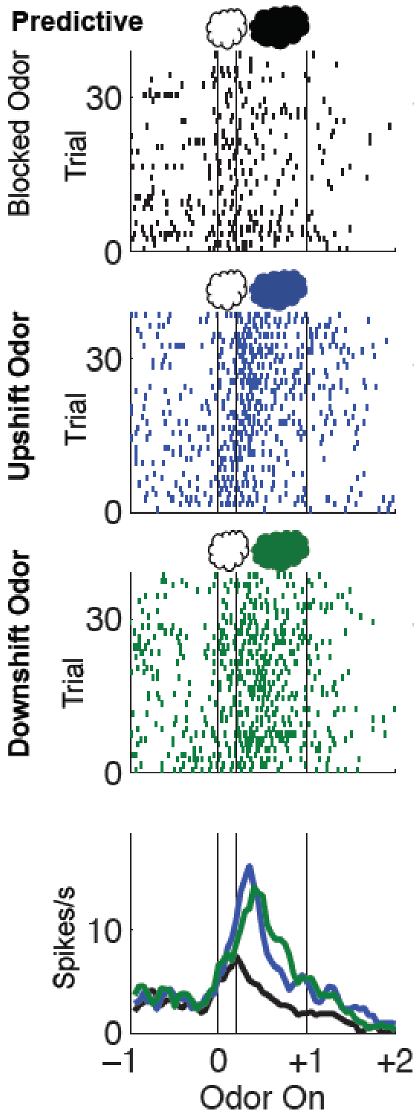

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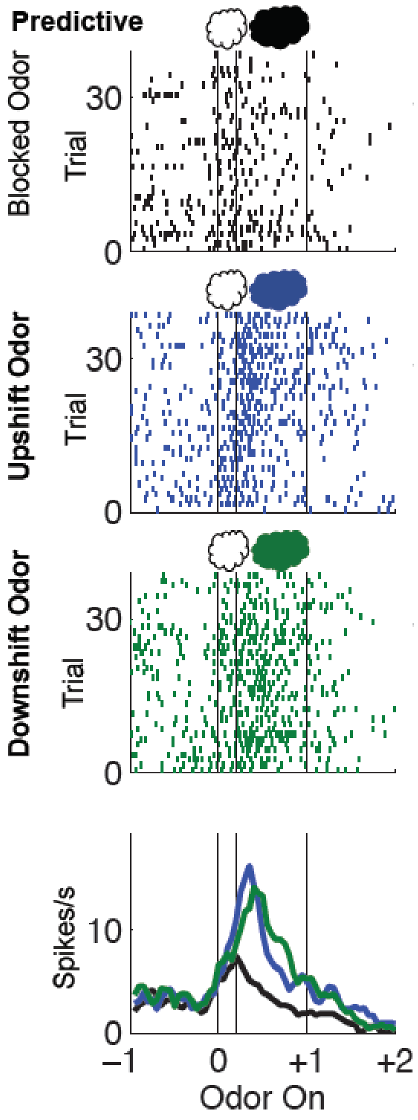
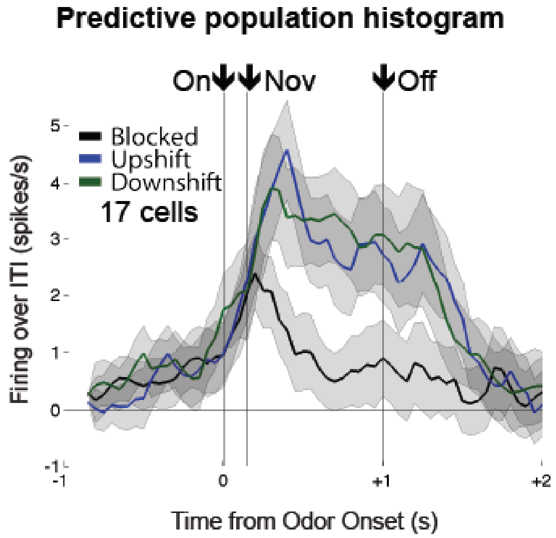

Predictive


Predictive population histogram

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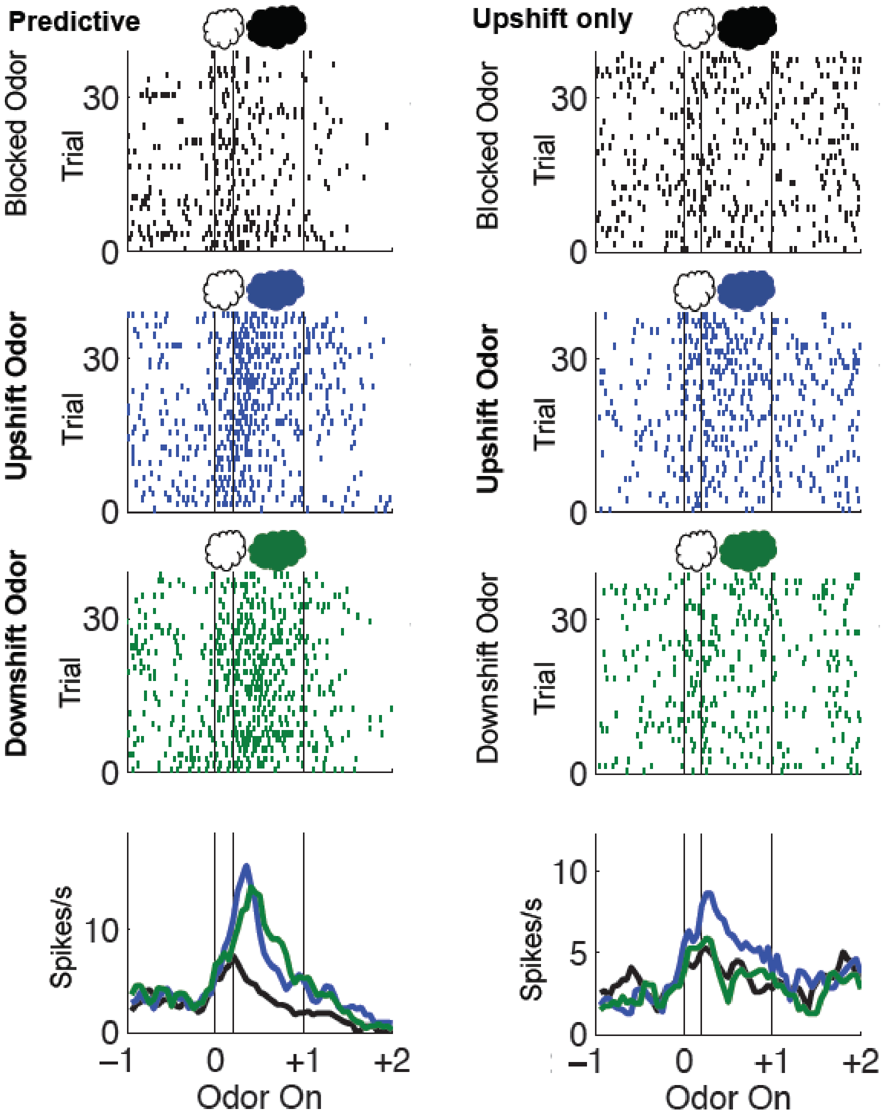

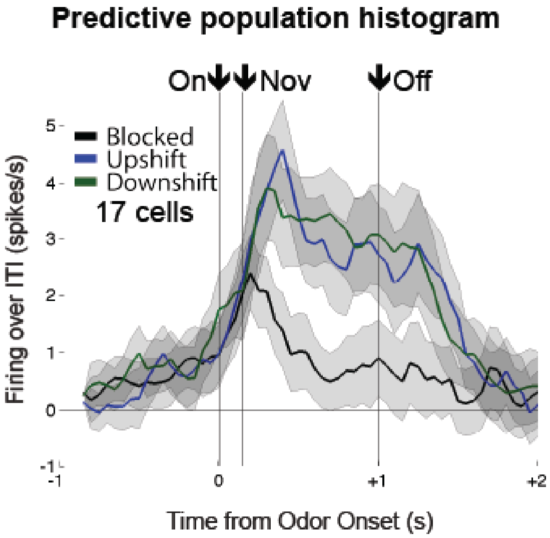

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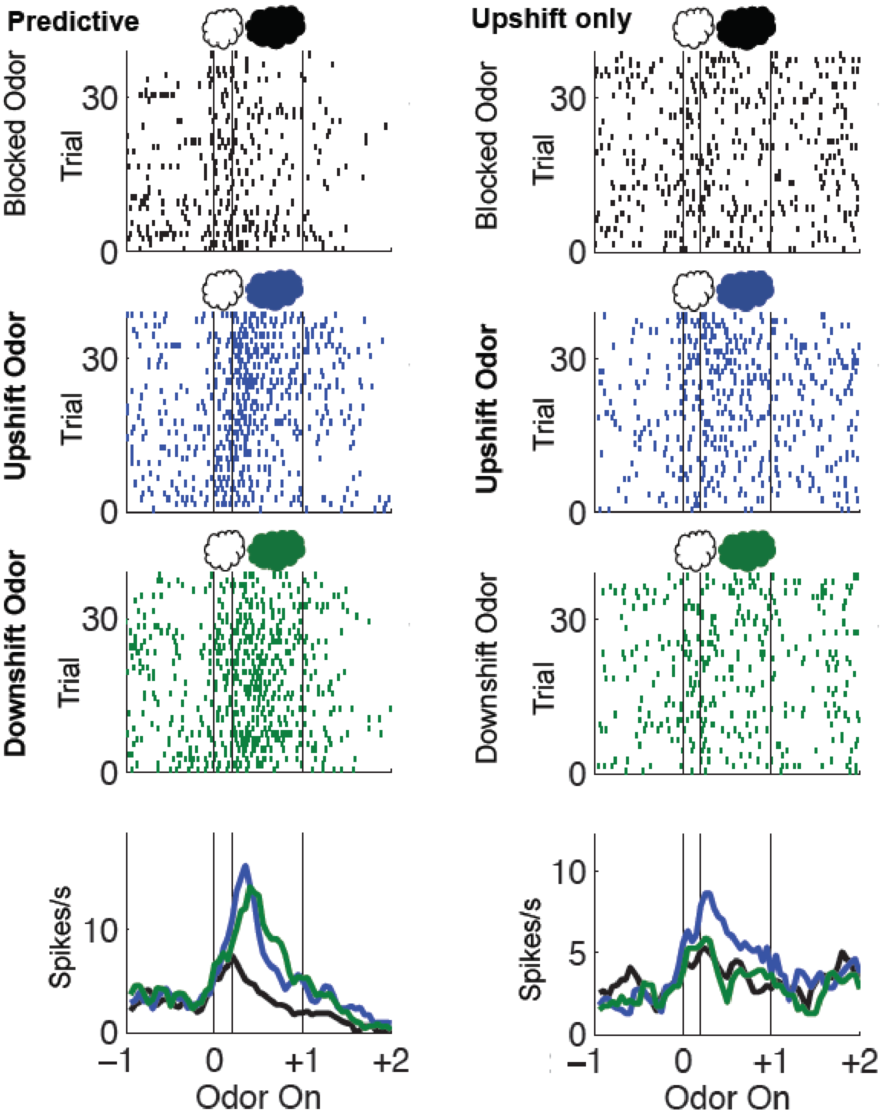

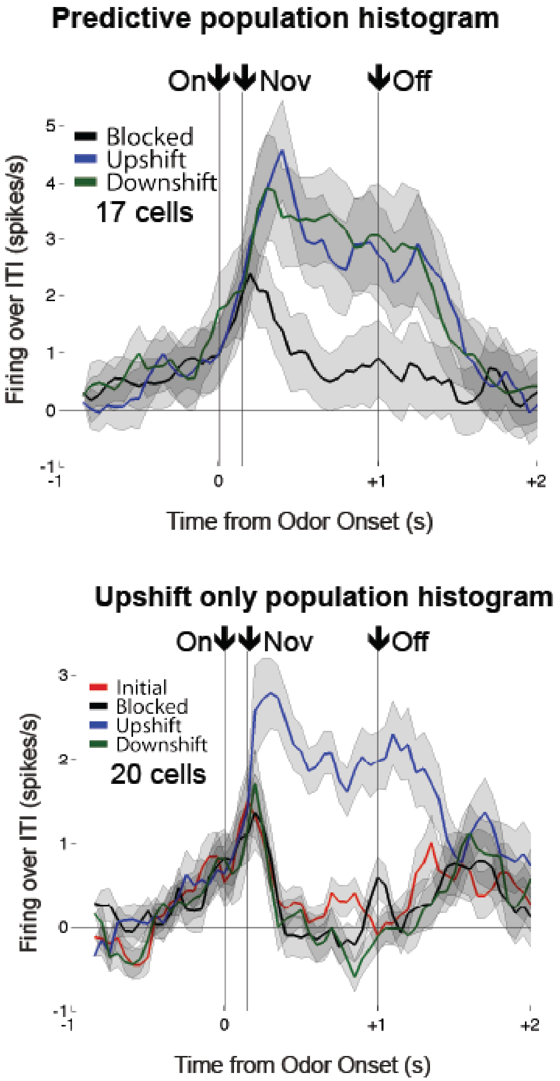

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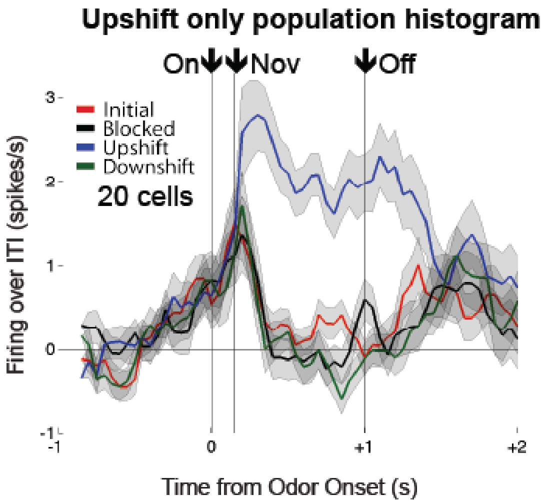

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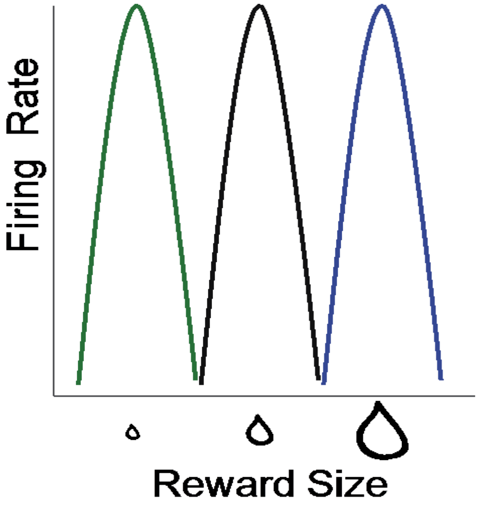
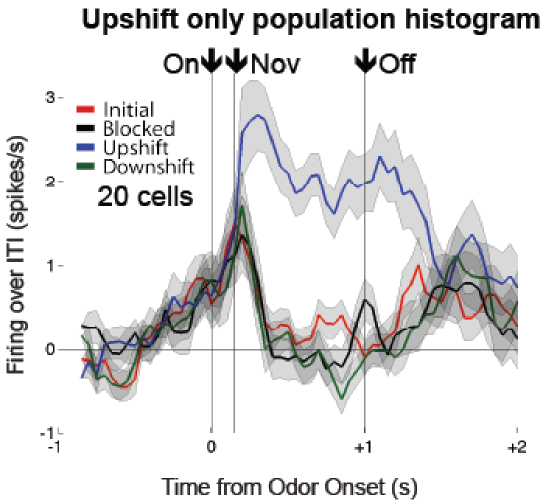

Firing Rate
Reward Size



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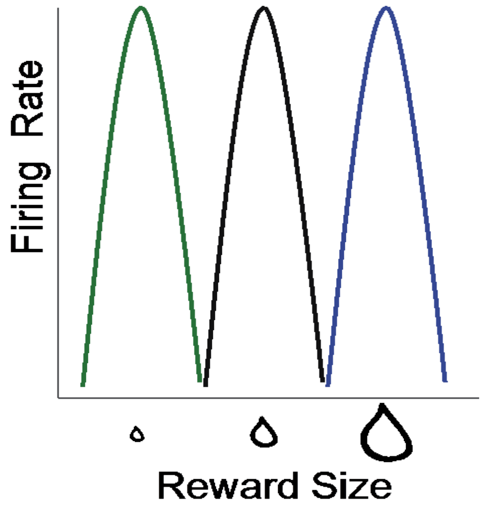
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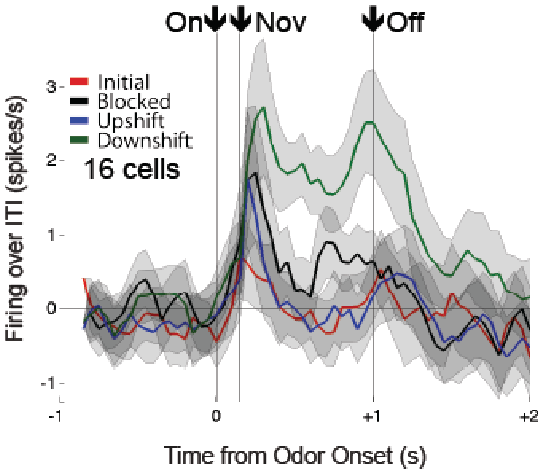
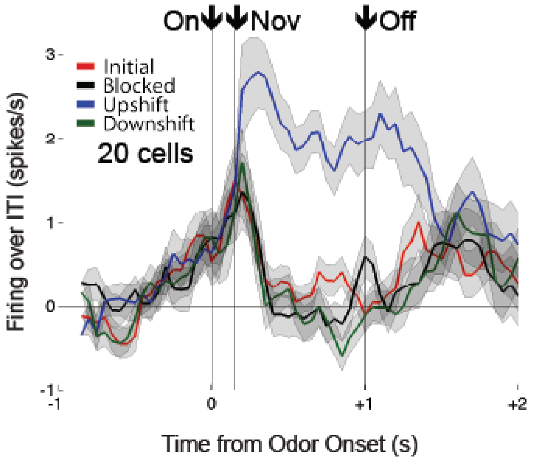

Downshift population histogram


Upshift only population histogram

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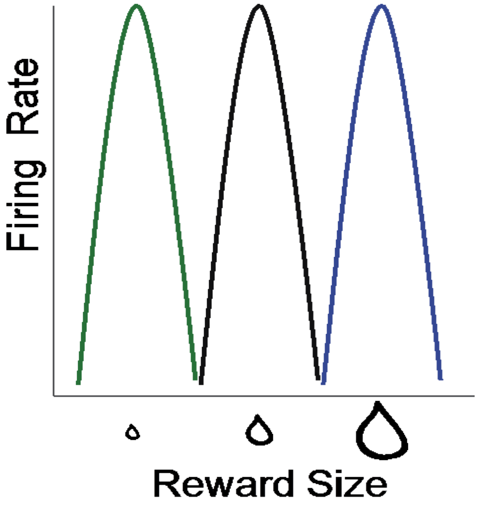
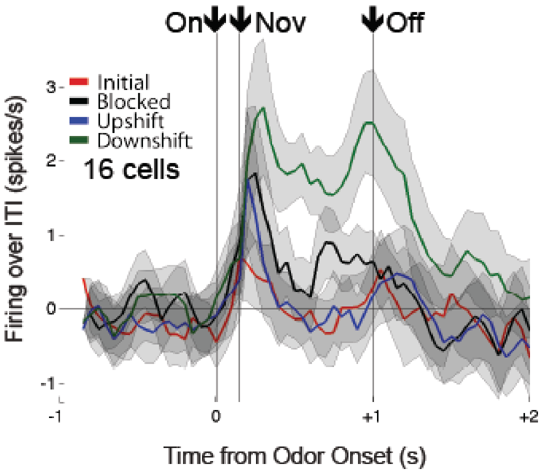
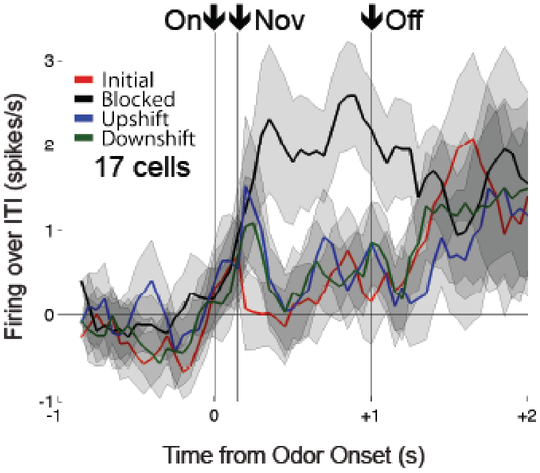
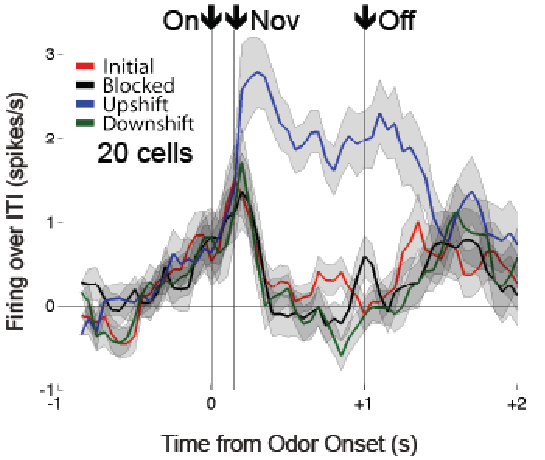
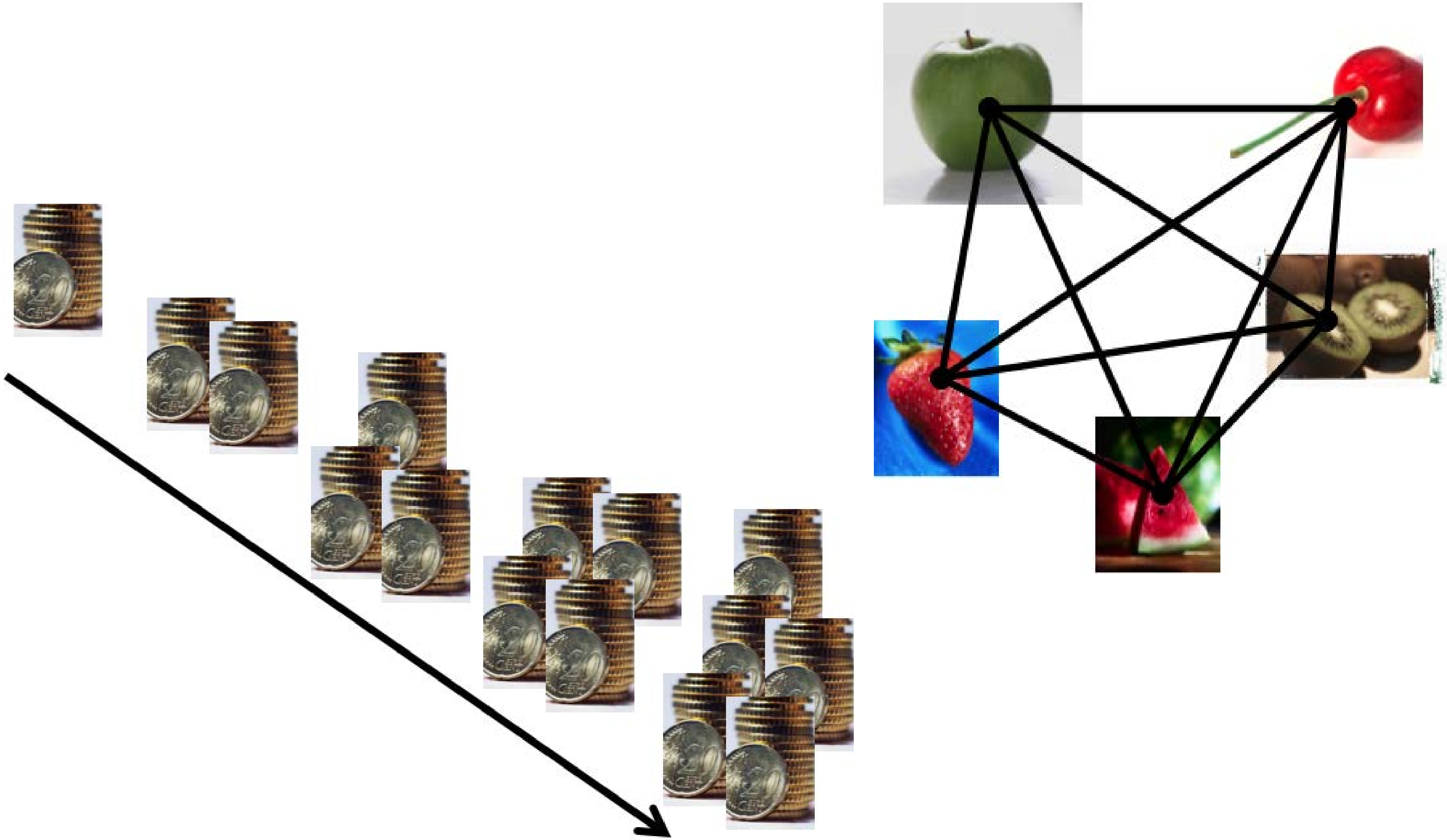



Downshift population histogram


Blocked population histogram


Upshift only population histogram

So type of information does the orbitofrontal cortex contribute?



Mike McDannald, PhD
Josh Jones, PhD
Guillermo Esber, PhD

Nina Lopatina

Tzu-Lan Liu, MS
Kathryn Burke, PhD

And generous grant support from the NIDA, NIA, NIMH.