

Doctoral thesis proposal

# Orexin and uncertainty effects on food-seeking behavior

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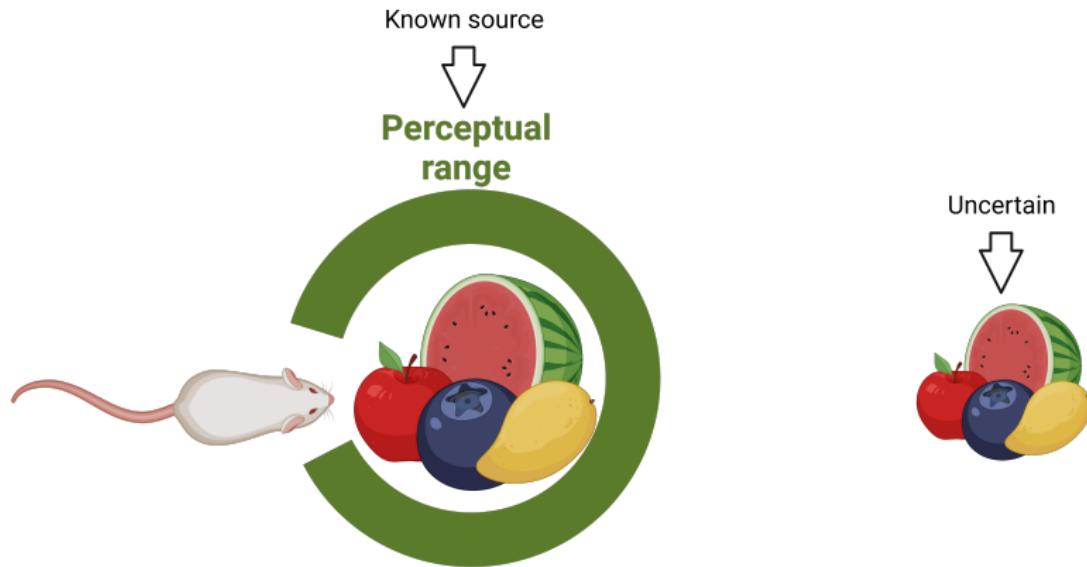
Neurobiology and Obesity (NBO) lab <https://www.nbolab.cl/>

Food-seeking and uncertainty

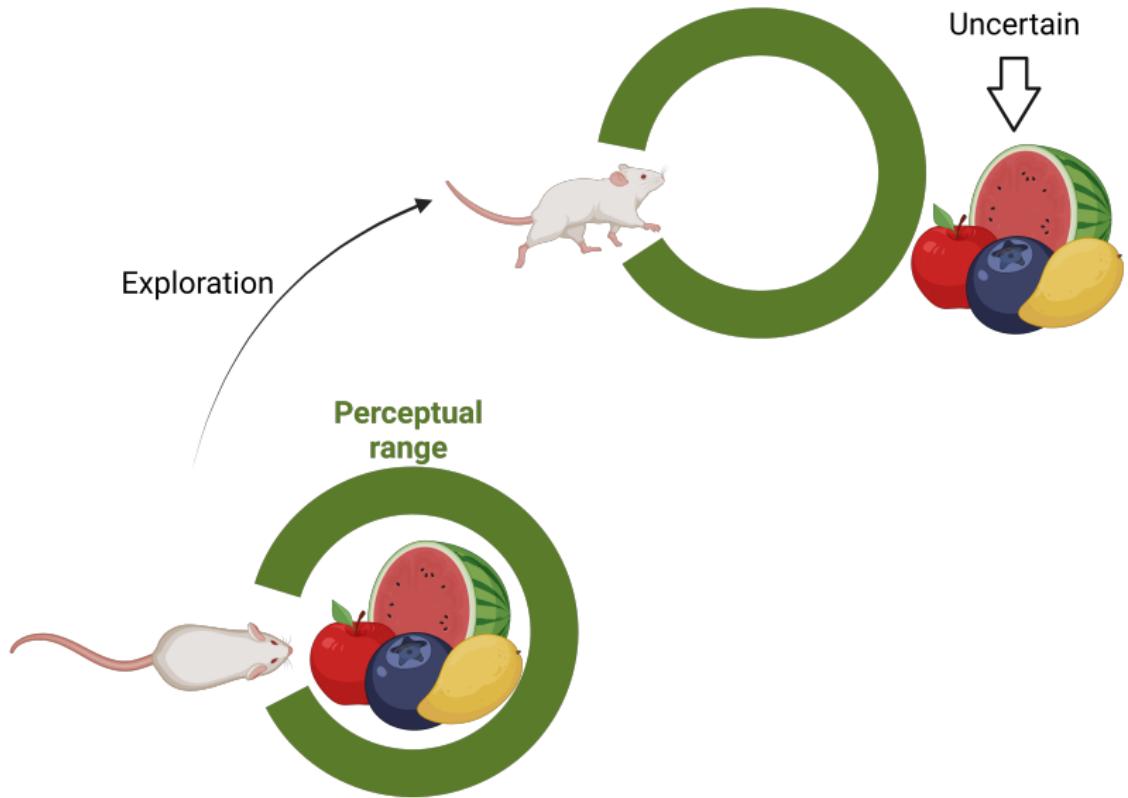
Food-seeking behavior is the coordination of locomotor activity with internal and external cues to procure food



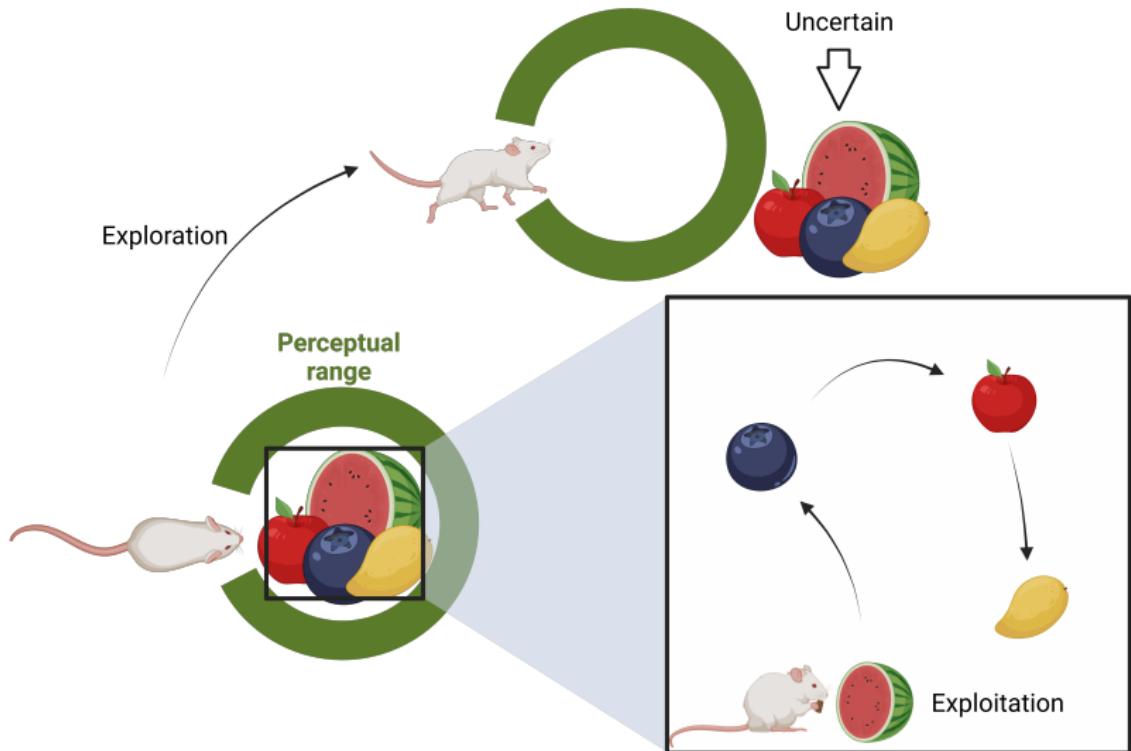
# Food-seeking behavior implies a state of partial knowledge



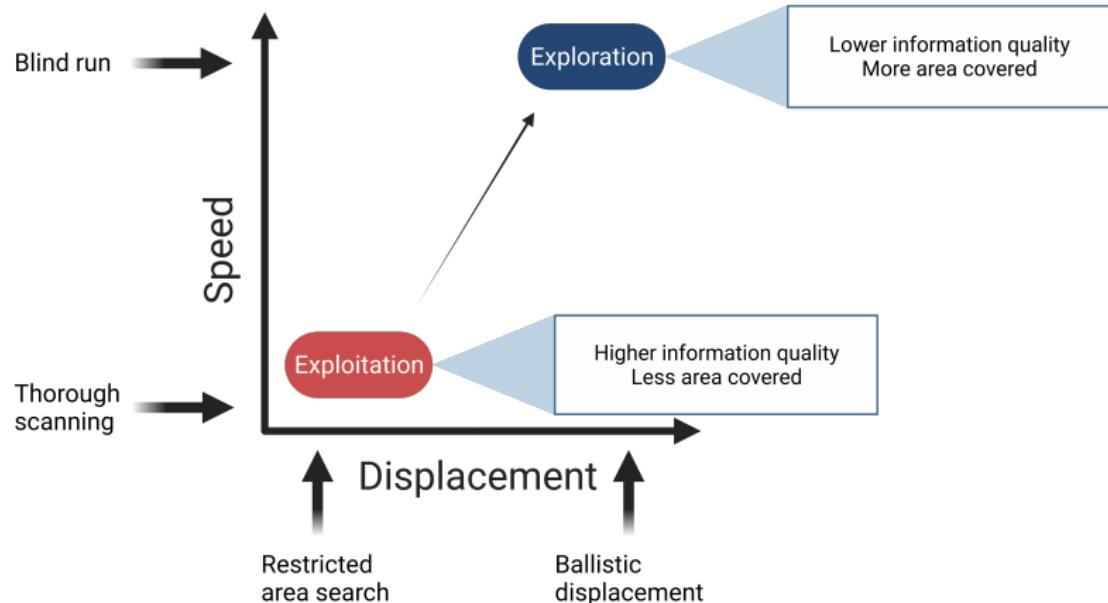
# Partial knowledge forces animals to explore for new food sources



At some point animals need to stop exploring and start exploiting

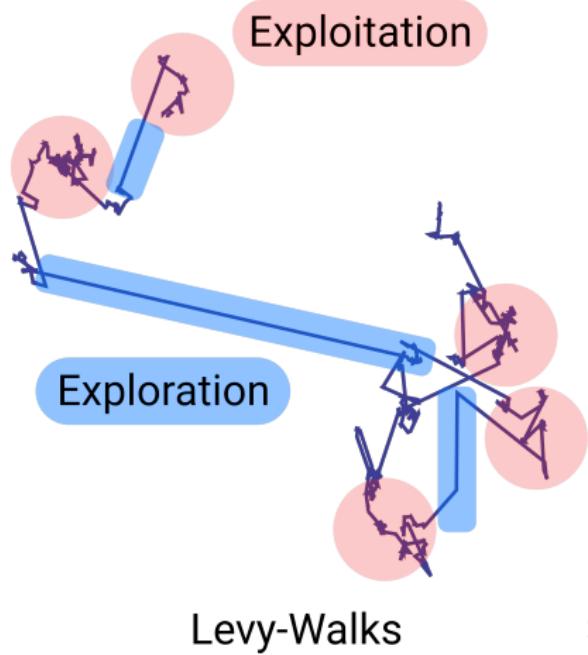


# Uncertainty is inherent to food-seeking behavior



<sup>1</sup>Bartumeus et al. (2014)

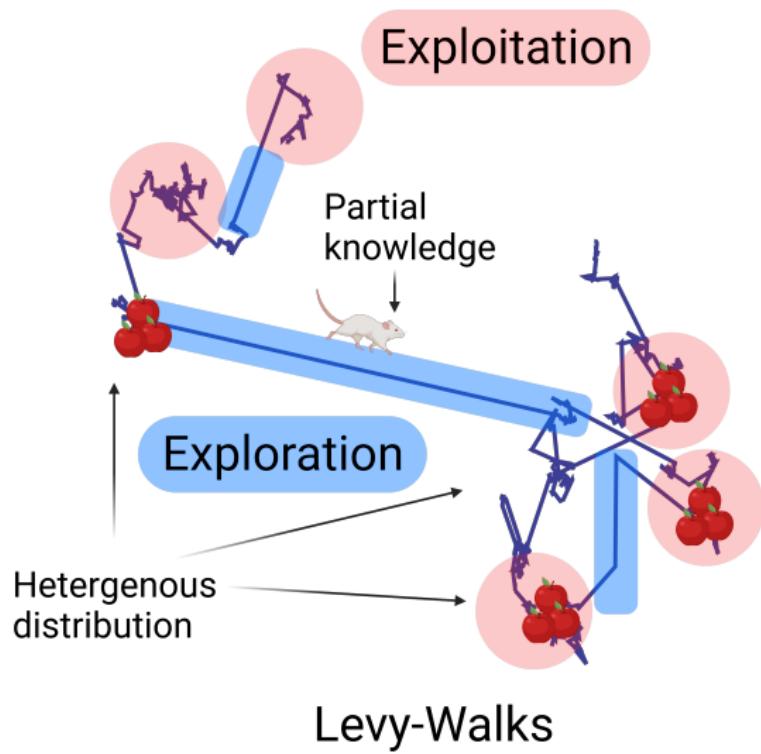
Food-seeking behavior evolved to deal with uncertainty,  
balancing between exploration and exploitation



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<sup>2</sup>Sims et al. (2014); Raichlen et al. (2014); Wosniack et al. (2017)

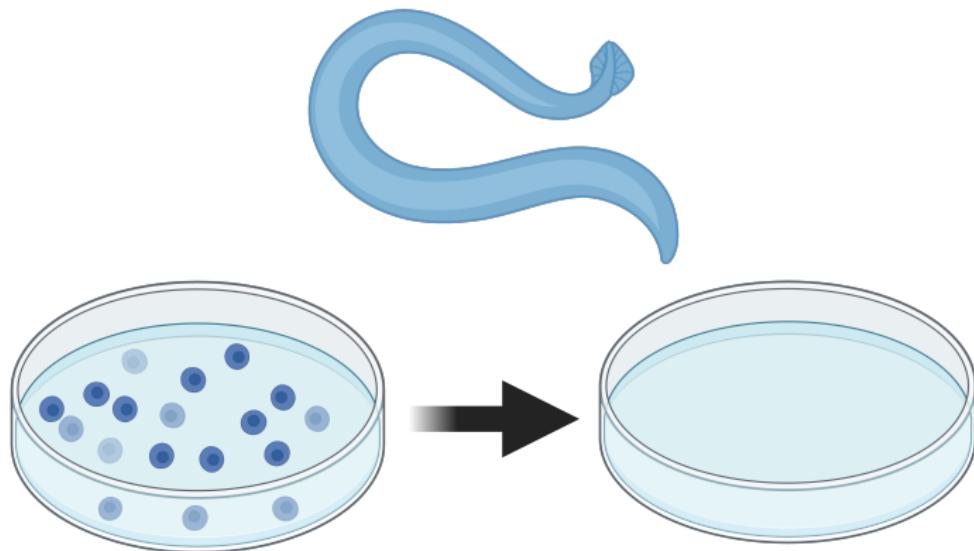
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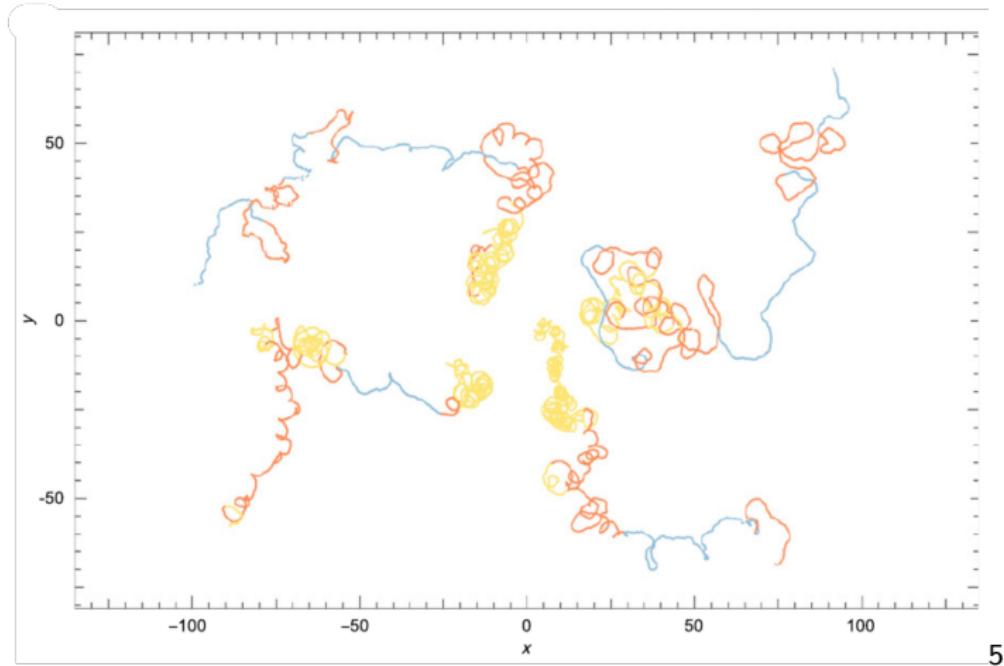
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# Dealing with uncertainty is inherent to food-seeking behavior



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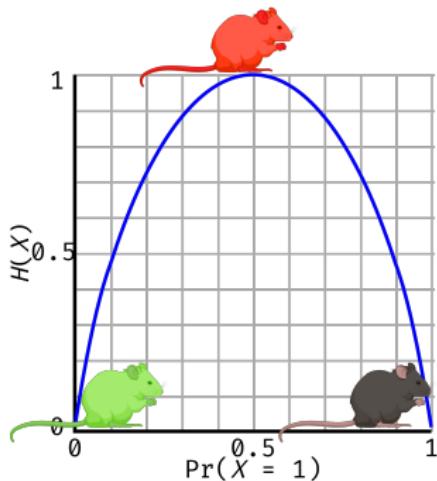
# Dealing with uncertainty is inherent to food-seeking behavior



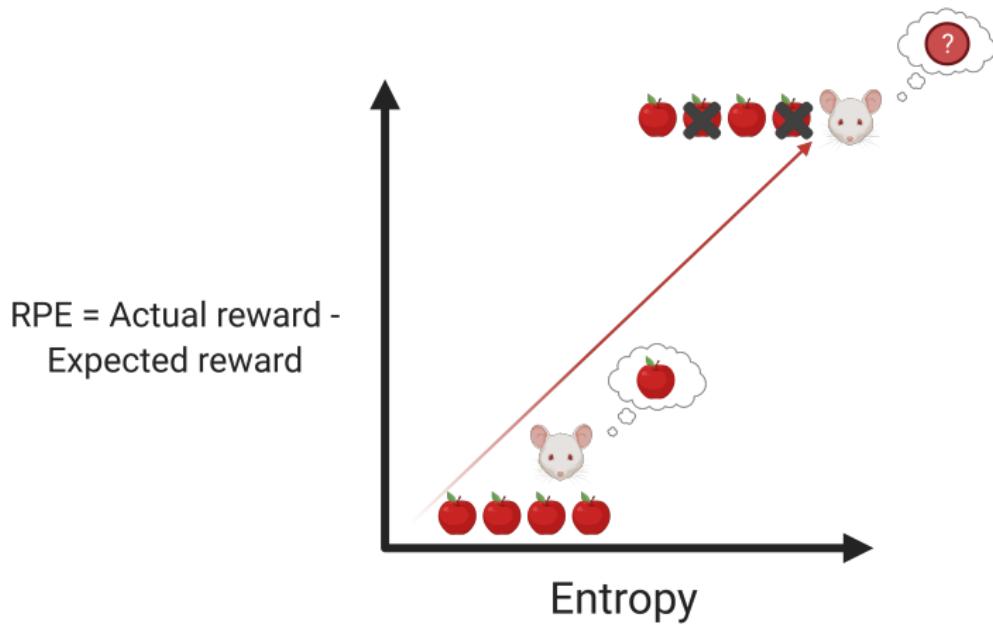
## Key points

- 1 Due to limited perceptual ranges, animals must balance between exploration and exploitation
- 2 Exploratory behavior is triggered to reduce uncertainty of unknown food-sources
- 3 Food-seeking behavior adapted to deal with uncertainty by balancing between exploration and exploitation

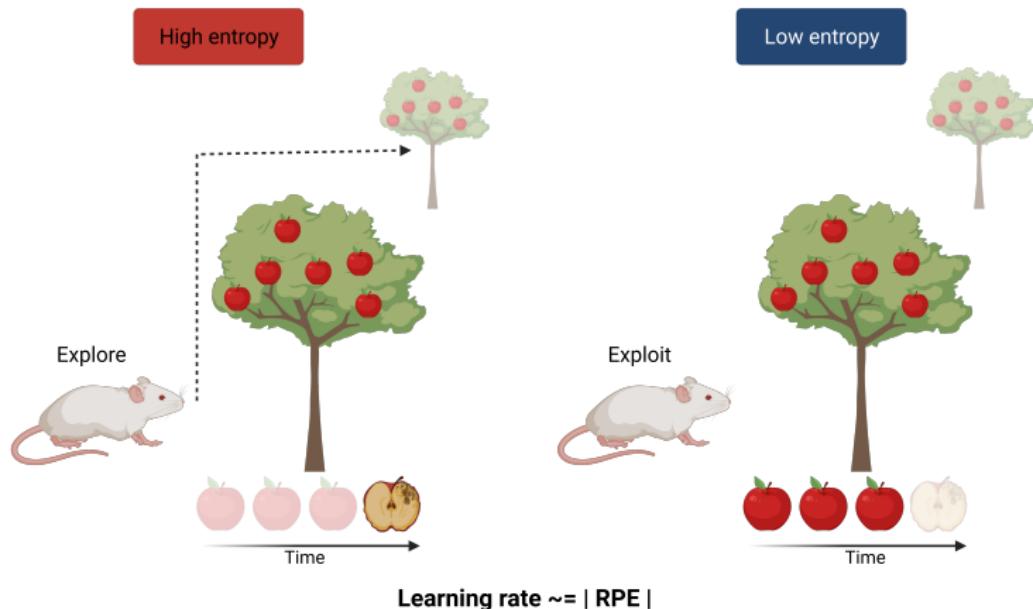
# Uncertainty and behavior: entropy relates the probability of obtaining food with uncertainty



Increasing entropy makes prediction harder, leading to larger reward prediction errors



# Reward prediction error changes the learning rate, adapting behavior to environment uncertainty



## Key points

- ① Entropy allows us to link food-access probability with uncertainty
- ② The reward prediction error offers an indirect measure of environment uncertainty
- ③ The reward prediction error bias exploration/exploitation through the learning rate

Modeling food-seeking behavior in uncertain environments

# Food-seeking behavior modeling starts by expected value computation



Expected value  $\sim=$  Past value + (RPE \* Learning rate)

Expected value  $\sim=$  Action | State

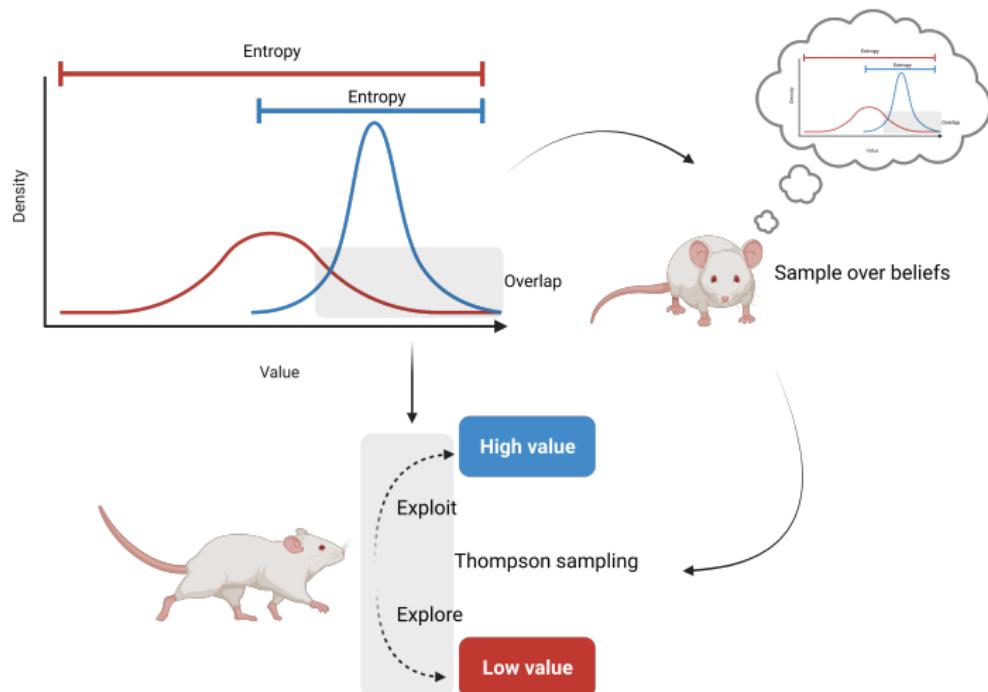
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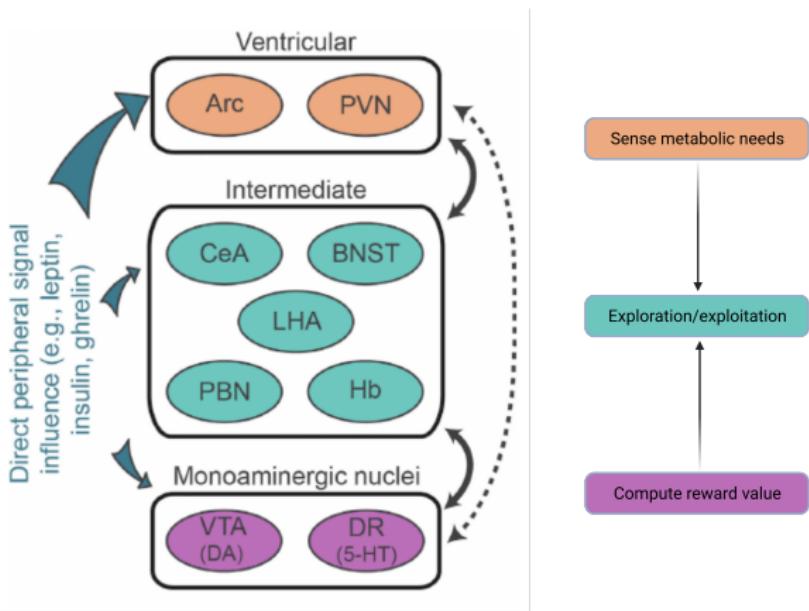


## Key points

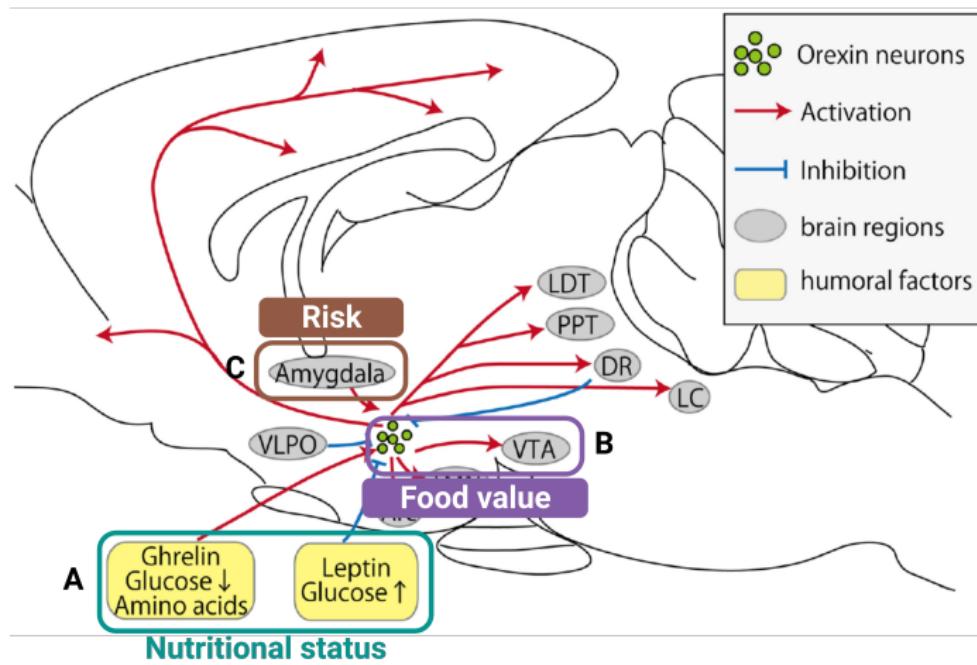
- 1 Uncertainty is inherent to food-seeking behavior and forces the animal to balance between exploration and exploitation
- 2 Uncertainty can be sensed indirectly through direct experience
- 3 The main aspects of food-seeking behavior can be modeled with RPE, learning rate and thompson sampling

Neural basis of food-seeking behavior

# Reward and feeding centers connectivity permits procuring rewarding food to meet metabolic demands

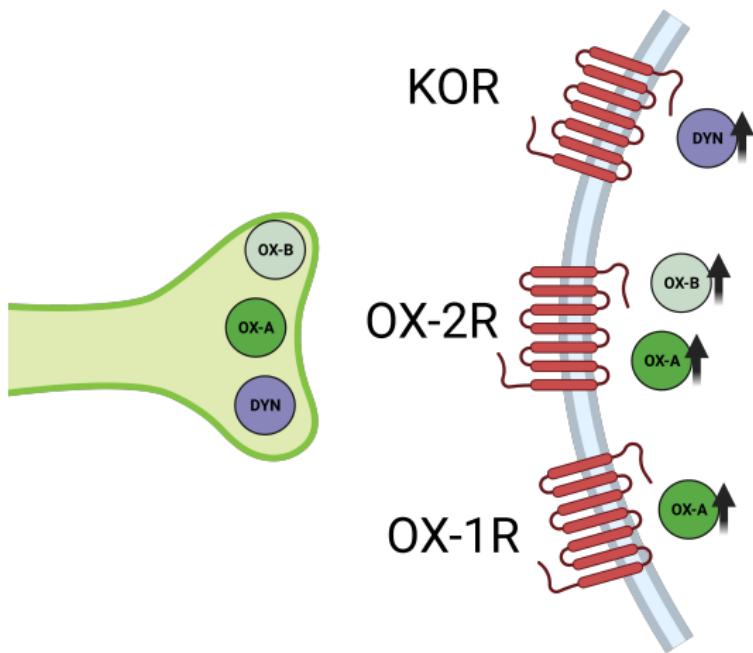


# Orexin could modulate exploration/exploitation through VTA DA activity

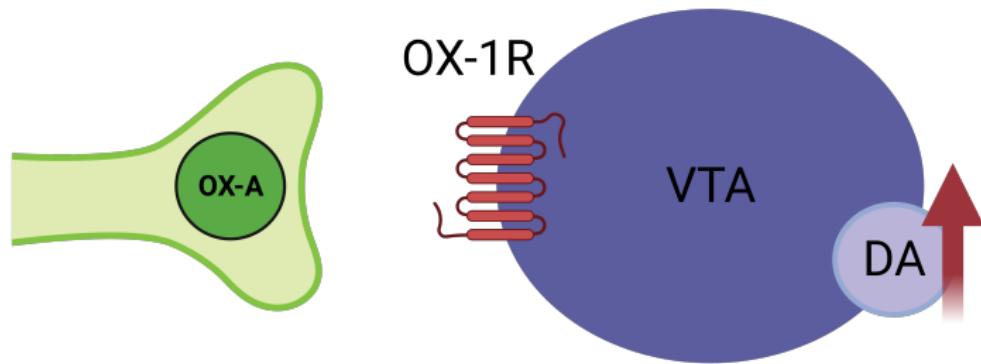


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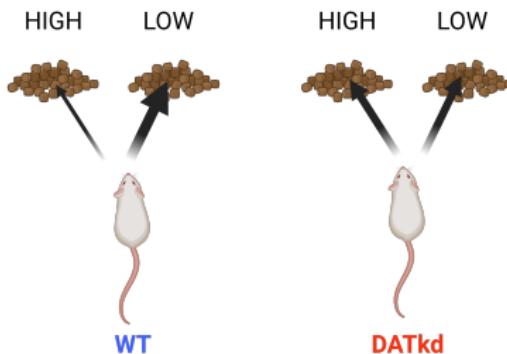
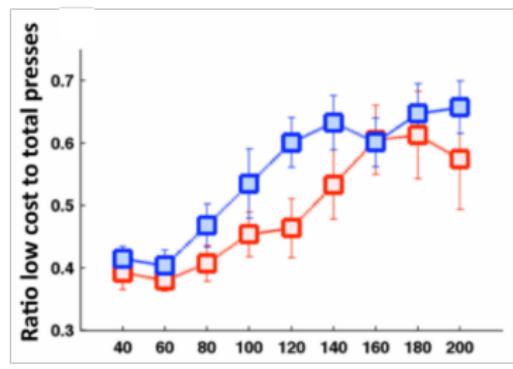


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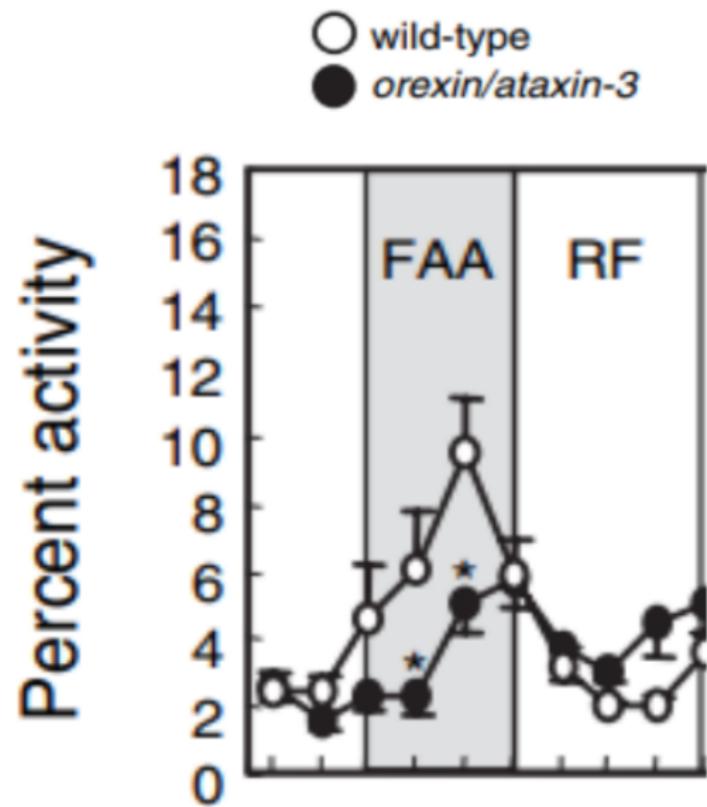


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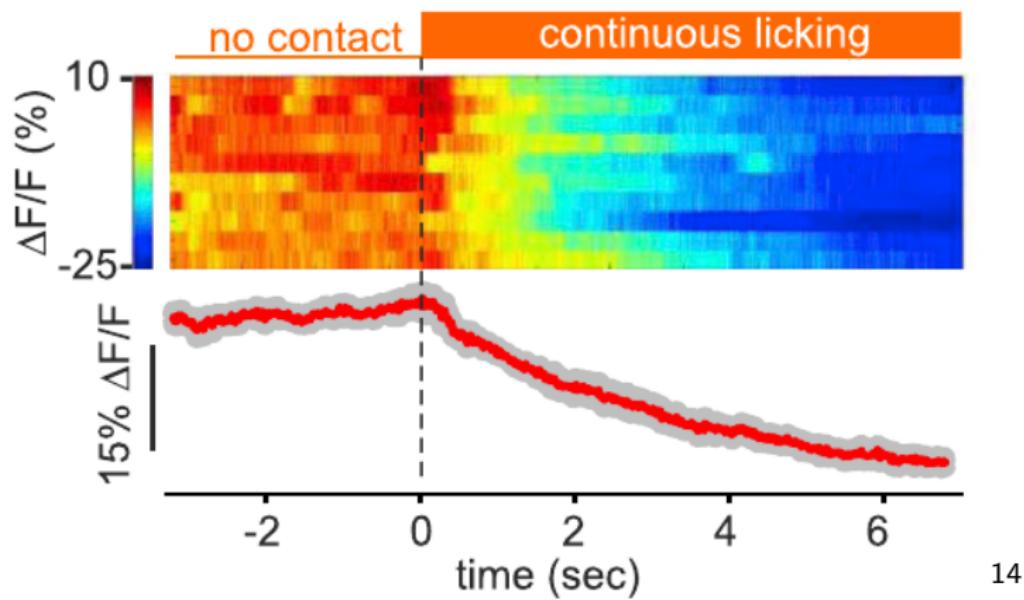
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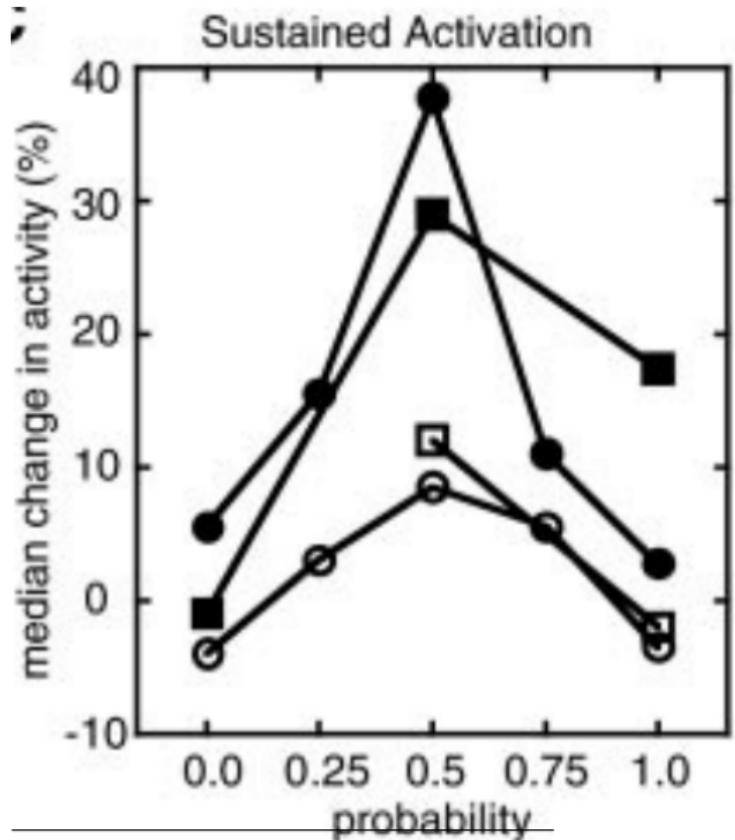
# LHA orexin activity is specific to food-seeking behavior



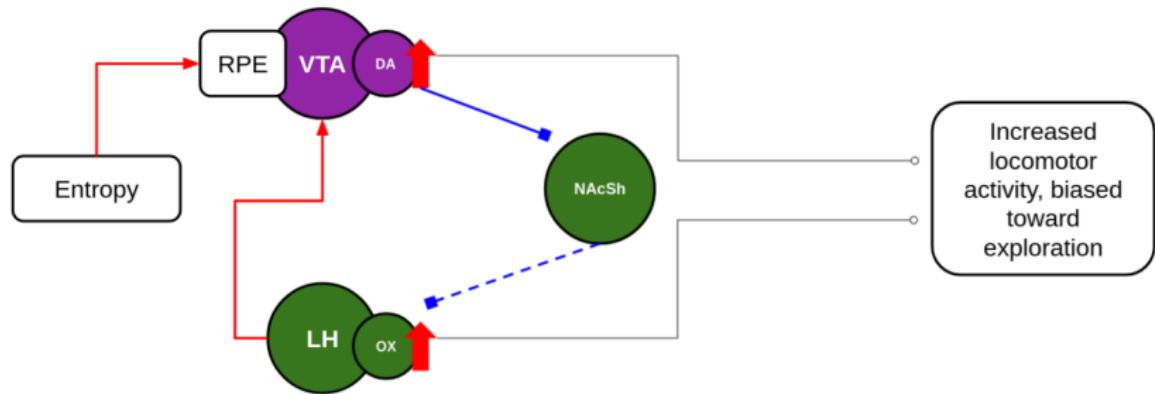
# LHA orexin activity is specific to food-seeking behavior



# VTA DA tonic activity encodes entropy



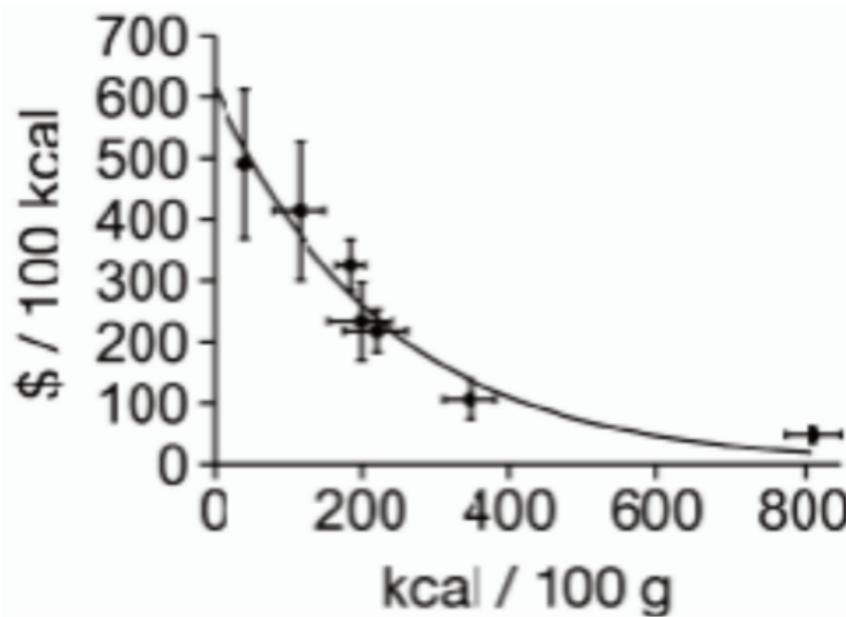
# Orexin could modulate uncertainty-driven food-seeking behavior through VTA DA activity



## Key points

- 1 Orexin coordinates locomotor activity towards procuring food
- 2 VTA DA tonic activity encodes entropy
- 3 Orexin functional connectivity with VTA, allows the modulation of exploration/exploitation in food-seeking behavior

## Food-seeking in modern obesogenic environments



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<sup>16</sup>Verdugo, Giannina, Arias, Vanessa, & Perez Leighton Claudio. (2016)

## References

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