

AnimalKind: Evolutionary & Neuroendocrine Perspectives of Animal & Human Prosociality

Key concepts:

- Prosociality, empathy, & altruism
- Encephalization quotient, absolute brain mass, and neuronal count
- Social Brain Hypothesis/SBH & Human Self-Domestication Hypothesis/HSD
- Theory of mind, emotional contagion, mirror neurons, & Von Economo neurons
- Oxytocin, empathetic brain regions, and effects of dysregulation on empathy

Authors

Isabella Welch, Dual Degree Candidate Physiology & Neurobiology/Allied Health Sciences, Class of 2024

Professor Stephen Trumbo, Biology Department

Assistant Professor John Redden, Physiology & Neurobiology

Affiliations

University of Connecticut

**UConn
NATION**

EST. 1881

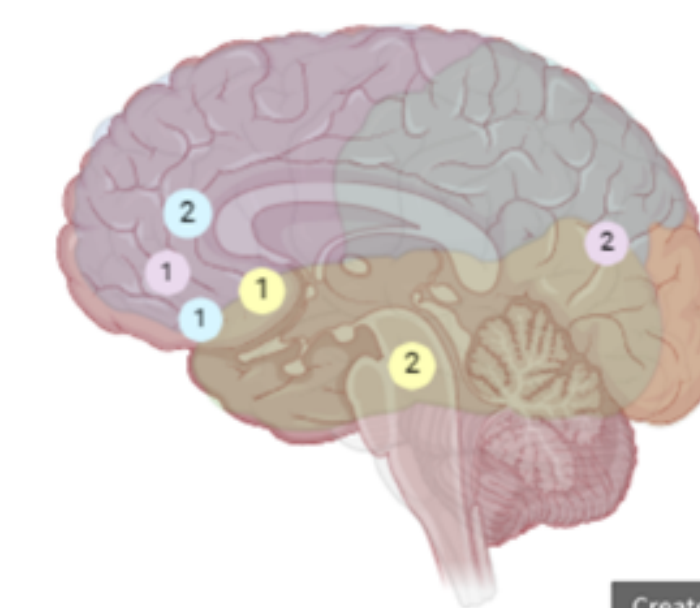
Introduction

- **Prosocial behaviors** are defined as behaviors that benefit other organisms at some cost to prosocial actors, and reciprocity is not required for an animal to act prosocially
- **Empathy** describes an organism's ability to both mentalize the emotional state of another organism and use this information accordingly.
- Prosociality has been evaluated previously by testing for **theory of mind**, presence of **mirror and Von Economo neurons**, **emotional contagion**, and through exploration of various **empathetic brain regions**.
- Theories such as the **Social Brain Hypothesis** and **Human Self-Domestication Hypothesis** have correlated mammalian brain size and human domestication features respectively to high levels of social activity in the animal kingdom.

Cognitive Empathy	Affective Empathy	Reward Empathy
1. dmPFC/vmPFC (dorsomedial & ventromedial prefrontal cortex) 2. TPJ (temporoparietal junction)	1. AI (anterior insula) 2. dACC/aMCC (dorsal & anterior midcingulate cortices, ACC in most animal studies)	1. NAc (nucleus accumbens) 2. VTA (ventral tegmental area)

Different brain regions house neural circuits related to different types of empathy.

Figure #
Brain regions associated with categorical types of empathy. Overlaid with brain lobes for TPJ location accuracy. Note that the ACC comprises most of the horizontal space directly above the corpus callosum. Created with BioRender.com.



Objective

1. **Why and how** have prosociality and empathy evolved?
2. In **what species** have prosociality and empathy evolved?
3. **What is the neuroendocrine basis** of prosocial/empathetic behaviors?
4. What happens when empathetic **signaling is disrupted**?

Methodology

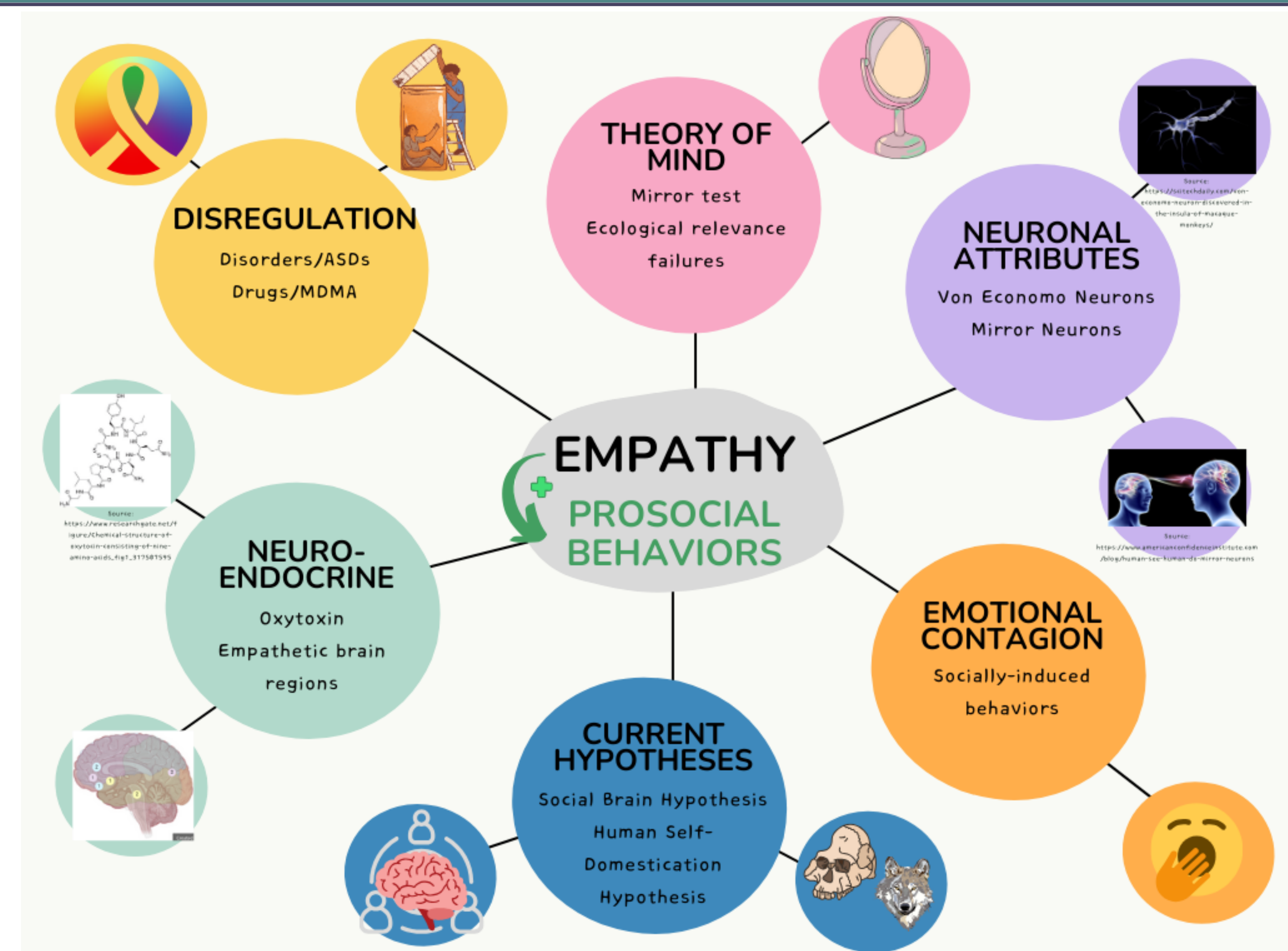
- Meta-analysis
 - Analysis using raw data from pre-existing literature (still in development)
 - Comprehensive tables regarding prosocial animal species and their subsequent exhibition of prosocial behaviors
 - Self-produced diagrams using BioRender

Results

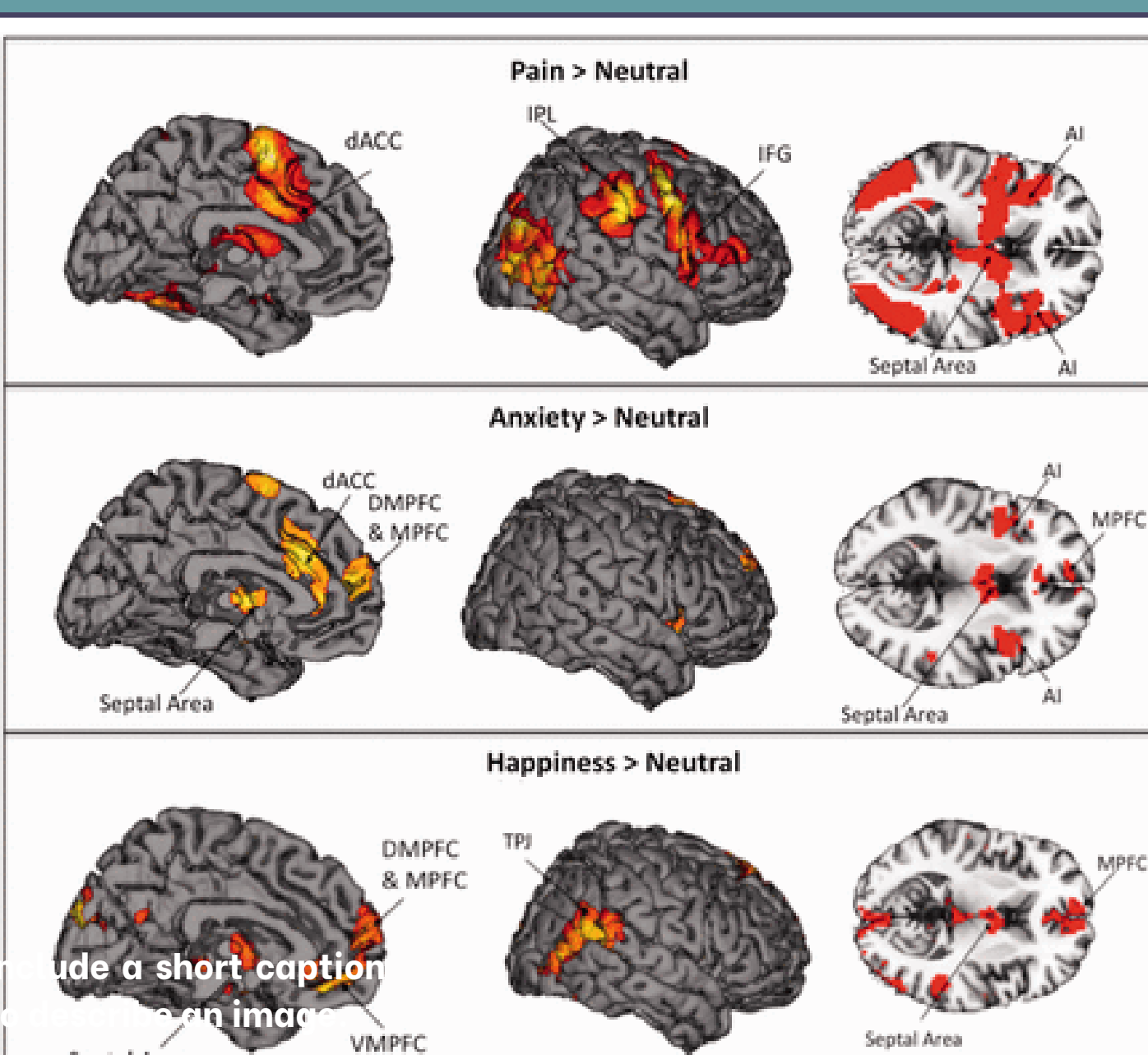
- Multiple animal species have been proven to act prosocially
 - Ex. Small mammals/rodents, some birds, cetaceans, primates, humans
- There are definitive brain regions linked to empathetic behavior
- Dysfunction to neural circuits related to empathy can lead to reduced exhibition of empathetic behaviors
 - Ex. MDMA use and social isolation, Autism Spectrum Disorders/ASDs

Analysis

- Brain size studies have proven that **EQ/encephalization quotient** is not as effective of a marker of brain size as previously thought
 - Absolute brain mass and neuronal number is a better indicator
 - Social brain hypothesis may hold true, but EQ should not be weighted heavily in pre-existing literature for this reason
- **Theory of mind**, though a helpful measure of self-awareness, may not need to be present in a species to prove empathetic and prosocial capabilities
 - There are factors such as mirror orientation and species limitations that reduce the reliability of theory of mind data
- Prosociality and empathy are two dynamic and complex processes that are affected by multiple factors, including **endogenous** (hormones and pathology) and **exogenous** (drugs/socialization) factors
- **Empathy promotes exhibition of prosociality/prosocial behaviors**



Neuronal and environmental effects on empathy, current hypotheses, and implications for dysregulated empathetic circuitry



Still in development:

- Associations between brain size and domestication features
- Understanding the purpose of evolution of empathy and prosociality (the "why")
- Human-specific research and subsequent analysis (asides Human Self-Domestication hypothesis)
 - Potential fMRI data for altruistic human candidates

Related Literature

1. <https://www.sciencedirect.com/science/article/abs/pii/S0168159118305872>
2. https://www.sciencedirect.com/science/article/pii/S0028393221001767?ref=pdf_download&fr=RR-2&rr=85f3d633be258ff0#bib16
3. <https://royalsocietypublishing.org/doi/full/10.1098/rstb.2017.0288>
4. <https://www.annualreviews.org/content/journals/10.1146/annurev-psych-010416-044201>
5. <https://www.nature.com/articles/s41586-018-0416-4>
6. <https://www.nature.com/articles/s41593-018-0246-6>
7. <https://academic.oup.com/scan/article/9/1/39/1672363#126943449>