Growing a social brain
by
Shir Atzil, Wei Gao, Isaac Fradkin and Lisa Feldman Barrett
Some of the topics

- A framework for sociality
- What is Allostasis?
- Rich club hubs
- “Predictive coding”
- Allostasis-driven learning of social concepts
Introduction

Social affiliation
What is Allostasis?

Allostasis

- Perceived Stress
- Individual Differences
- Physiologic Responses
- Behavioral responses

Adaptation

Allostasis Load

Parental Care
Allostatic load 😞
Comparative relationship between social strategy and metabolism

- Large brains in primates are associated with both increased metabolism and increased social demands.
- There is a relationship between social status and standard metabolic rate in Atlantic salmon, such that socially dominant fish have higher metabolic rates.
- High energy requirements imposed on reproductively active females are an important determinant of the phenomenon of female social dominance in, a Madagascar primate.
Allostasis and social strategies across species

- Similar genetic basis for social development and energy metabolism
  - Changes in gene expression in primates
- Social deficits in bees and humans share a neural gene expression signature
  - Social deficits in non-social bees and autistic spectrum disorder humans are associated with the gamma-aminobutyric acid (GABA) receptor and voltage-gated ion channel genes, which are involved in allostasis
Rich club hubs

Central role in information integration and communication
The brain is malleable in early life and sensitive to social input.

- Including long-distance functional synchronization and rich club hubs within the core networks are missing in newborns.

- Human brain development is a protracted process that starts in utero and lasts for up to 25 years postnatal.

- During the first perinatal weeks, the brain is characterized by maximized plasticity.
Development of the default mode network and salience network
Development of the default mode network and salience network

Intensive social care during critical years
Predictive Coding

Cognitive science framework

- Sensory input
- Categories: A group of sensations with common features/goal/action
- Concepts

Predictive coding framework

- Perception
- Organization
- Probabilistic models: A group of sensations with common features/goal/action
- Predictions
A predictive coding approach to social development

\[ \mu_1 = \mu_0 + (x - \mu_0)\tau \]

- \( \mu_1 \) denotes brain’s updated hypothesis
- \( \mu_0 \) denotes brain’s prior prediction
- \( x \) denotes sensory signal
- \( \tau \) denotes the weight of prediction error
A predictive coding approach to social development

\[
P('Mommy' | \text{Interoception, Extroception}) = P('Mommy') \times P(\text{Interoception} | 'Mommy') \times P(\text{Extroception} | 'Mommy')
\]

Corresponding with Bayesian models of the brain, equation shows that the infant's concept of 'mommy' is conditional on interoceptive and exteroceptive information.
Major nodes of 'Social Brain'

- Anterior insula
- Anterior cingulate cortex (pain processing, emotion, memory)
- Ventro-medial prefrontal cortex (decision making)
Insular cortex

- The anterior insula is a hub that integrates exteroceptive to interoceptive inputs.
- The posterior insula receives input such as pain, temperature, itch, local oxygen status, and sensual touch.
Social Development
Allostasis-driven learning of social competencies (Synchrony)
Emotion and social concepts are environmentally constructed in each culture, and transferred between generations in social dyads during early life social 'training'
Social pain 😞

- Rejection
- Loss
- Break-ups

Increased activation in the dACC and the AI
Hierarchy of needs

Maslow Hierarchy of needs
Social “Things”

Social Perception → Social Inferences → Social Behavior
Heider and Simmel Movie
The insula lights up with activity when someone feels or anticipates pain.

Size of amygdala correlates with how many friends you have.

Amygdala
Conclusion

Growing a social brain’ is at the basis of every human’s wellbeing.

Early infancy is a critical time for establishing the biology of a healthy mind.

As humans, taking responsibility on shaping our (social) brains can potentially impact science, societies and our children’s education.
References

- https://www.ncbi.nlm.nih.gov/pmc/
- https://www.britannica.com/science/
- https://ruthfeldmanlab.com
- https://www.nature.com/nathumbehav/research
- https://icons8.com/icons

Dunbar, R. I. & Shultz, S. Evolution in the social brain. *Science*
And Others
Thanks for attention 😊

Any questions 🚫