北京師範大學心理学部

Developmental Population Neuroscience

发展人口神经科学（个体情感与脑）

左西年 (Xi-Nian Zuo)

Beijing Normal University

State Key Lab of Cognitive Neuroscience & Learning

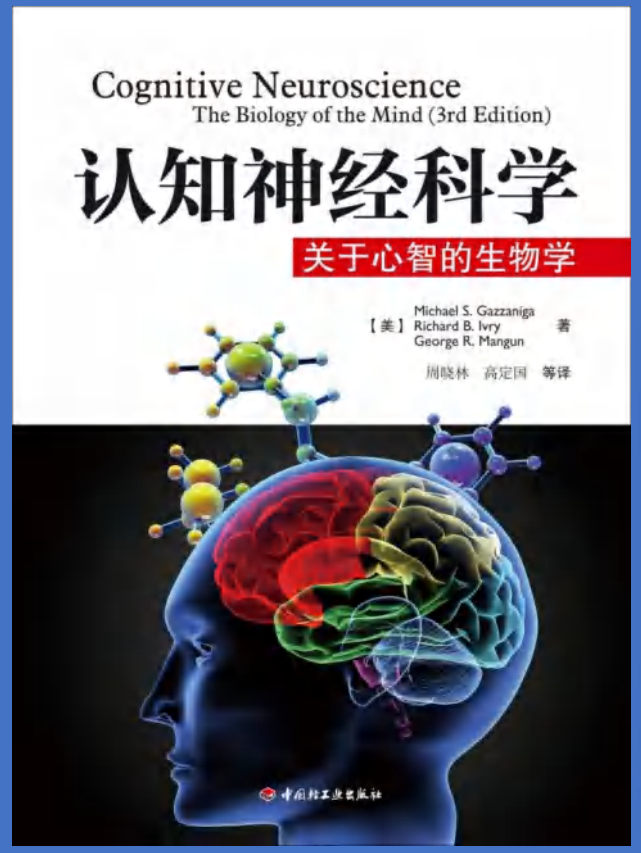
National Basic Science Data Center

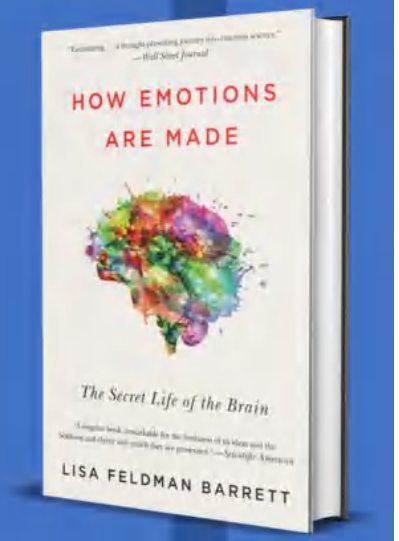
Chinese Data-sharing Warehouse for In-vivo Imaging Brain

七情六欲《礼记·礼运》

喜怒哀乐《礼记·中庸》

第九章





情绪与发展认知神经科学

秦绍正

http://deepneuro.bnu.edu.cn/?p=43&page=3

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Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala

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STUDIES in animals have shown that the amygdala receives highly processed visual input[1,2], contains neurons that respond selectively to faces[3], and that it participates in emotion[4,5] and social behaviour[6]. Although studies in epileptic patients support its role in emotion[7], determination of the amygdala's function in humans has been hampered by the rarity of patients with selective amygdala lesions[8]. Here, with the help of one such rare patient, we report findings that suggest the human amygdala may be indispensable to: (1) recognize fear in facial expressions; (2) recognize multiple emotions in a single facial expression; but (3) is not required to recognize personal identity from faces. These results suggest that damage restricted to the amygdala causes very specific recognition impairments, and thus constrains the broad notion that the amygdala is involved in emotion.

杏仁核

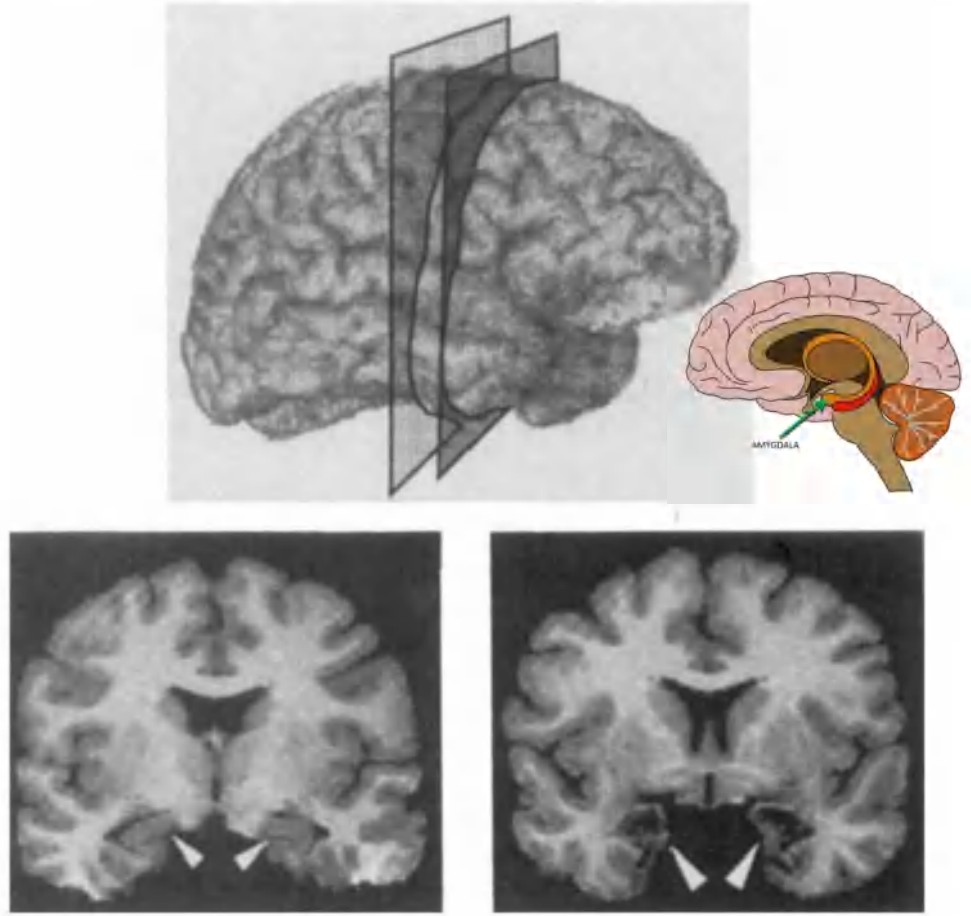

FIG. 1 t_1-weighted MR images of S.M.'s brain. Planes of section are shown at the top, on a three-dimensional reconstruction[26] of S.M.'s brain. There is extensive bilateral amygdala damage (lower right image, large arrowheads) with sparing of neocortex and hippocampus (lower left image, small arrowheads). The tissue of the amygdala has been replaced by mineral deposits as a result of Urbach–Wiethe disease[11].

The Biology of Fear

Review

Ralph Adolphs

Each of us has felt afraid, and we can all recognize fear in many animal species. Yet there is no consensus in the scientific study of fear. Some argue that 'fear' is a psychological construct rather than something discoverable through scientific investigation. Others argue that the term 'fear' cannot properly be applied to animals because we cannot know whether they feel afraid. Studies in rodents show that there are highly specific brain circuits for fear, whereas findings from human neuroimaging seem to make the opposite claim. Here, I review the field and urge three approaches that could reconcile the debates. For one, we need a broadly comparative approach that would identify core components of fear conserved across phylogeny. This also pushes us towards the second point of emphasis, an ecological theory of fear that is essentially functional. Finally, we should aim even to incorporate the conscious experience of being afraid, reinvigorating the study of feelings across species.

Introduction

Could you be in a state of fear without feeling afraid? Is fear applicable in species like rats? What about flies? And how would you know? Laypeople have no difficulty using the word 'fear' in everyday conversation, yet are quickly stumped by questions such as these. So are psychologists and biologists. Despite an explosion of recent findings, spurred in large part by funding to help understand mood- and anxiety disorders, the field of emotion research is more fragmented than ever. Much of this fragmentation, and much of the excitement, comes from the highly interdisciplinary nature of how fear is being investigated. A flurry of neurobiological data has come from two technical developments: functional magnetic resonance imaging (fMRI) applied to humans[1] and optogenetics (applied to mice). Yet findings from these two approaches, together with ecological and psychological work, have not resulted in the emergence of any consensus on how to operationalize or investigate the emotion fear. I shall review this field from a broad perspective and suggest an approach to investigating fear that aims to move beyond the debates, and to reinvigorate studies by returning to some of the historical roots.

At the outset, we need an operational definition of 'fear'. The approach I advocate is pragmatic: fear is an intervening variable between sets of context-dependent stimuli and suites of behavioral responses. Its usefulness is explanatory, and one can be agnostic about any correspondences with other psychological, let alone neurobiological, states. Such a variable could take on a consistent set of values within an individual, and differ systematically between individuals, making it a candidate for a personality trait. It could be linked to variation in genotype, at least in part, making it a candidate for an endophenotype.

Several features of such a concept of 'fear' are important to stress. First and foremost: it is a functional definition. Fear is a central state of an organism (Box 1). It is not identified with the conscious feeling of being afraid, nor with fear behaviors such as skittering and running away. Both feelings and behavior can of course be used as evidence for a central state of fear; but the evidence for the state is not the state itself. Instead, fear as a central state is what causes the conscious experience (in some species and under some conditions) and what causes the fear behaviors (again, the details depend to some extent on species and circumstance). Fear in turn is caused by particular sets of stimuli (in a context-dependent way). Fear is what links sets of stimuli to patterns of behaviors. Unlike with reflexes, this link in the case of an emotion like fear is much more flexible. (Hence all the parentheticals qualifiers in this paragraph) and the state can exist for some time after the eliciting stimuli (disengaging the state of fear from the eliciting stimuli, unlike with reflexes).

Specifying the sets of stimuli that normally elicit fear, and the sets of behavioral, autonomic, endocrine, and cognitive responses caused by fear, is of course a large and complex task. It is made easier by statistical regularities in the environment, and by phylogenetic continuity. There are evolved sets of behavioral packages to particular classes of stimuli encountered in a particular context in the case of rats [1], as in humans [2]. Ecologists uncover the packages of behaviors and classes of stimuli as they occur in their natural environment; psychologists attempt to link their findings to the rest of cognition, and neuroscientists seek to figuring out how the stimuli can be linked to the behaviors by the brain.

Historical and Current Debates

Theories of emotion have a long and checkered history, and perennial questions remain. How many emotions are there? Are emotions discrete or dimensional? What is their function? What are unique to humans? Historically, much of the work has been done in philosophy and psychology, with an almost exclusive focus on humans. There is debate concerning whether there is a small set of 'basic' emotions that might be universal [3], and alternative accounts have proposed underlying dimensional frameworks and theories based on the physiological construction of emotions [4–6] (Table 1).

More recently, these debates have been informed by functional neuroimaging, and in particular by several meta-analyses that have tried to glean patterns of regional brain activation seen across large numbers of studies. More than a century ago, the psychologist William James already envisioned emotions as corresponding to specific psychophysiological patterns in the body [7], although he recognized that each instance of an emotion might have a different pattern. Indeed, finding reliable psychophysiological patterns that would classify emotion categories — for example, happiness versus sadness — is an idea for which there has been little empirical support. Nowadays this picture has been transposed into the brain, and the debate remains alive: are there specific brain systems for happiness, for fear, for anger, for sadness?

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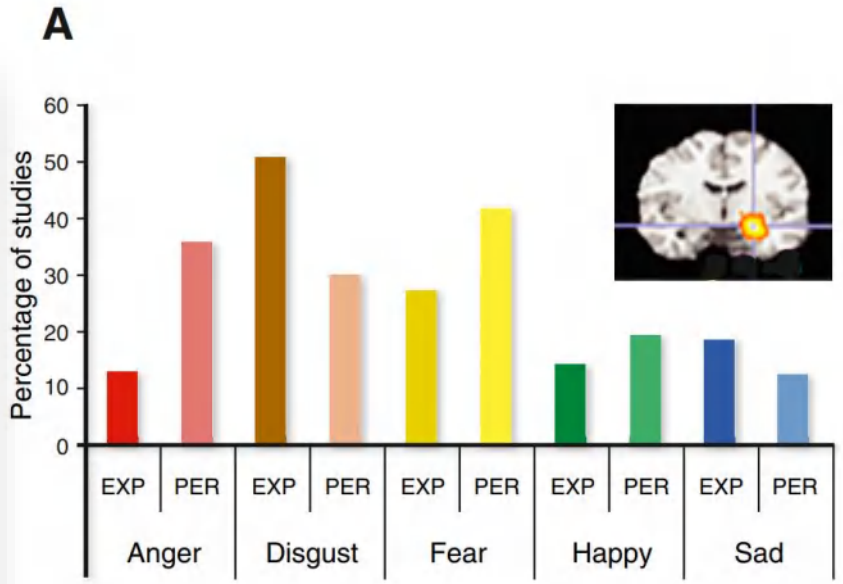
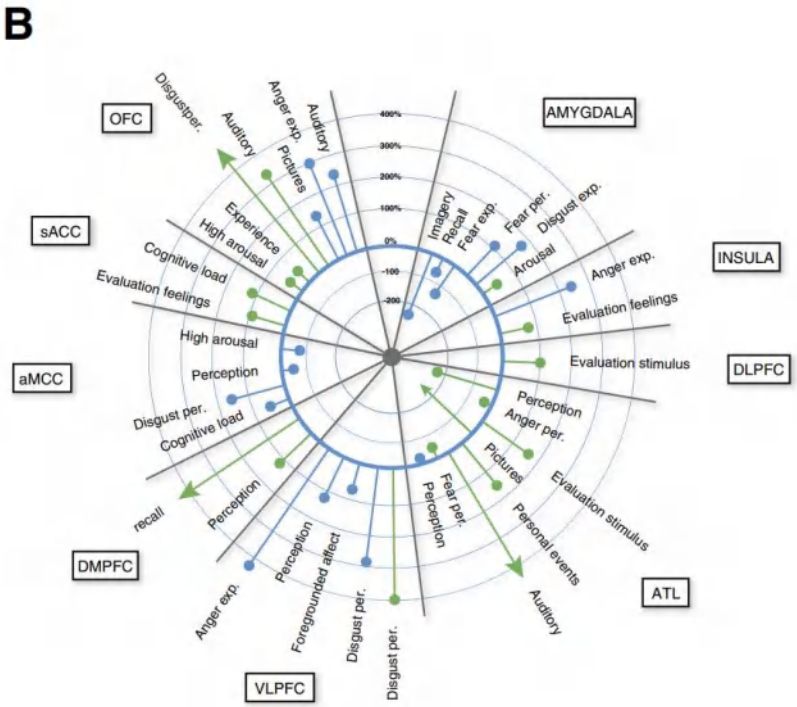
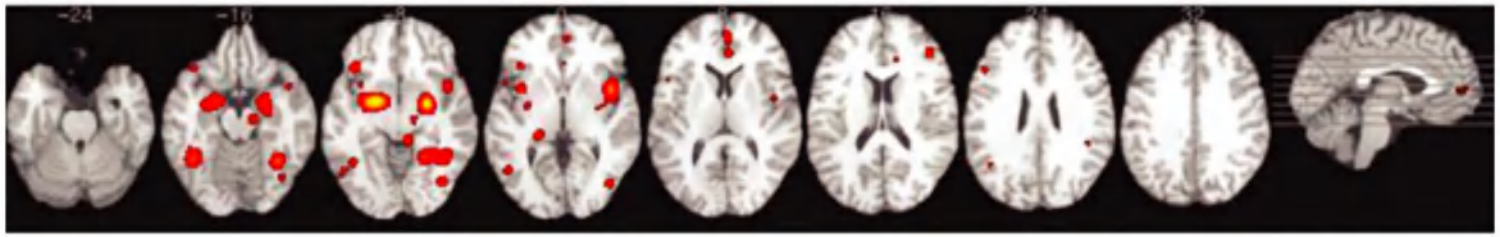
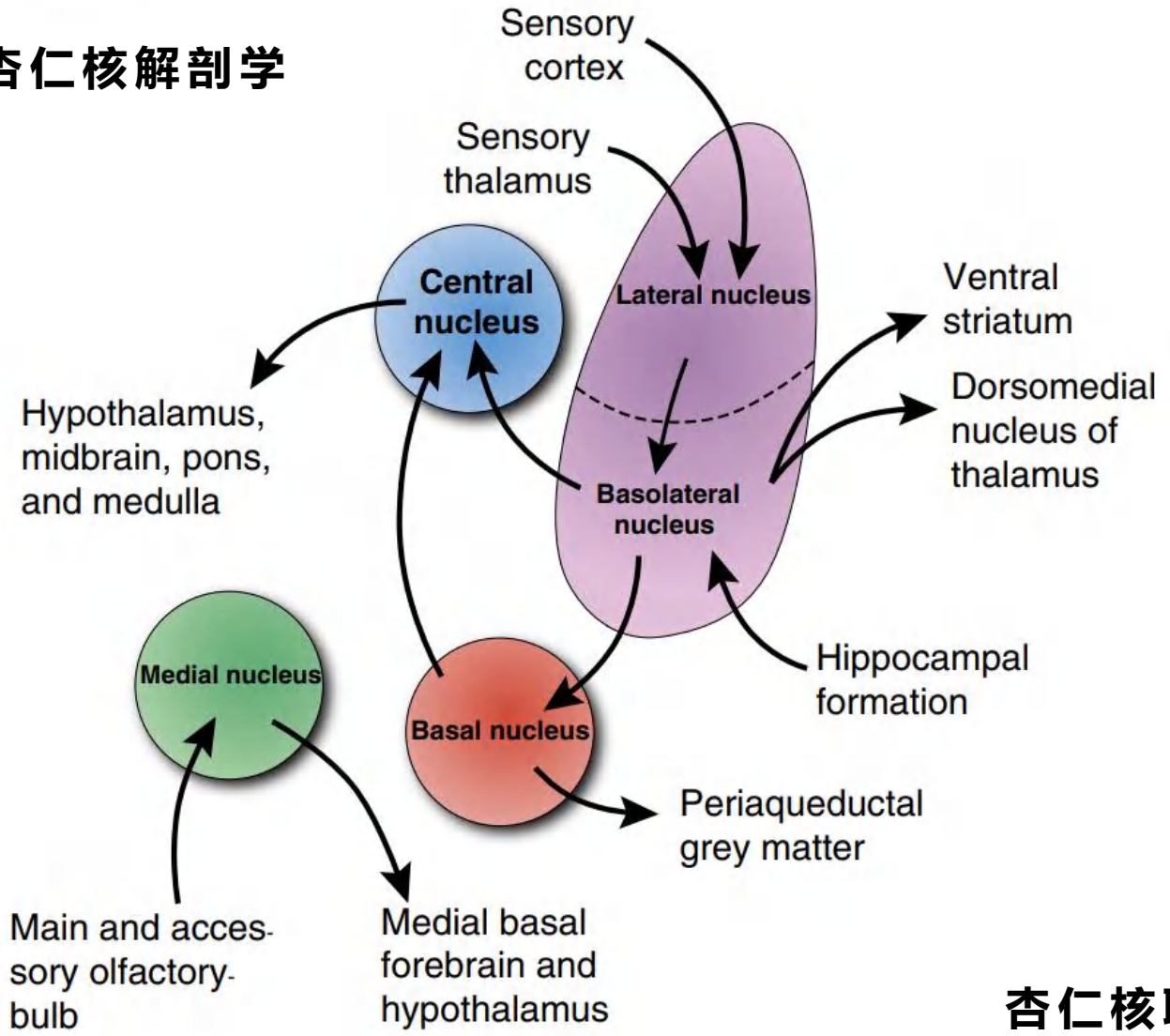




恐惧的生物学



杏仁核解剖学



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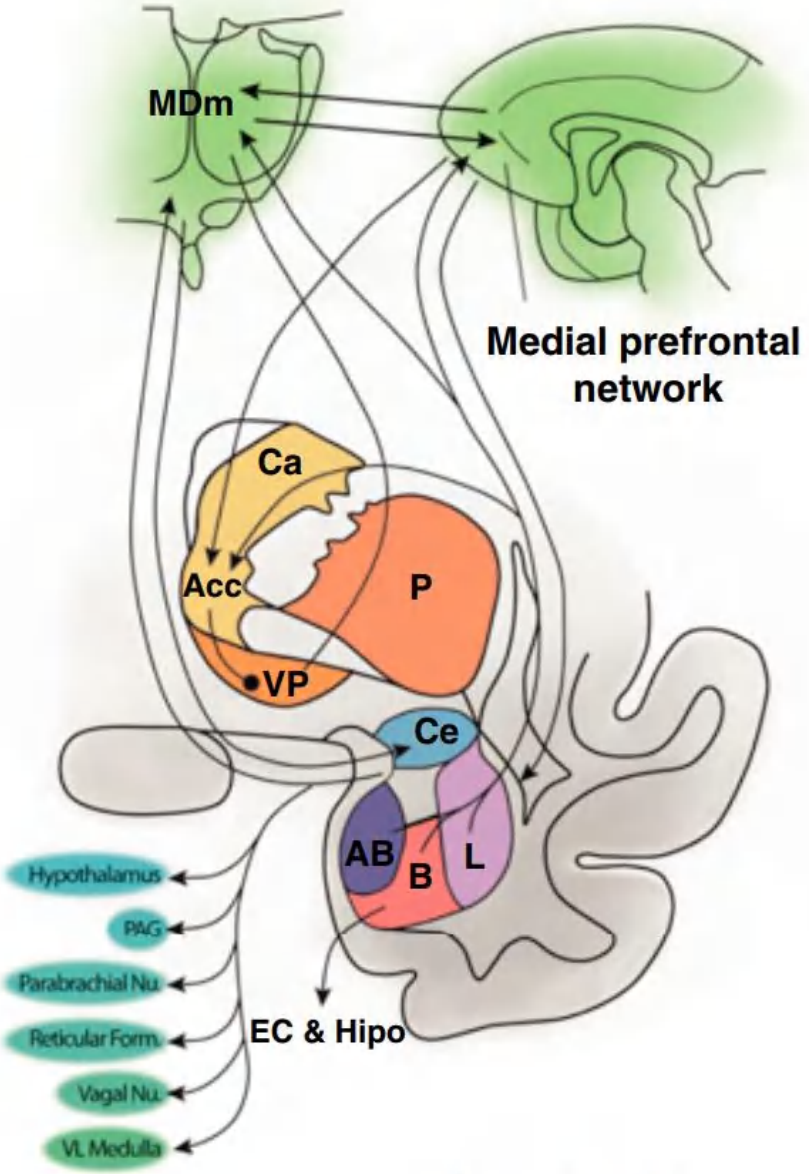


Current Biology

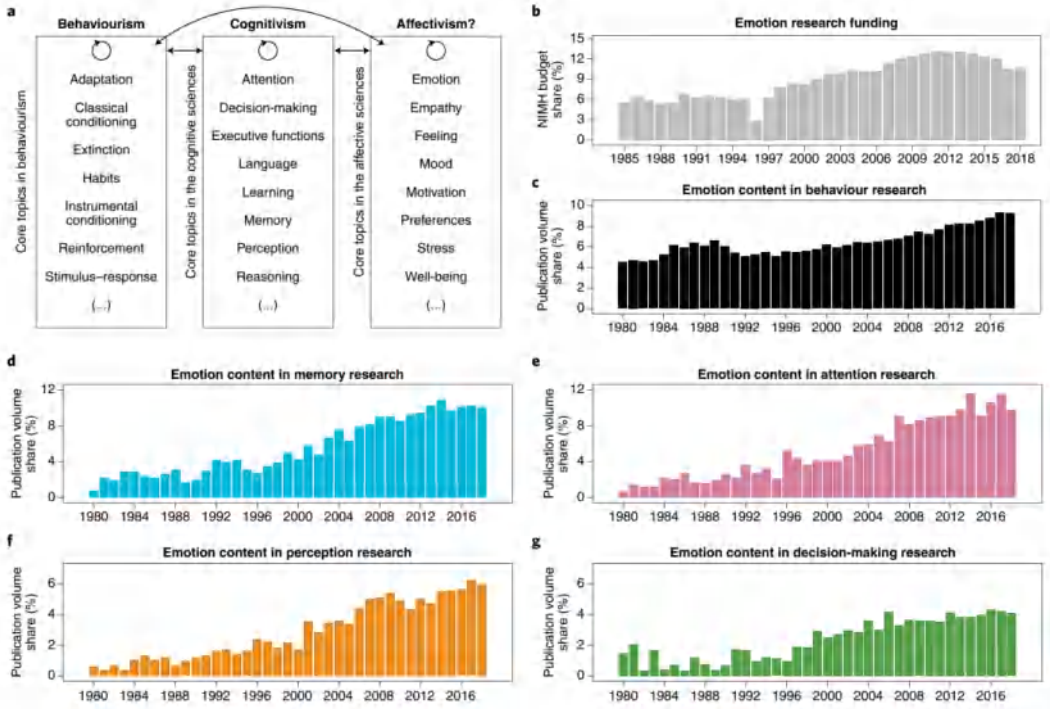
人类情感的脑科学

comment

The rise of affectivism

Research over the past decades has demonstrated the explanatory power of emotions, feelings, motivations, moods, and other affective processes when trying to understand and predict how we think and behave. In this consensus article, we ask: has the increasingly recognized impact of affective phenomena ushered in a new era, the era of affectivism?

Daniel Dukes, Kathryn Abrams, Ralph Adolphs, Mohammed E. Ahmed, Andrew Beatty, Kent C. Berridge, Susan Broomhall, Tobias Brosch, Joseph J. Campos, Zanna Clay, Fabrice Clément, William A. Cunningham, Antonio Damasio, Hanna Damasio, Justin D'Arms, Jane W. Davidson, Beatrice de Gelder, Julien Deonna, Ronnie de Sousa, Paul Ekman, Phoebe C. Ellsworth, Ernst Fehr, Agneta Fischer, Ad Foolen, Ute Frevert, Didier Grandjean, Jonathan Gratch, Leslie Greenberg, Patricia Greenspan, James J. Gross, Eran Halperin, Arvid Kappas, Dacher Keltner, Brian Knutson, David Konstan, Mariska E. Kret, Joseph E. LeDoux, Jennifer S. Lerner, Robert W. Levenson, George Loewenstein, Antony S. R. Manstead, Terry A. Maroney, Agnes Moors, Paula Niedenthal, Brian Parkinson, Ioannis Pavlidis, Catherine Pelachaud, Seth D. Pollak, Gilles Pourtois, Birgitt Roettger-Roessler, James A. Russell, Disa Sauter, Andrea Scarantino, Klaus R. Scherer, Peter Stearns, Jan E. Stets, Christine Tappolet, Fabrice Teroni, Jeanne Tsai, Jonathan Turner, Carien Van Reekum, Patrik Vuilleumier, Tim Wharton and David Sander



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神经影像大数据与心脑关联：方法学框架与应用

杨志*，左西年*

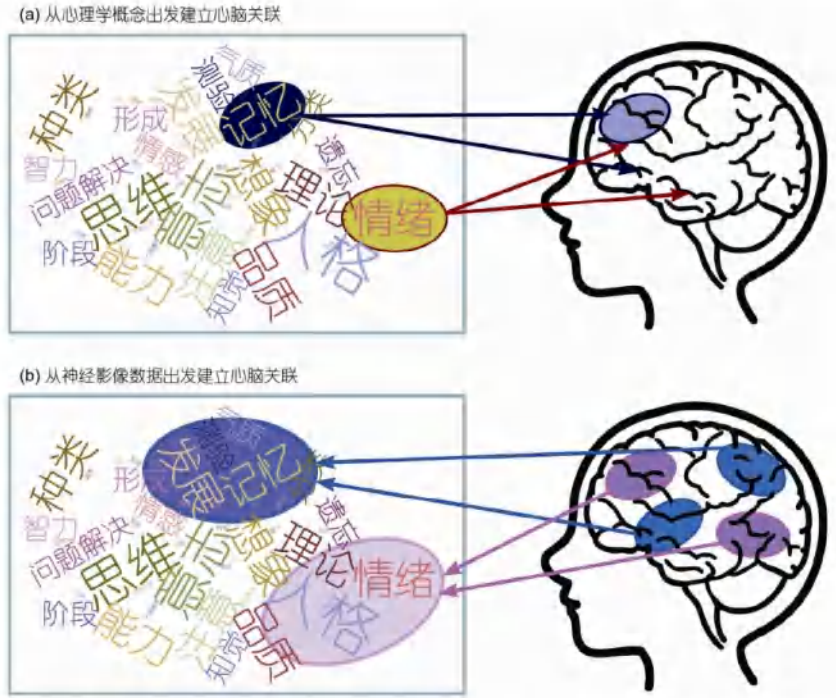
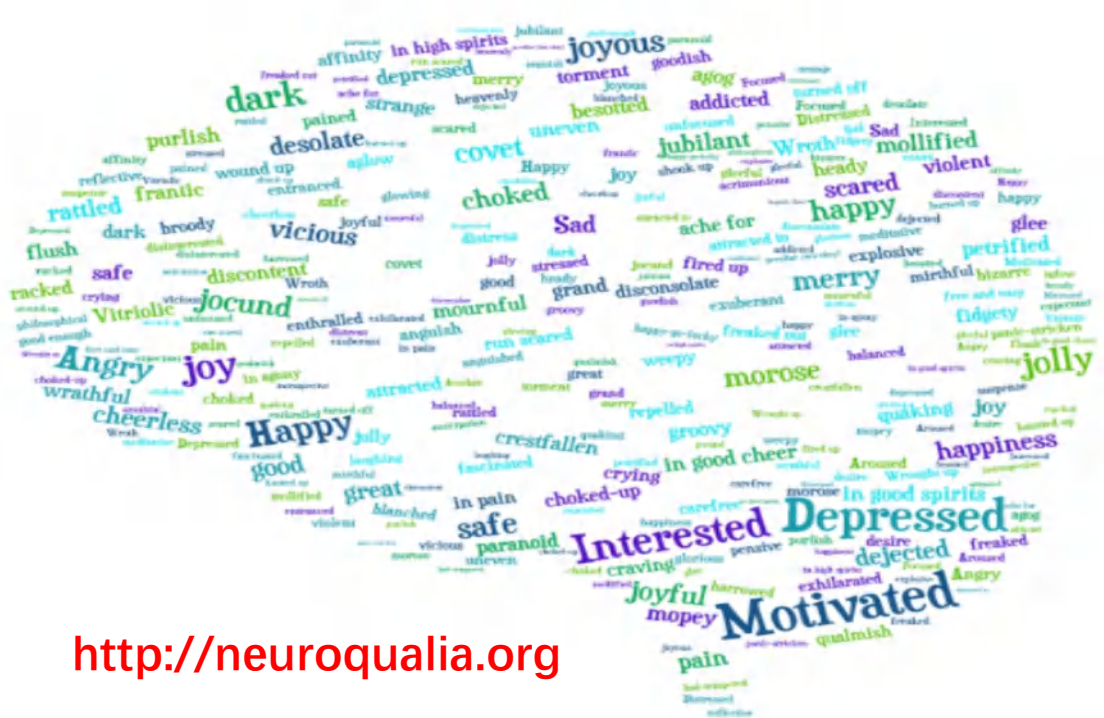


图 1 两种心脑关联的研究策略. (a) 传统的心脑关联研究策略: 从现有心理学概念出发, 检验与心理学概念关联的脑活动特征; (b) 以脑为中心的心脑关联研究策略: 从脑功能网络出发, 检验与脑功能网路关联的心智、行为特征集合

The Human Affectome Project

A global multidisciplinary collaboration in affective neuroscience

人类情感组项目



http://neuroqualia.org

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Review article

The Human Affectome Project: A dedication to Jaak Panksepp

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Affect
Human affectome

ABSTRACT

Mapping the neural basis of the Affectome was certainly the goal of Jaak Panksepp as he extended the work of a long line of thinkers from William James to Paul Maclean. Jaak's contribution was not just an incremental step, but a move to embrace feelings as a key component of affective science. His goal was to develop objective behavioral measures as he identified the neural substrates associated with affective states. He dedicated his career to studying the biological roots of emotional operating systems and his 1998 book "Affective Neuroscience" stands as a seminal accomplishment that provided a foundation for a field of research that has flourished since. His influences can be seen in many of the reviews created for this project and his early references to comfort zones are central to the human affectome. Indeed, Jaak was a tireless investigator who challenged our thinking, and he gave us many insights and gifts. We are immensely grateful for his contributions and this special issue is dedicated to his memory.

WordNet-feelings: A linguistic categorisation of human feelings

Advaith Siddharthan · Nicolas Cherbuin · Paul J. Eslinger · Kasia Kozlowska · Nora A. Murphy · Leroy Lowe

The computational linguistics effort involved an automated search of over 4.5 million English books containing close to half a trillion words (Siddharthan et al., 2018). The taskforce was then asked to review and categorize 11,386 word "senses" (a word sense is one of the meanings of a word), which resulted in a new affective dataset comprised of 3664 word senses (feelings). An initial list of 14 categories was created based on consultation with the literature. A group of 107 scientists received a subset of words each, and assigned each word sense to a category. When disagreement between at least two annotators emerged, the disagreement was resolved by merging or renaming categories. The process continued until each word sense is reliably assigned to a single category

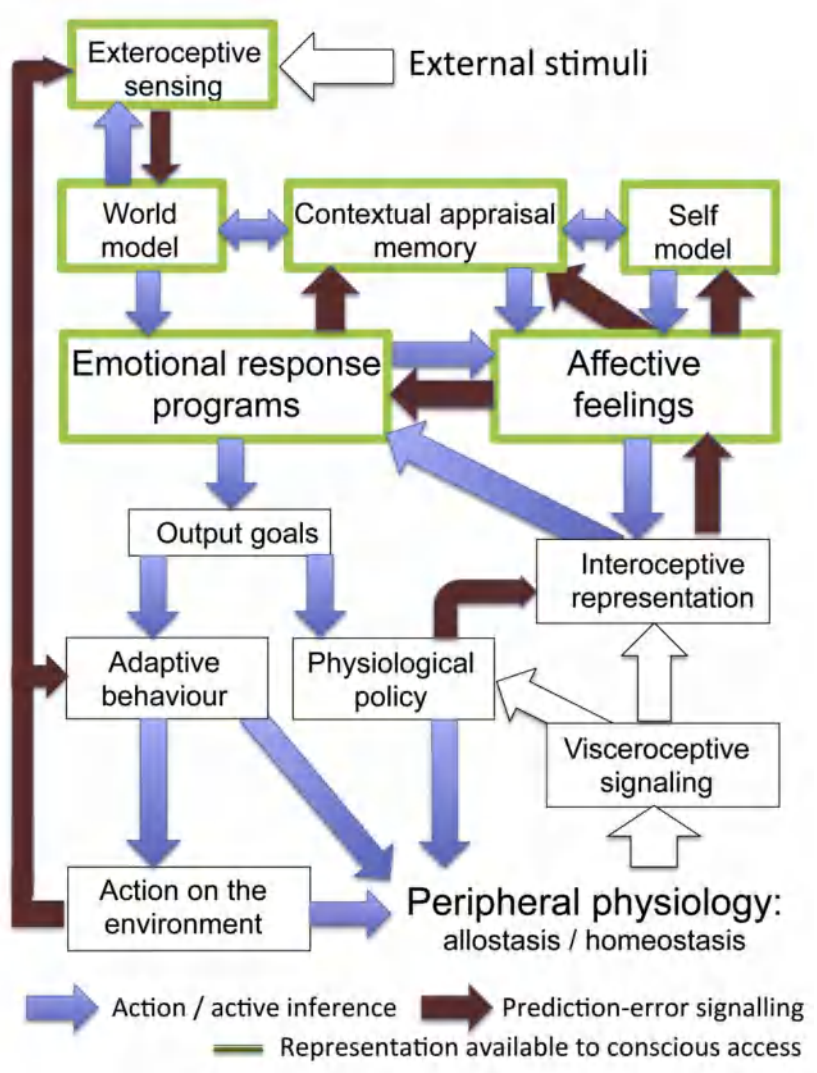
Reviews	Linguistics categories
1) Physiological	1) Physiological
2) Self	2) Self
3) Social	3) Social
4) Actions	4) Actions/Prospects
5) Anticipatory	
6) Fear	
7) Attention	5) Attention
8) Hedonics	6) Hedonics
9) Motivation	7) Attraction/Repulsion
10) Anger	8) Anger
11) Happiness	9) General Wellbeing
12) Sadness	

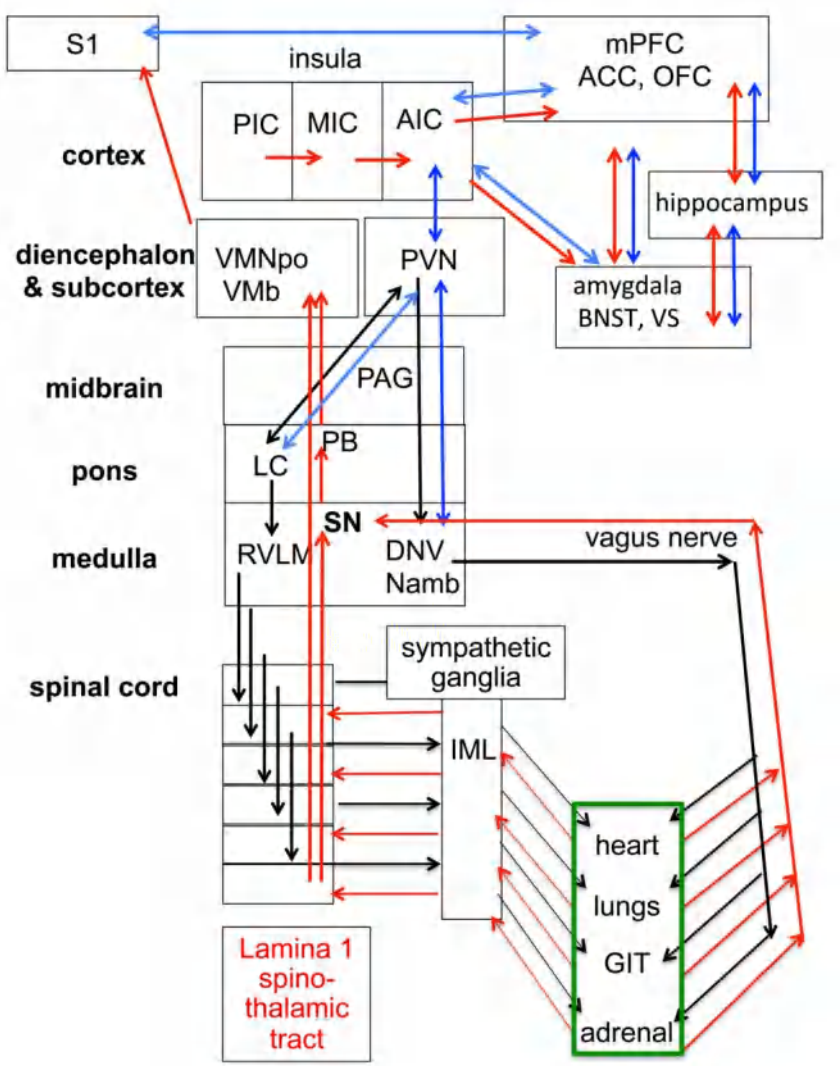
Category	Scope
Physiological or Bodily states (`Physio`)	Feelings related to specific physiological/bodily states (e.g.hungry,warm,nauseus) include feelings that relate to the current status of mental function (e.g.dizzy, forgetful, etc.) and feelings related to energy levels (e.g. vital, tired). However this category does not include levels of arousal (e.g., excited, relaxed, etc.)
Attraction and Repulsion (`Attract`)	Feelings of attraction (e.g. love, attracted, hooked, etc.) or repulsion (e.g. dislike, disgusted, etc)
Attention (`Attent`)	Feelings related to focus, attention or interest (e.g. interested, curious, etc), or the lack of focus, attention or interest (e.g. uninterested, apathetic, etc)
Social (`Social`)	Feelings related to the way a person interacts with others (e.g, accepting, ungrateful, etc.), feelings related to the way others interact with that person (e.g. appreciated, exploited, trusted, etc.), or feelings of one person for or towards others (e.g. sympathy, pity, etc.) that are not covered by other categories (specifically, does not include feelings of Anger, Fear, Attraction or Repulsion).
Actions and Prospects (`Action`)	Feelings related to goals, tasks and actions (e.g. purpose, inspired), including feelings related to planning of actions or goals (e.g., ambitious), feelings related to readiness and capacity of planned actions (e.g. ready, daunted), feelings related to levels of arousal, typically involving changes to heart rate, blood pressure, alertness, etc., physical and mental states of calmness and excitement (e.g. relaxed, excited, etc.), feelings related to a person's approach, progress or unfolding circumstances as it relates to tasks/goals within the context of the surrounding environment (e.g. organized, overwhelmed, surprised, cautious, etc.), feelings related to prospects (e.g. afraid, anxious, hopeful, tense, etc.). This category does not include feelings pertaining to Attention, (e.g. curious), Physiological energy levels (e.g. refreshed), or Social feelings that reflect attitudes towards others.
Hedonics (`Hedon`)	Feelings that relate to pleasurable and painful sensations and states of mind, where pleasurable includes milder feelings related to comfort and pleasure (e.g. comfortable, soothed, etc.) and painful likewise includes feelings related to discomfort and suffering (e.g.suffering, uncomfortable, etc.) in addition to pain. This category does not include feelings of Anger, Fear, Attraction, Repulsion or General Wellbeing
Anger (`Anger`)	All forms of anger, directed towards self, others or objects / events (e.g. rage, anger, etc).
General Well-Being (`Well`)	Feelings that relate to whether or not someone is happy, content, or sad. Feelings of general wellness that refer in a non-specific way to how someone is feeling overall (e.g. great, good, okay, fine, bad, terrible, etc.). If someone used one of these general overarching terms to describe their overall wellness, further questions would be needed to uncover the underlying (more specific) feelings that are contributing to their overall assessment of their general wellness. This category is only for "general" terms and should not be used when a more specific category applies.
Other (`Other`)	If none of the above categories apply, but nonetheless, the sentence "I feel X[ed]" is plausible for the given word sense. This category includes feelings related to appraisals of the self with respect to categories such as: size (e.g. big, etc.), weight (e.g. fat, etc.), age (e.g. old, etc.), gender (e.g. masculine, etc.), fitness (e.g. unfit, etc.), intelligence (e.g. smart, etc.), attractiveness (e.g. beautiful, etc.), dress and adornment (e.g. fashionable, etc.) uniqueness (e.g. unremarkable, etc.), general normality (e.g. weird, etc.) self-esteem (e.g. self-loathing, etc.) identity and belonging (e.g. Buddhist, American)
Not a feeling (`Not`)	This category is only to be used when the working definition of a feeling does not apply to this word sense, neither "I feel X[ed]" nor "I have a feeling of X" is plausible for the given word sense, and none of the above categories fit either. Note that this is expected to be a common case as the words you annotate can have many different senses and not all (or indeed any) need to be feelings.

continued ...

Physiological Category

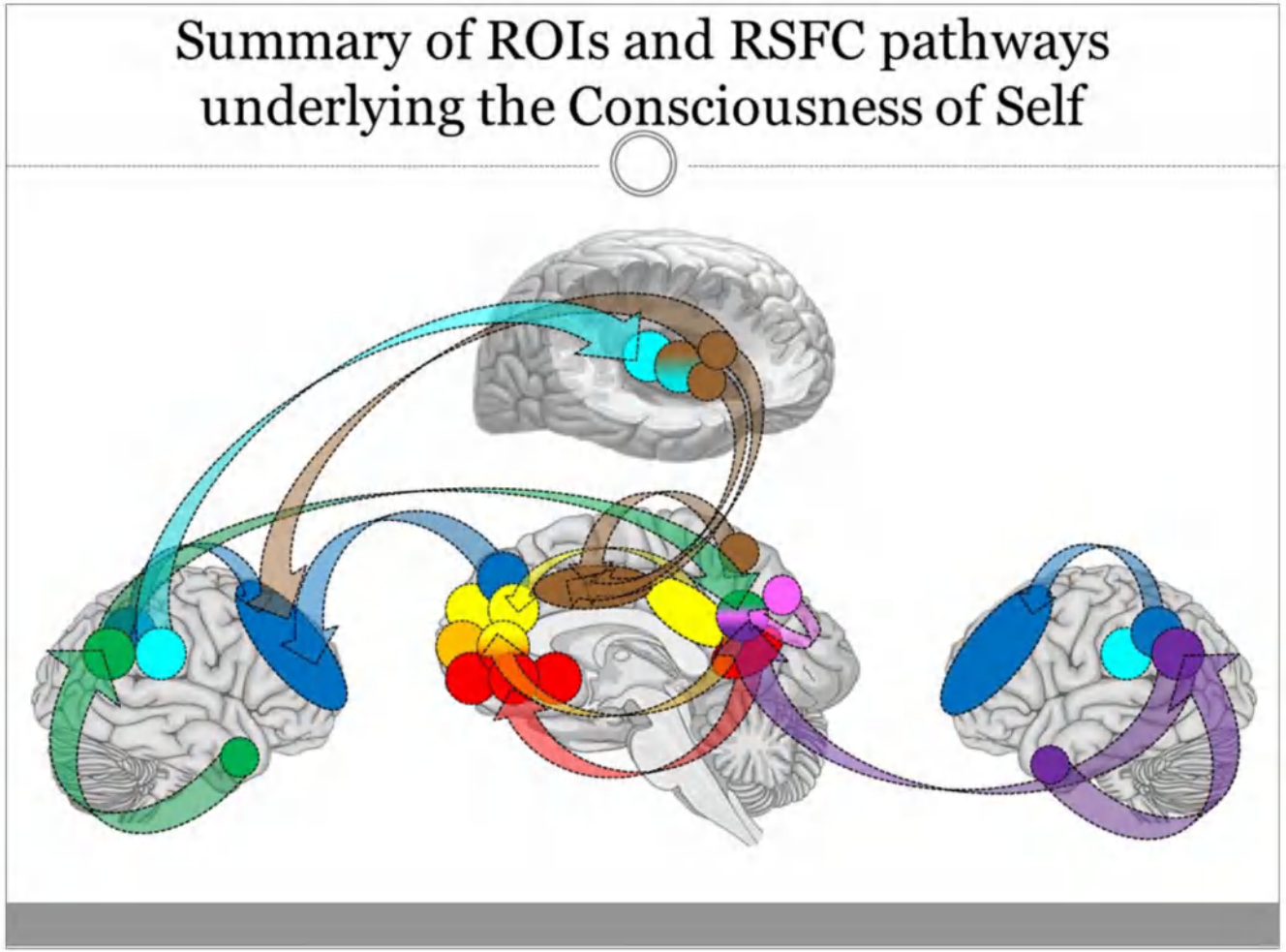
情绪反应程序及情感意识获取系统

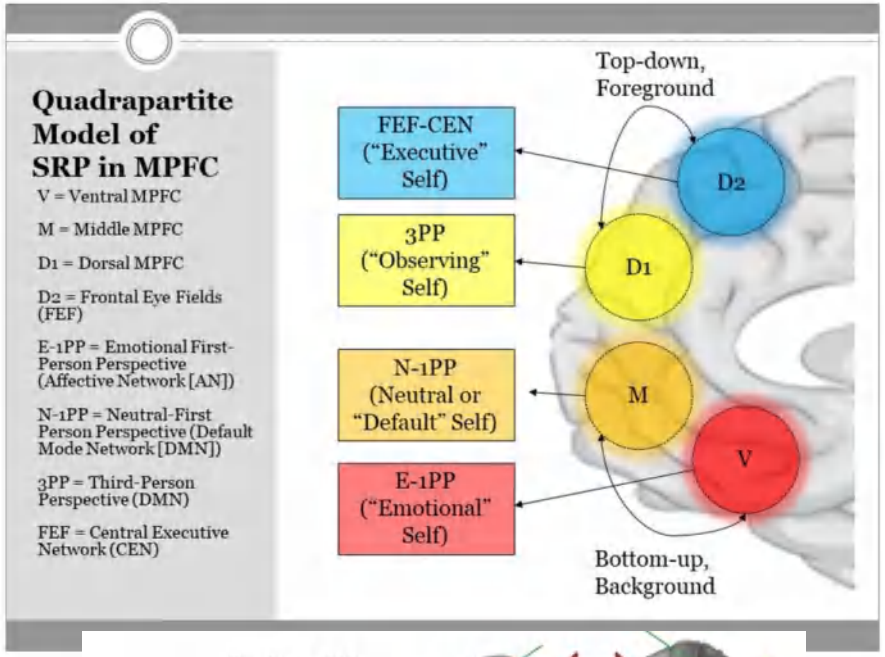


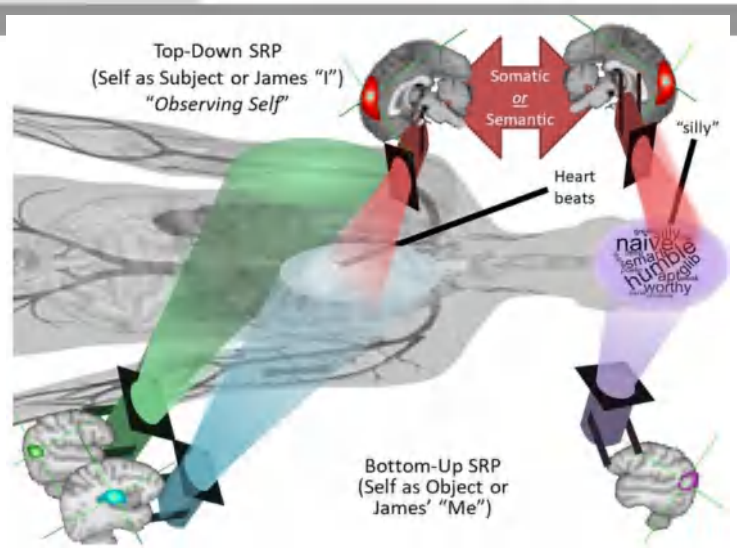


内感受与情绪环路

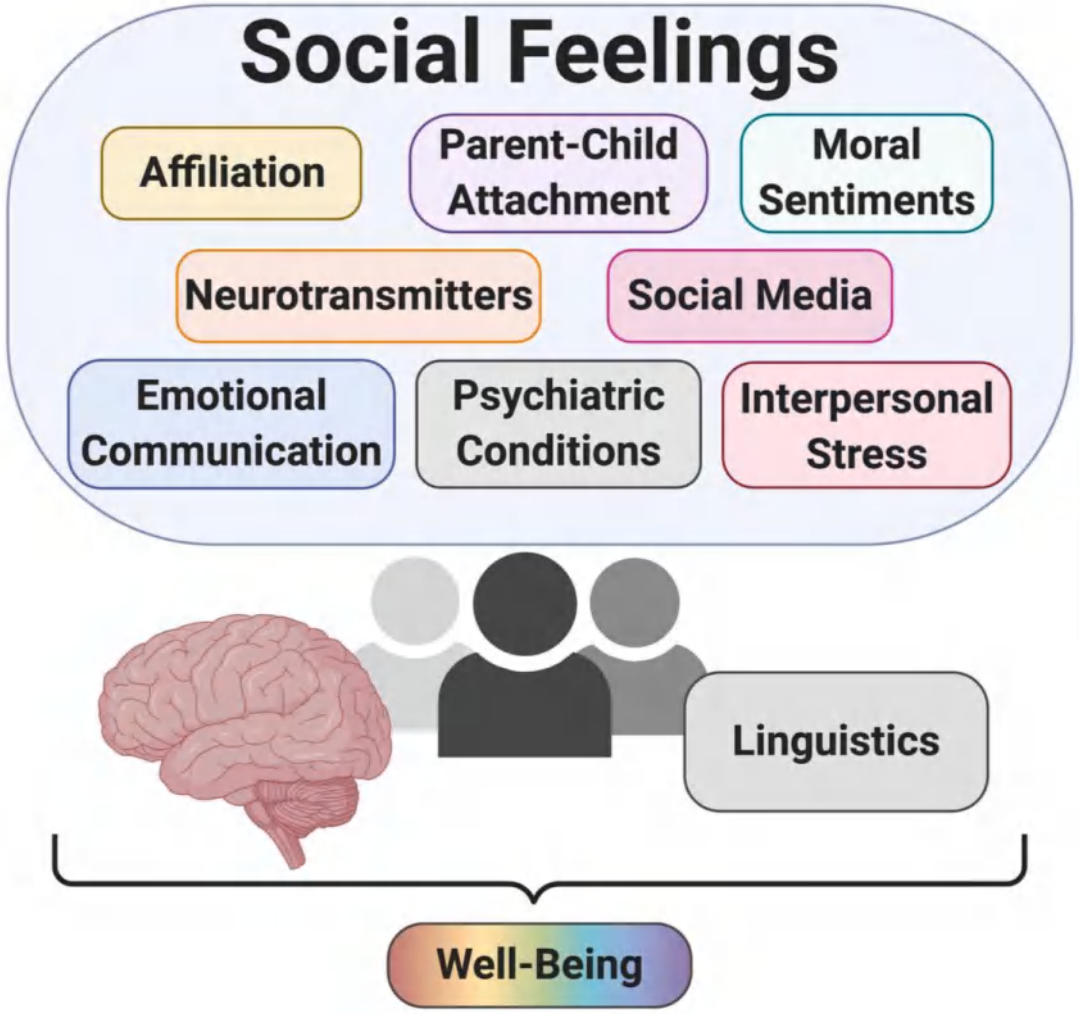
Self Category

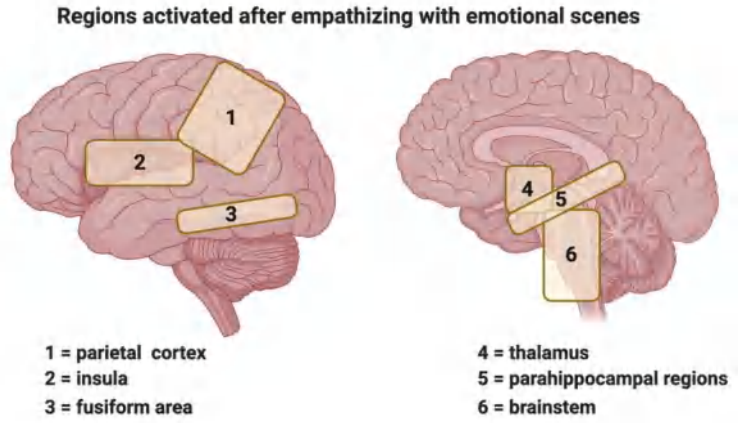


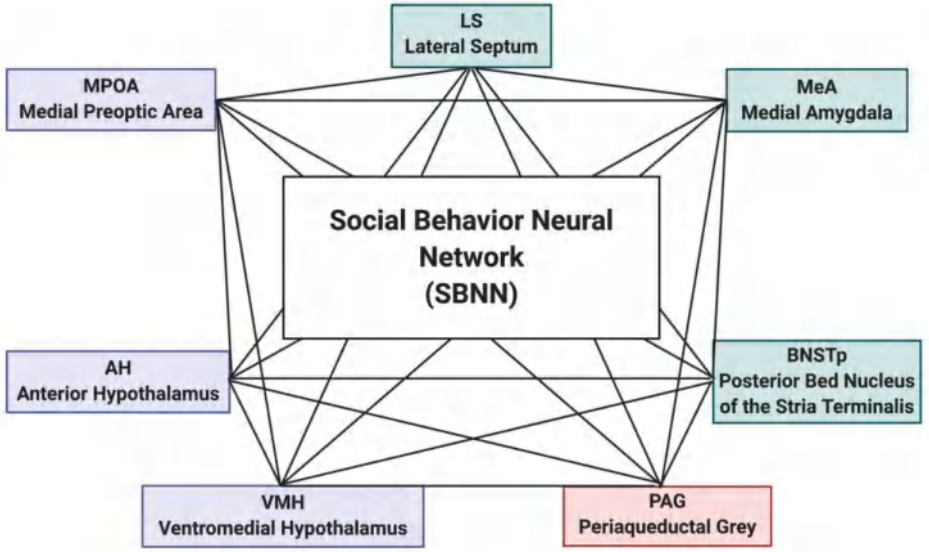




Social Category

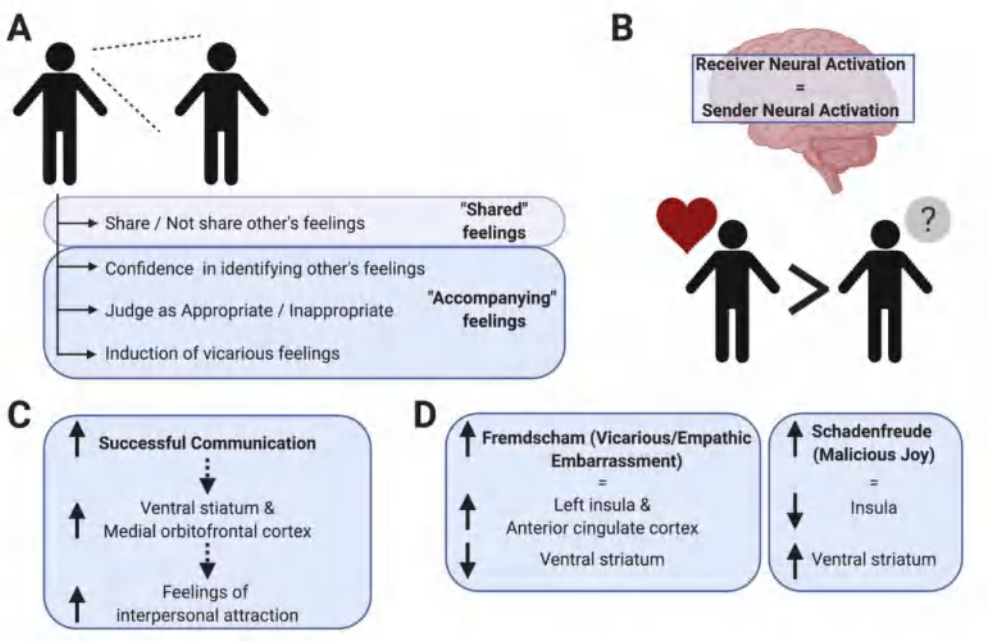






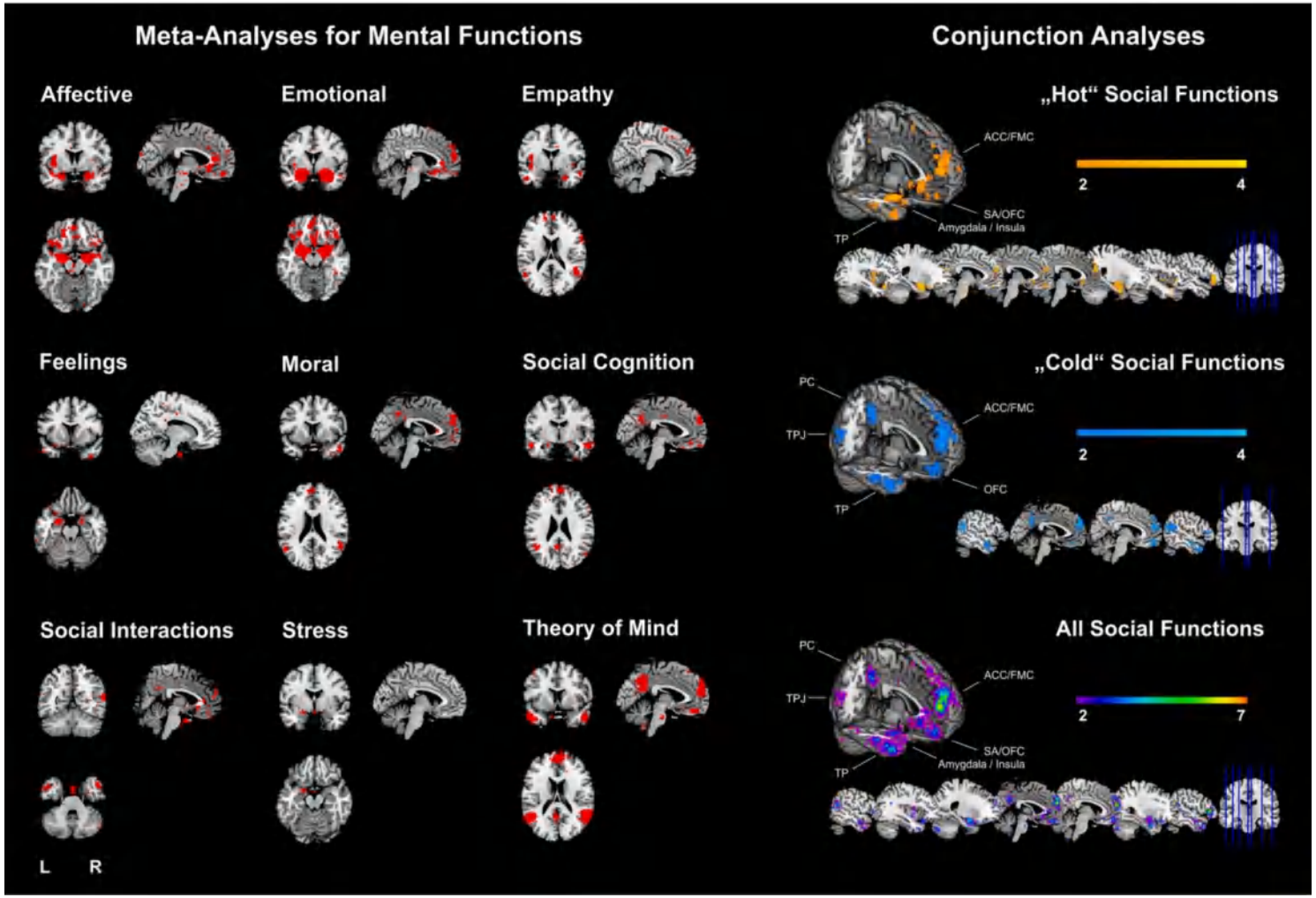
Social Category

情绪沟通的脑活动



Anatomical Region	Stress	Affective	Emotional	Feelings	Empathy	Social Cognition	Social Inter-actions	Moral	Theory Mind
	"Hot" emotional-affective social functions					*"Cool" cognitive social functions*			
Frontomedian cortex		X	X	X	X	X	X	X	X
Anterior cingulate cortex		X	X	X	X	X	X	X	X
Subcallosal area		X	X	X		X	X		X
Frontolateral cortex			X		X	X	X		X
Orbitofrontal cortex		X	X	X	X	X	X	X	X
Insula		X	X	X	X		X	X	X
Temporo-parietal junction					X	X	X	X	X
Temporal pole				X	X	X	X	X	X
Precuneus				X	X	X	X	X	X
Globus pallidus			X						
Amygdala	X	X	X	X	X	X	X		
Midbrain		X	X		X	X	X		
Pituitary Gland	X				X		X		
Mammillary bodies	X								

Social Category



From journal articles to computational models: a new automated tool

ARTICLES

neurosynth.org

Large-scale automated synthesis of human functional neuroimaging data

Tal Yarkoni[1], Russell A Poldrack[2–4], Thomas E Nichols[5,6], David C Van Essen[7] & Tor D Wager[1]

The rapid growth of the literature on neuroimaging in humans has led to major advances in our understanding of human brain function but has also made it increasingly difficult to aggregate and synthesize neuroimaging findings. Here we describe and validate an automated brain-mapping framework that uses text-mining, meta-analysis and machine-learning techniques to generate a large database of mappings between neural and cognitive states. We show that our approach can be used to automatically conduct large-scale, high-quality neuroimaging meta-analyses, address long-standing inferential problems in the neuroimaging literature and support accurate 'decoding' of

analyses[1], our framework is fully automated and allows rapid and scalable synthesis of the neuroimaging literature. We show that this framework can be used to generate large-scale meta-analyses for hundreds of broad psychological concepts; support quantitative inferences about the consistency and specificity with which different cognitive processes elicit regional changes in brain activity; and decode and classify broad cognitive states in new data solely on the basis of observed brain activity.

RESULTS

Overview

Figure 1 | Automated machine-learning–based meta-analysis of fMRI data. A computer scans thousands of journal articles for a specific keyword or phrase a researcher is interested in (such as 'working memory') and computes a map of the brain showing the probability of any region being associated with it.

Actions Category

A sensorimotor control framework for understanding emotional communication and regulation

Justin H.G. Williams, Charlotte F. Huggins, Barbra Zupan, Megan Willis, Tamsyn E Van Rheenen, Wataru Sato, Romina Palermo, Catherine Ortner, Martin Krippl, Mariska Kret, Joanne M. Dickson, Chiang-shan R. Li, Leroy Lowe

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Facial expression
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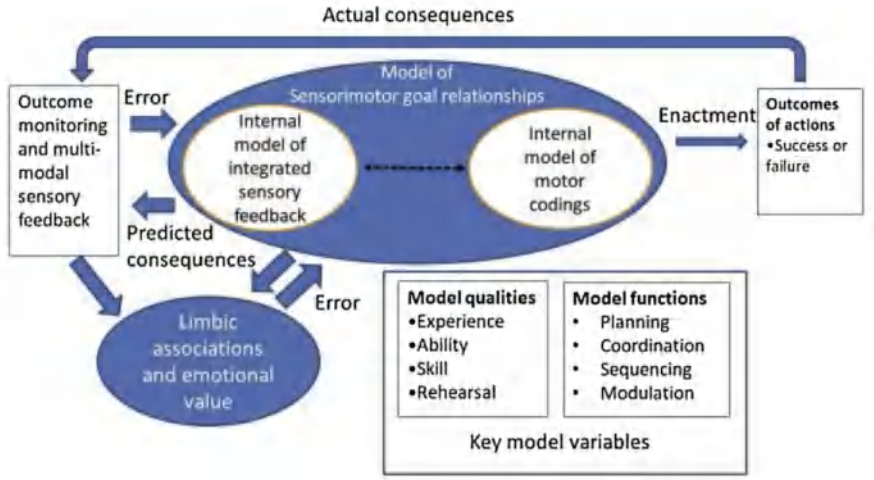
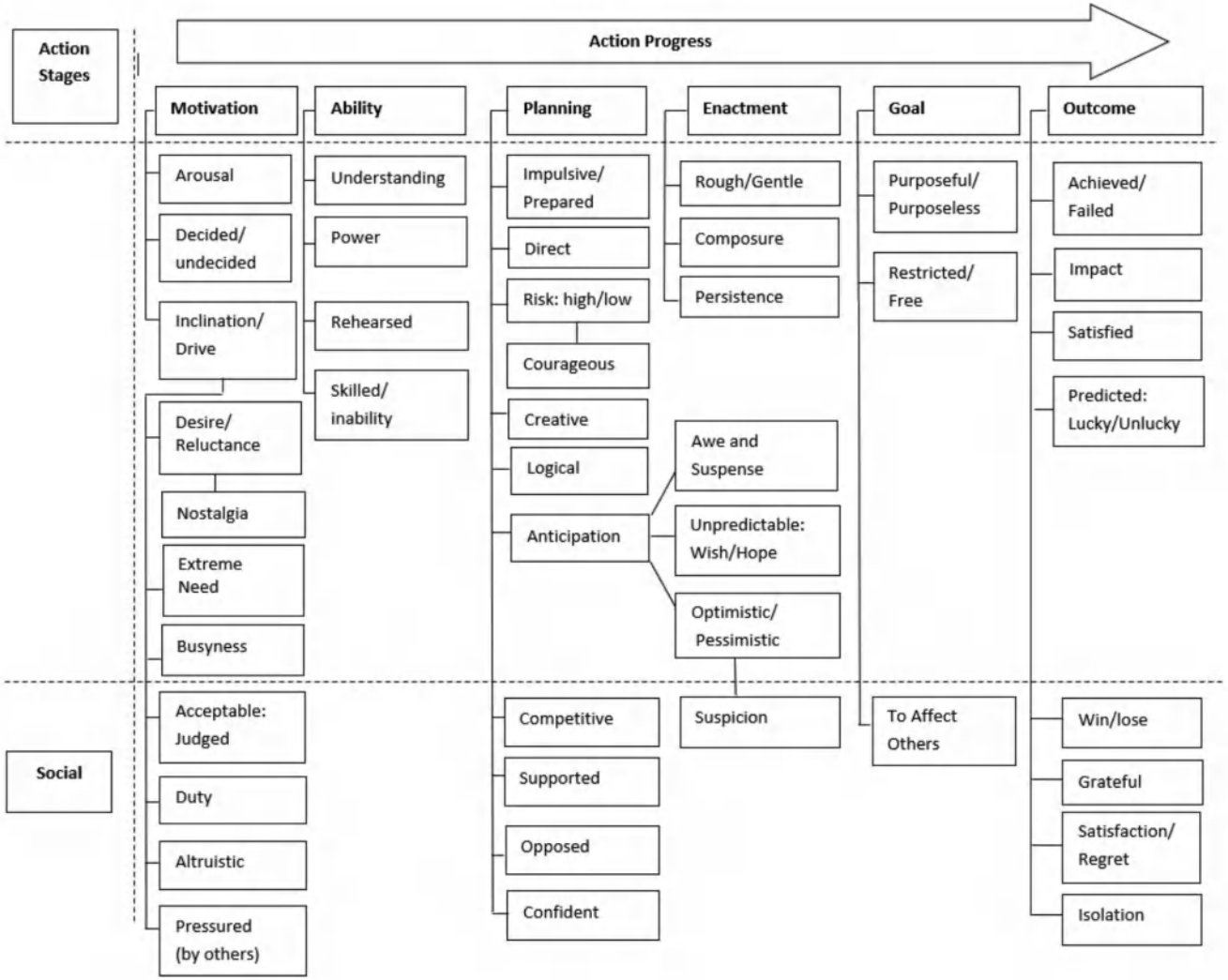
Planning
Linguistics
Emotion regulation
Cognitive appraisal
Embodied cognition
Mirror neurons

ABSTRACT

Our research team was asked to consider the relationship of the neuroscience of sensorimotor control to the language of emotions and feelings. Actions are the principal means for the communication of emotions and feelings in both humans and other animals, and the allostatic mechanisms controlling action also apply to the regulation of emotional states by the self and others. We consider how motor control of hierarchically organised, feedback-based, goal-directed action has evolved in humans, within a context of consciousness, appraisal and cultural learning, to serve emotions and feelings. In our linguistic analysis, we found that many emotion and feelings words could be assigned to stages in the sensorimotor learning process, but the assignment was often arbitrary. The embodied nature of emotional communication means that action words are frequently used, but that the meanings or senses of the word depend on its contextual use, just as the relationship of an action to an emotion is also contextually dependent.





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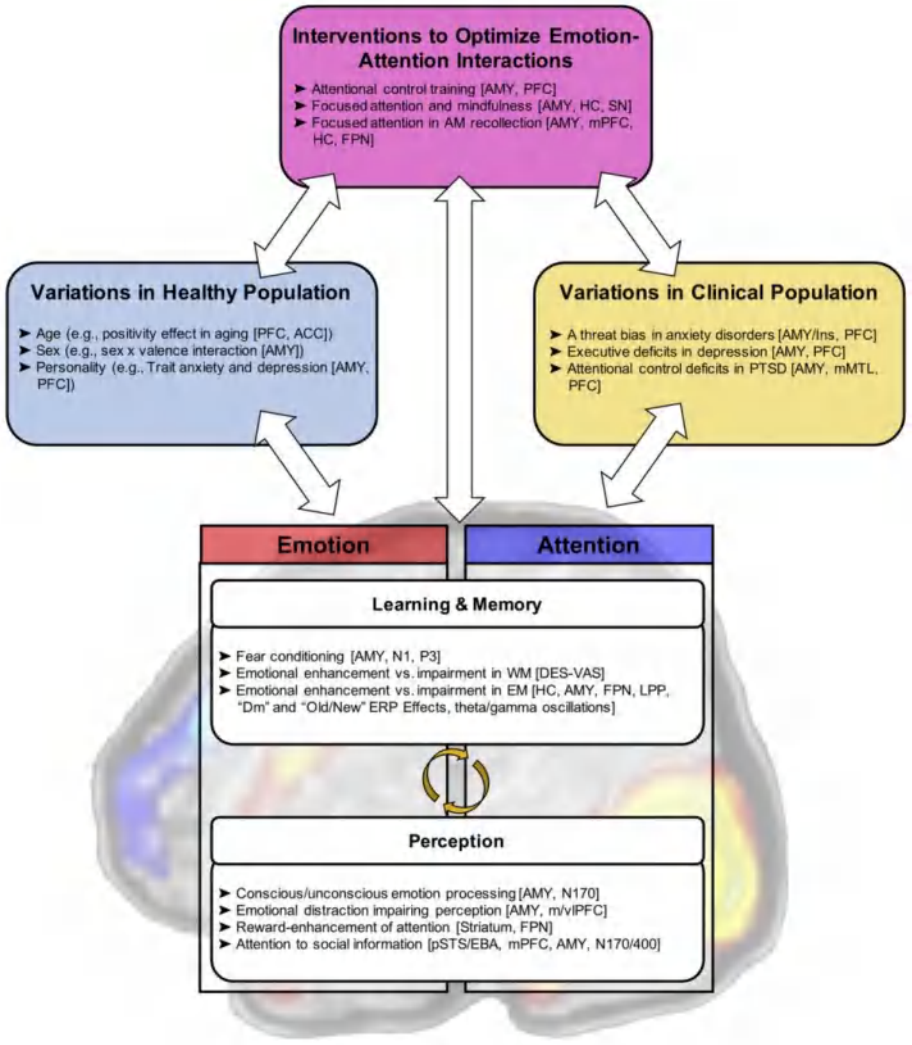

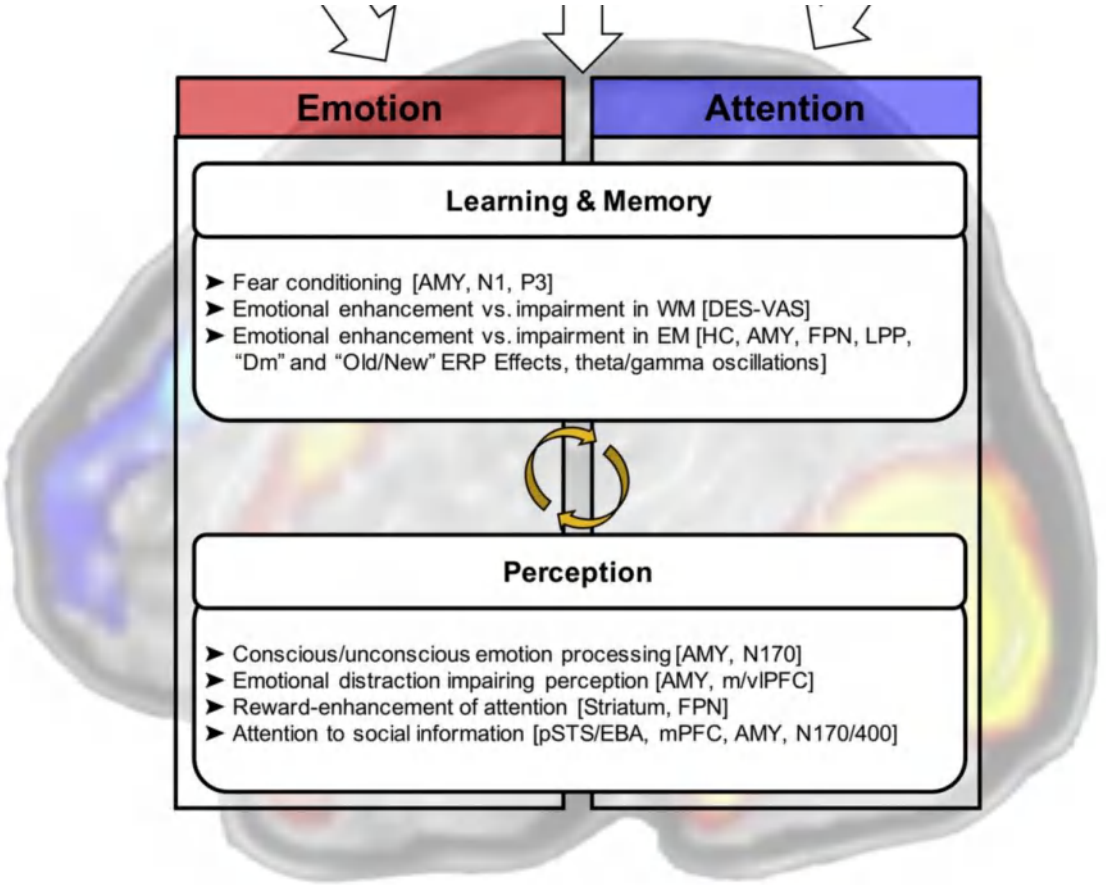

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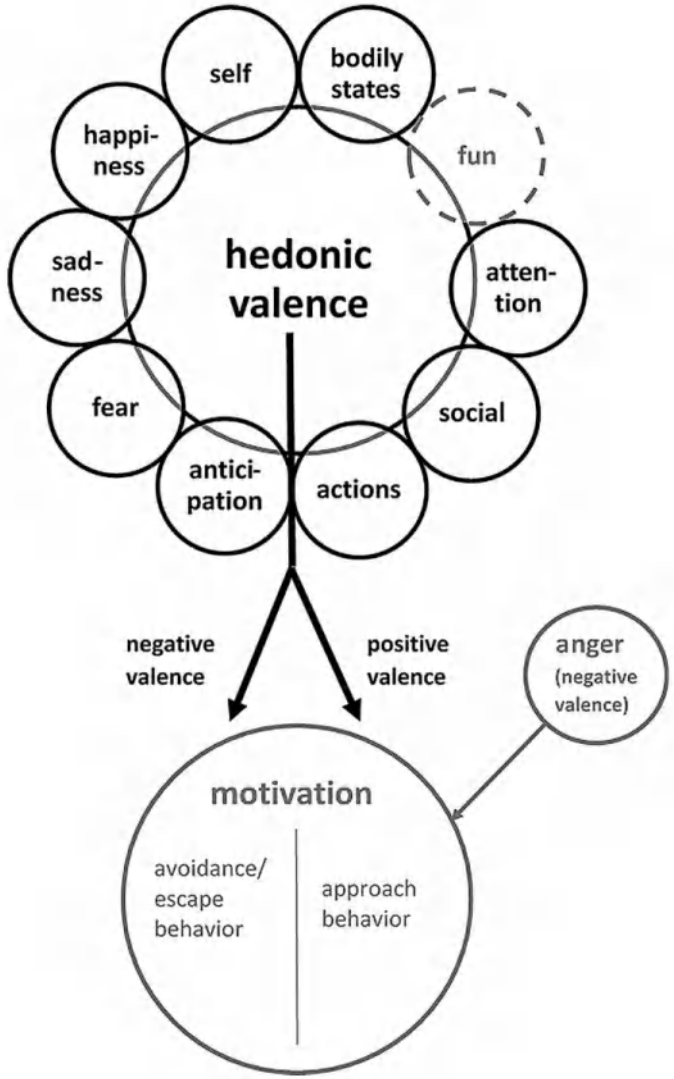

The role of hedonics in the Human Affectome

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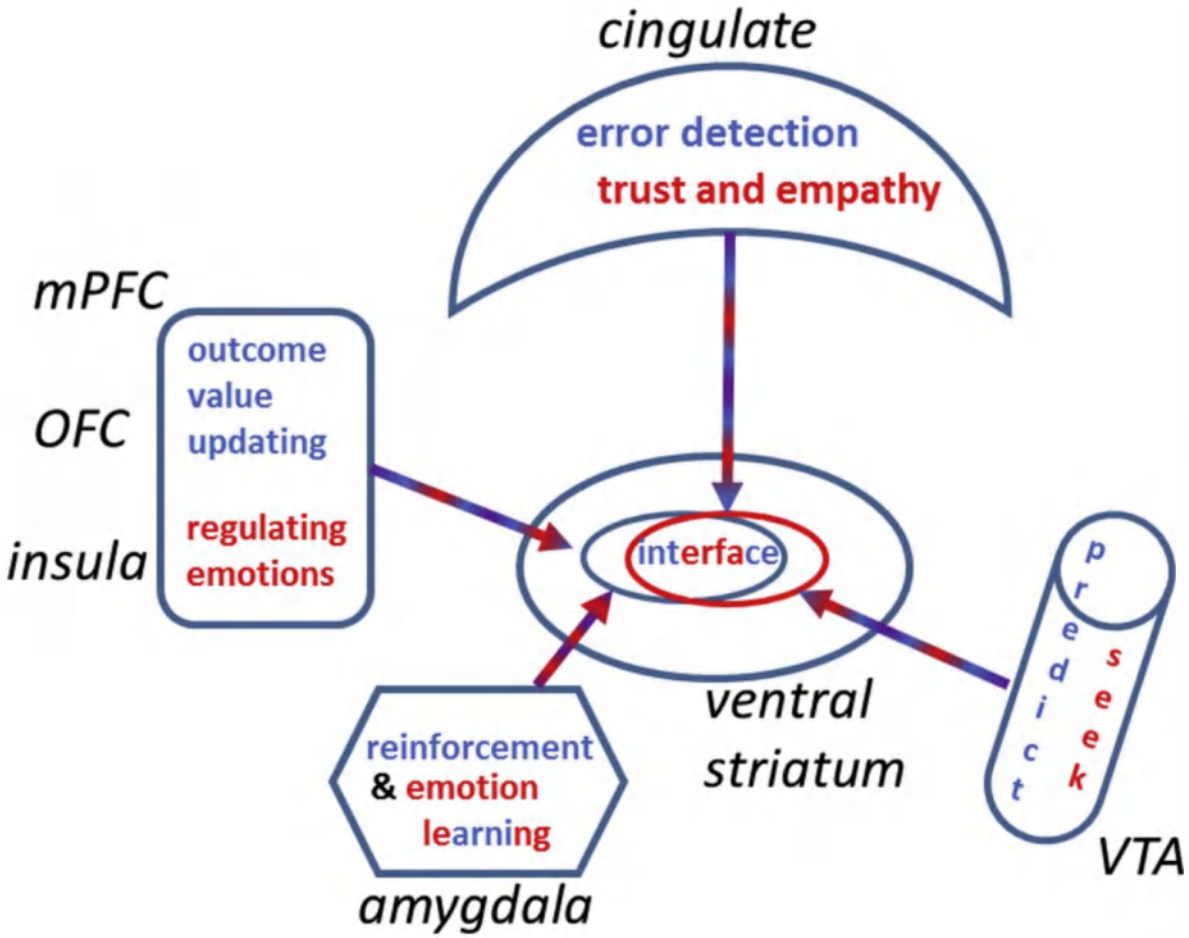
ARTICLE INFO

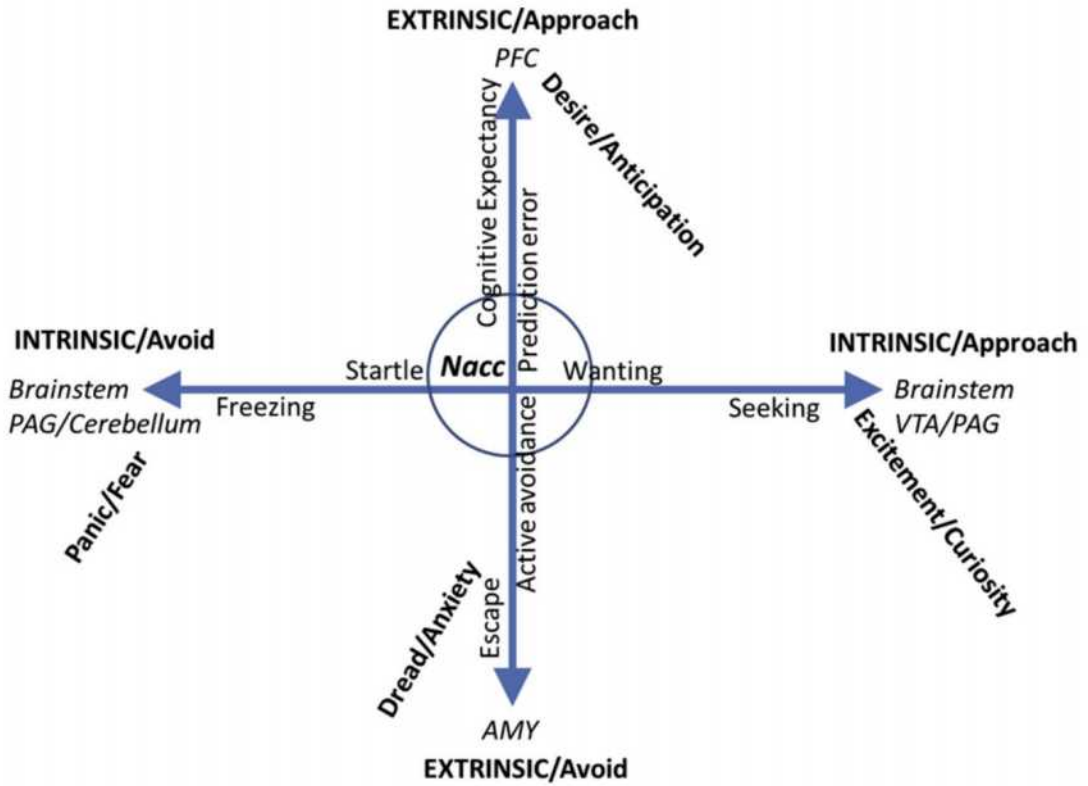
Keywords:
Pleasure
Displeasure
Reward
Pain
Valence
Nucleus accumbens
Ventromedial prefrontal cortex
Orbitofrontal cortex

ABSTRACT

Experiencing pleasure and displeasure is a fundamental part of life. Hedonics guide behavior, affect decision-making, induce learning, and much more. As the positive and negative valence of feelings, hedonics are core processes that accompany emotion, motivation, and bodily states. Here, the affective neuroscience of pleasure and displeasure that has largely focused on the investigation of reward and pain processing, is reviewed. We describe the neurobiological systems of hedonics and factors that modulate hedonic experiences (e.g., cognition, learning, sensory input). Further, we review maladaptive and adaptive pleasure and displeasure functions in mental disorders and well-being, as well as the experience of aesthetics. As a centerpiece of the *Human Affectome Project*, language used to express pleasure and displeasure was also analyzed, and showed that most of these analyzed words overlap with expressions of emotions, actions, and bodily states. Our review shows that hedonics are typically investigated as processes that accompany other functions, but the mechanisms of hedonics (as core processes) have not been fully elucidated.

Motivation Category





Motivation Category

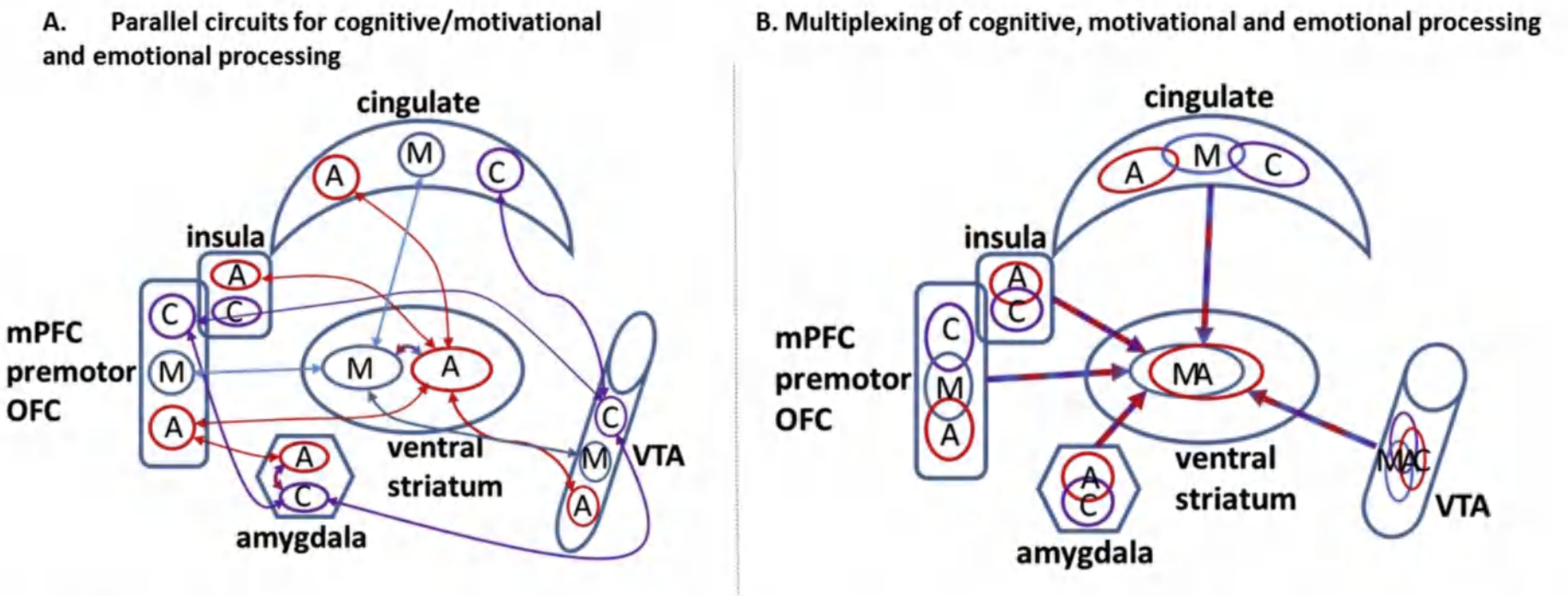
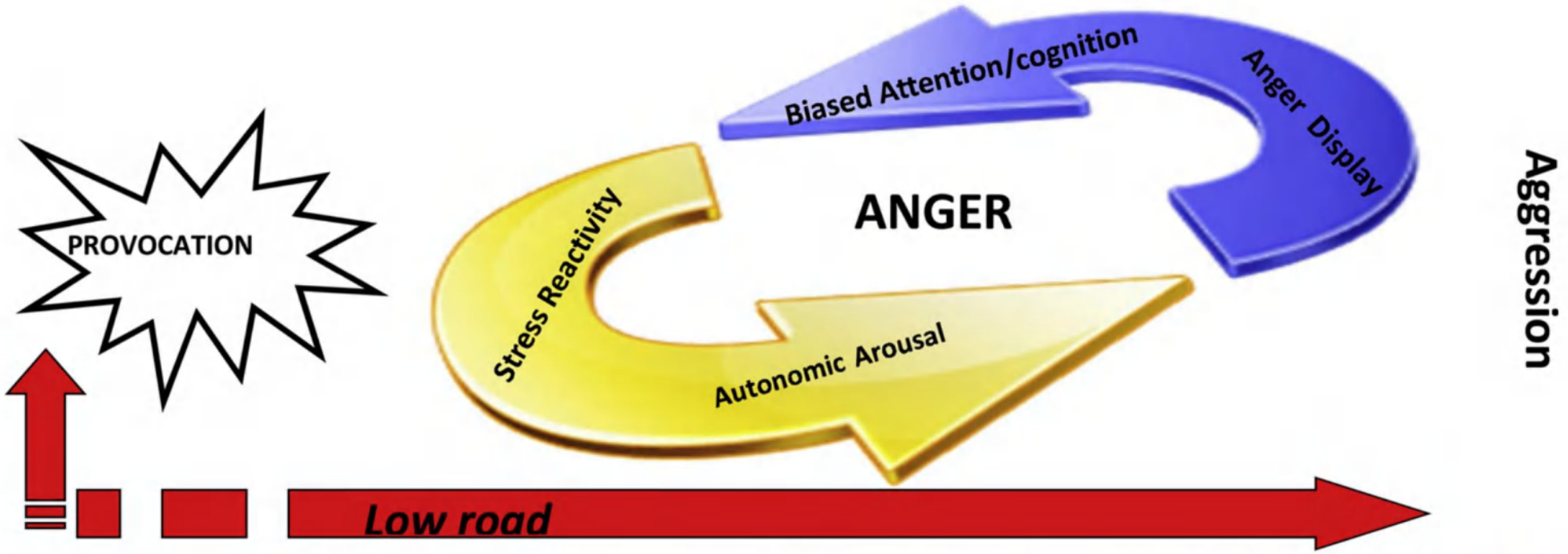


Fig. 6. Models of cognitive (C), motivational (M) and affective (A) integration within key brain regions including medial prefrontal cortex (mPFC), premotor cortex, orbitofrontal cortex (OFC), insula, cingulate, amygdala, ventral striatum and ventral tegmental area (VTA). A. A depiction of parallel pathways for cognitive, motivational and emotional processing. Heterogeneous cell groups are primarily involved leading to an independence of functioning within forebrain cell groups and a local intrinsic integration within specific subcortical sites (e.g., ventral striatum and amygdala). B. A depiction of overlapping cell groups involved in diverse functions. Cell ensembles at one point in time are mainly involved in cognitive-motivational processing while at another point in time emotional amplification of neural activity.

Anger Category



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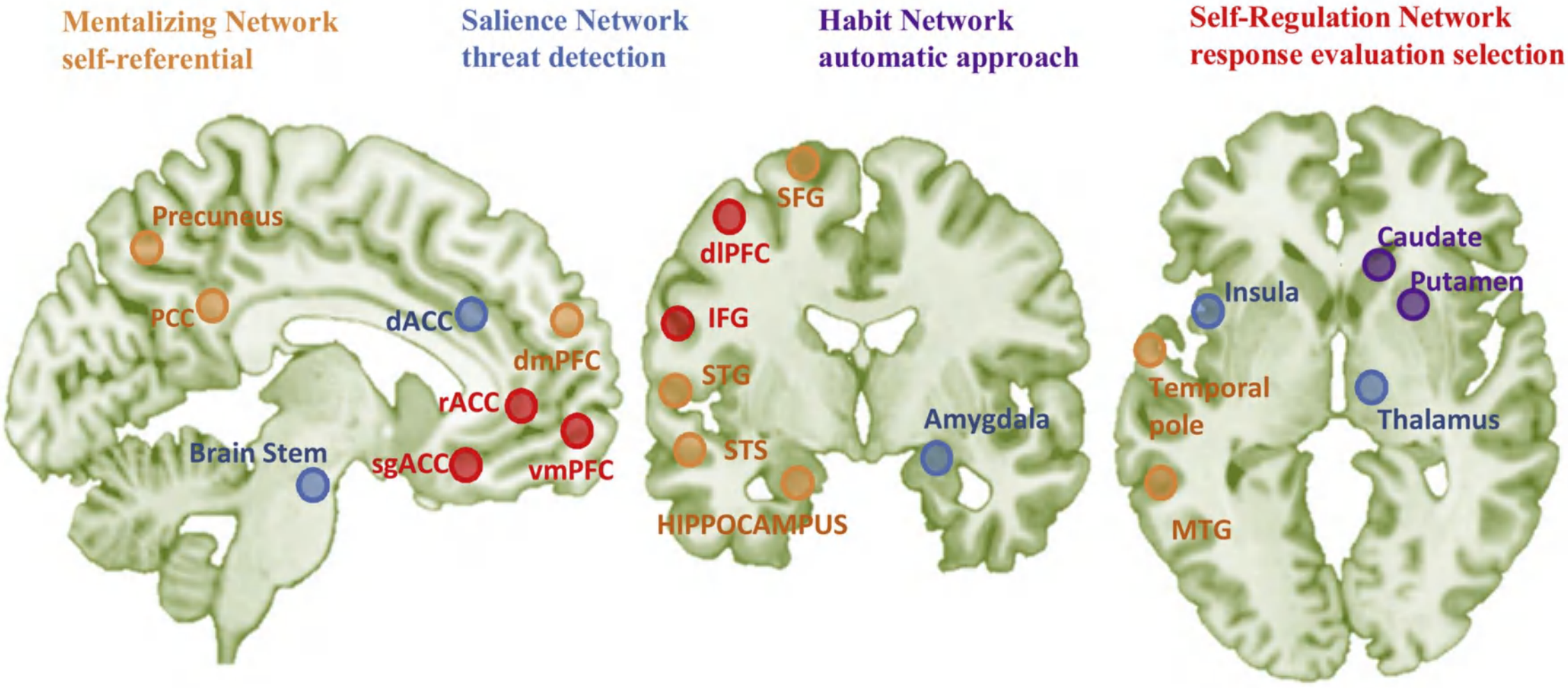
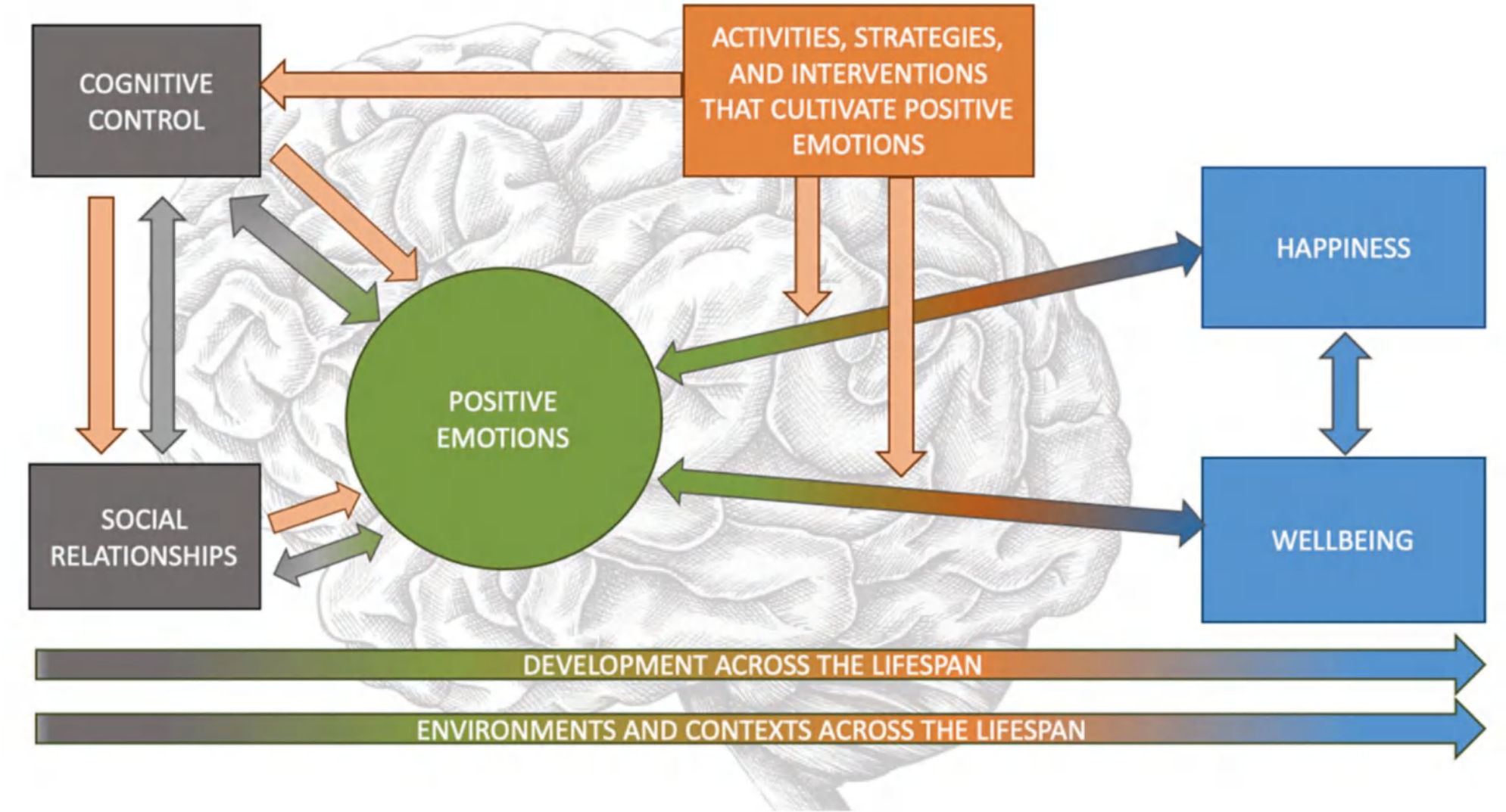


Happiness Category



Sadness Category

Milestones in Emotion Theory

The ongoing emotion debate has been likened to the Hundred Years' War between England and France. Here are some important milestones:

1872 — Darwin publishes *The Expression of Emotions in Man and Animals* identifying the **muscles of grief**

1884 — James argues that emotions are **the subjective experience of physiological changes**

1931 — Cannon demonstrates that **emotion may arise without visceral afferent feedback**

1962 — Schacter emphasises the importance of **cognitive factors** in determining the experience of emotion

1982 — Panksepp argues that emotions (e.g. sorrow) arise from distinct **hard-wired circuitry** within the **visceral-limbic brain** (the 'panic' command system)

1983 — Ekman proposes that **'basic emotions' can be distinguished autonomically**

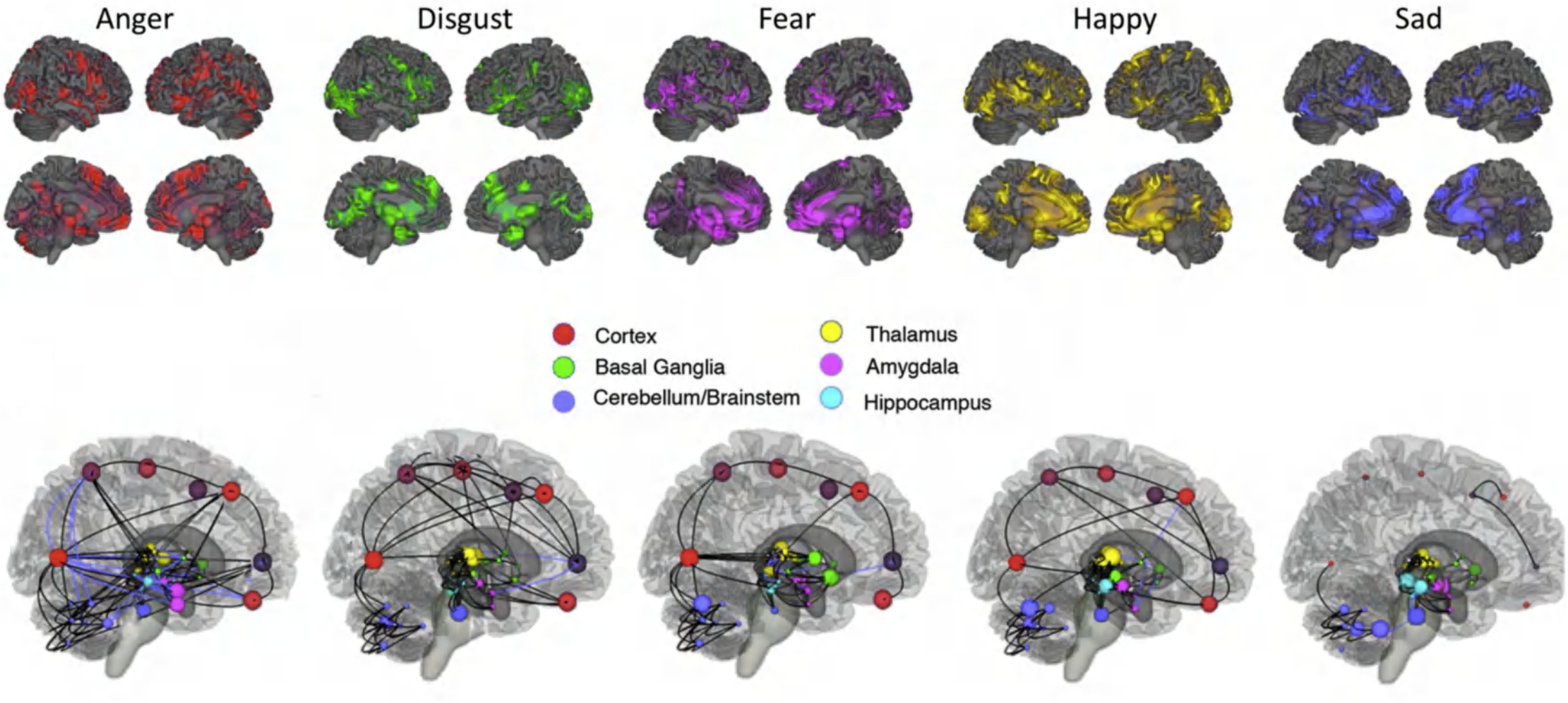
1992 — Davidson proposes **approach-withdrawal model**, emphasising reduced left-prefrontal EEG activity in sadness and depression

1999 — Mayberg shows increases in **limbic-paralimbic regions** and corresponding decreases in neocortical regions in sadness & depression

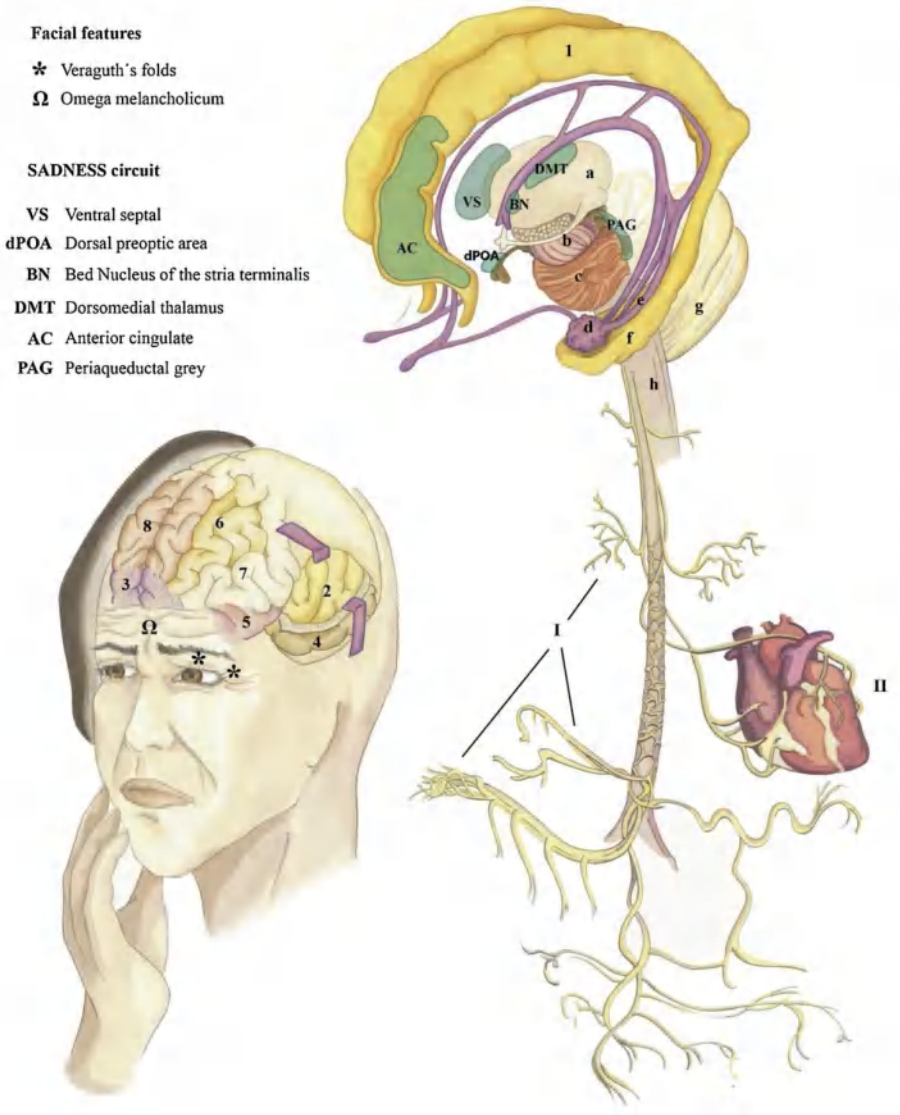
2009 — Porges presents evidence that long-term social isolation in prairie voles leads to **increased heart rate and reduced variability**

2012 — Feldman Barrett argues that emotions are subserved by basic neural operations, i.e. **psychological constructionism**

Sadness **Category**



Sadness **Category**



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Review article

The neuroscience of sadness: A multidisciplinary synthesis and collaborative review

Juan A. Arias[a,b], Claire Williams[a], Rashmi Raghvani[a], Moji Aghajani[c,l], Sandra Baez[d,l], Catherine Belzung[e,l], Linda Booij[f,g,l], Geraldo Busatto[h,l], Julian Chiarella[f,g,l], Cynthia HY Fu[i,l], Agustin Ibanez[k,l,m,n,o,t,l], Belinda J. Liddell[p,l], Leroy Lowe[q,l], Brenda W.J.H. Penninx[c,l], Pedro Rosa[h,l], Andrew H. Kemp[a,h,r,*]

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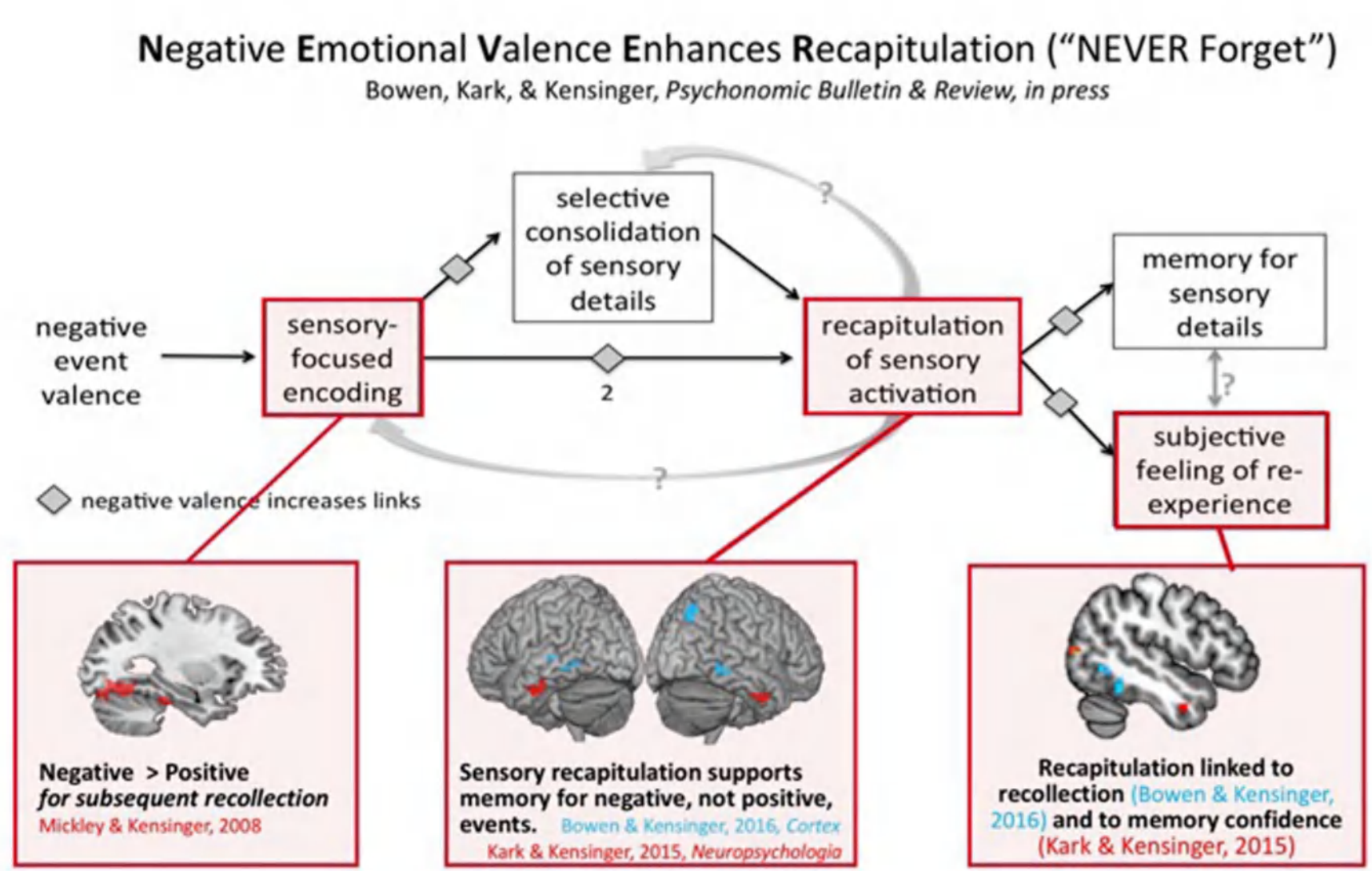
ARTICLE INFO

Keywords:
Sadness
Major depressive disorder
Basic emotions

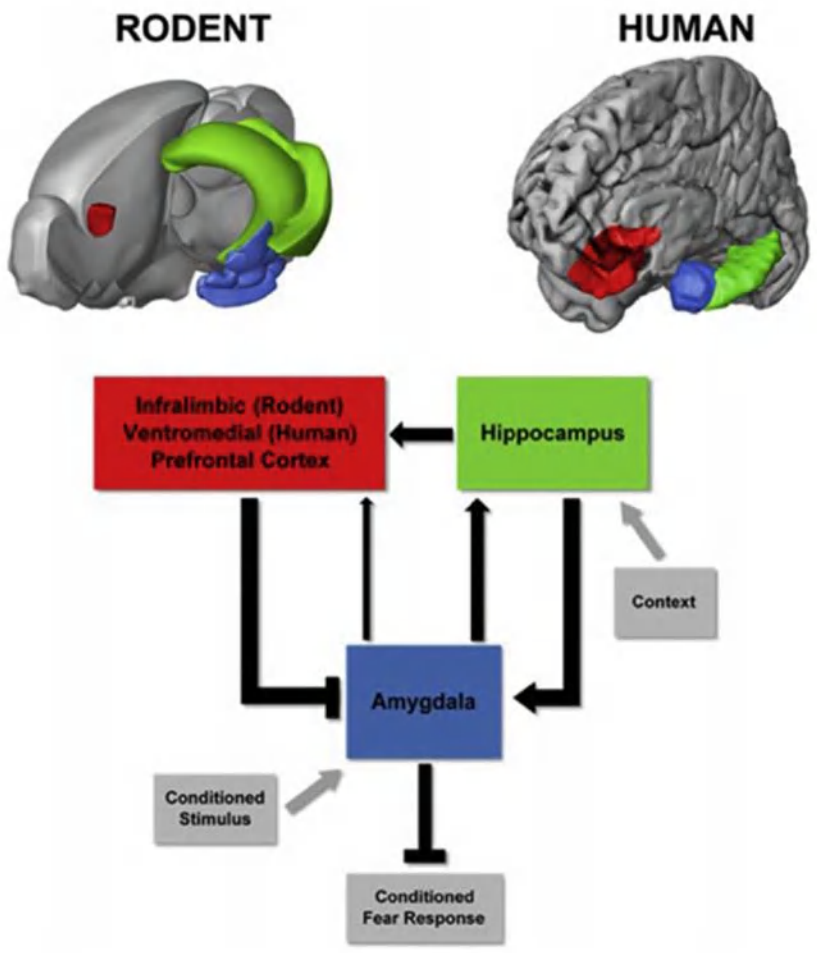
ABSTRACT

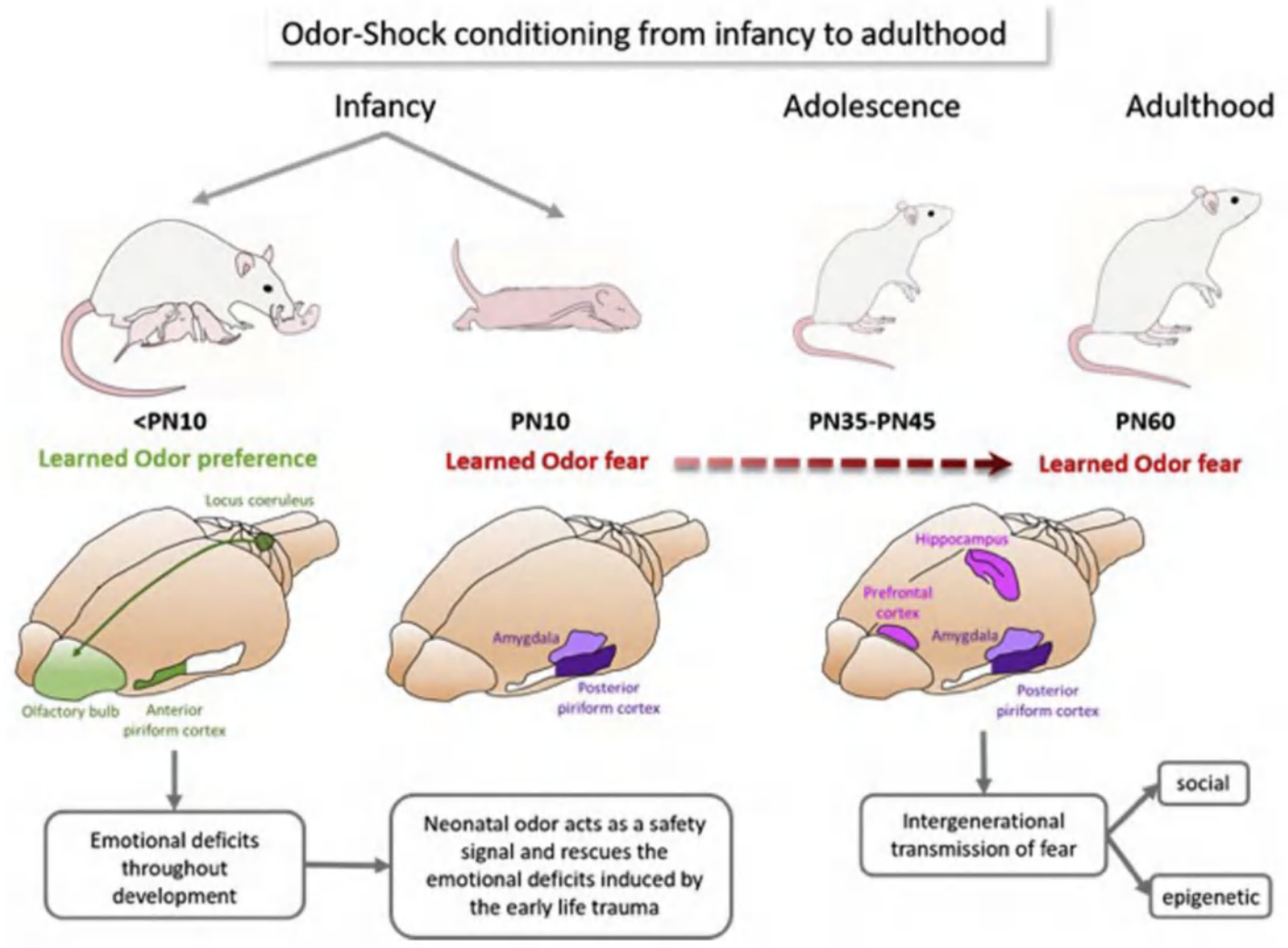
Sadness is typically characterized by raised inner eyebrows, lowered corners of the mouth, reduced walking speed, and slumped posture. Ancient subcortical circuitry provides a neuroanatomical foundation, extending from dorsal periaqueductal grey to subgenual anterior cingulate, the latter of which is now a treatment target in disorders of sadness. Electrophysiological studies further emphasize a role for reduced left relative to right

Fear Category



Fear Category





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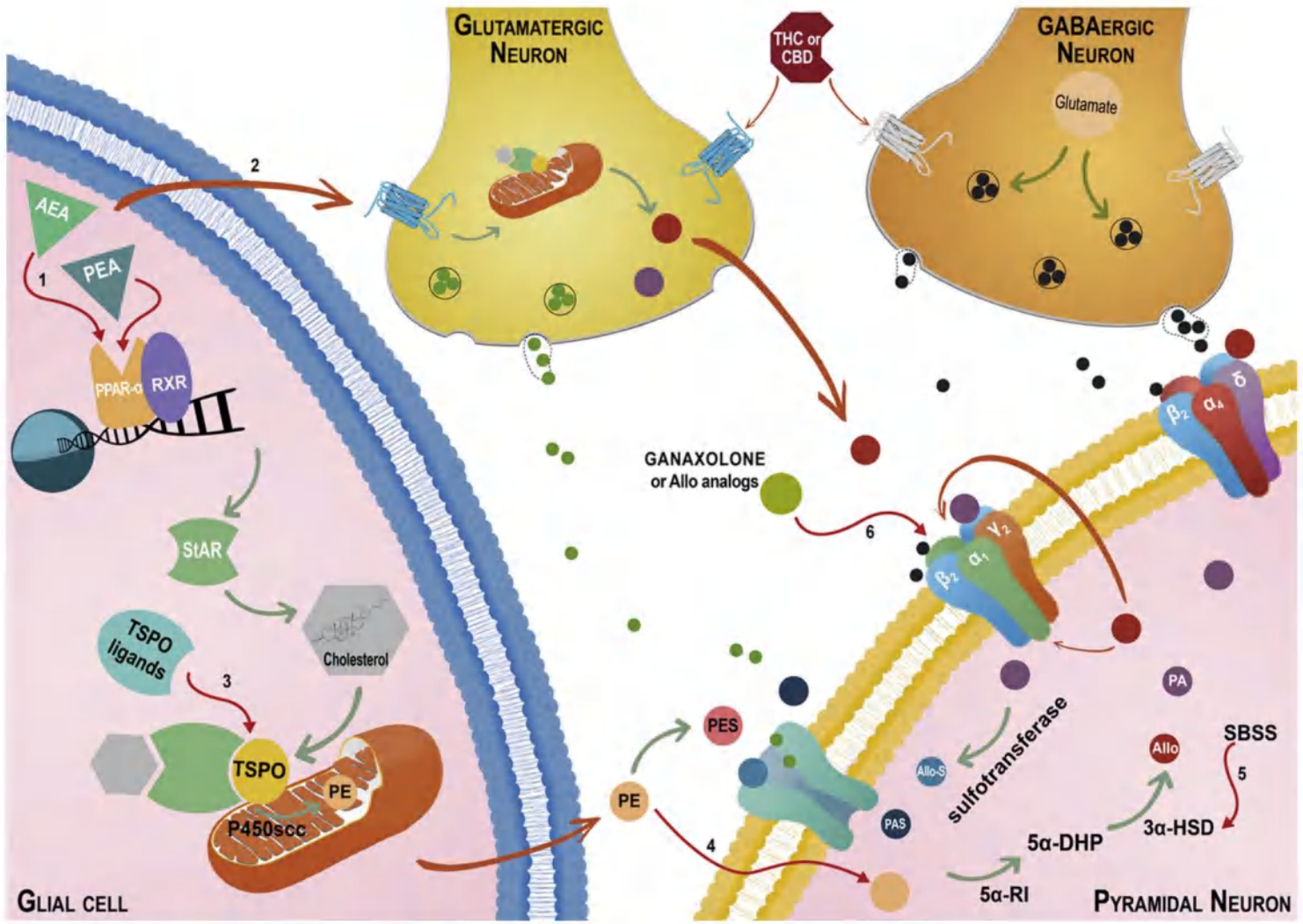
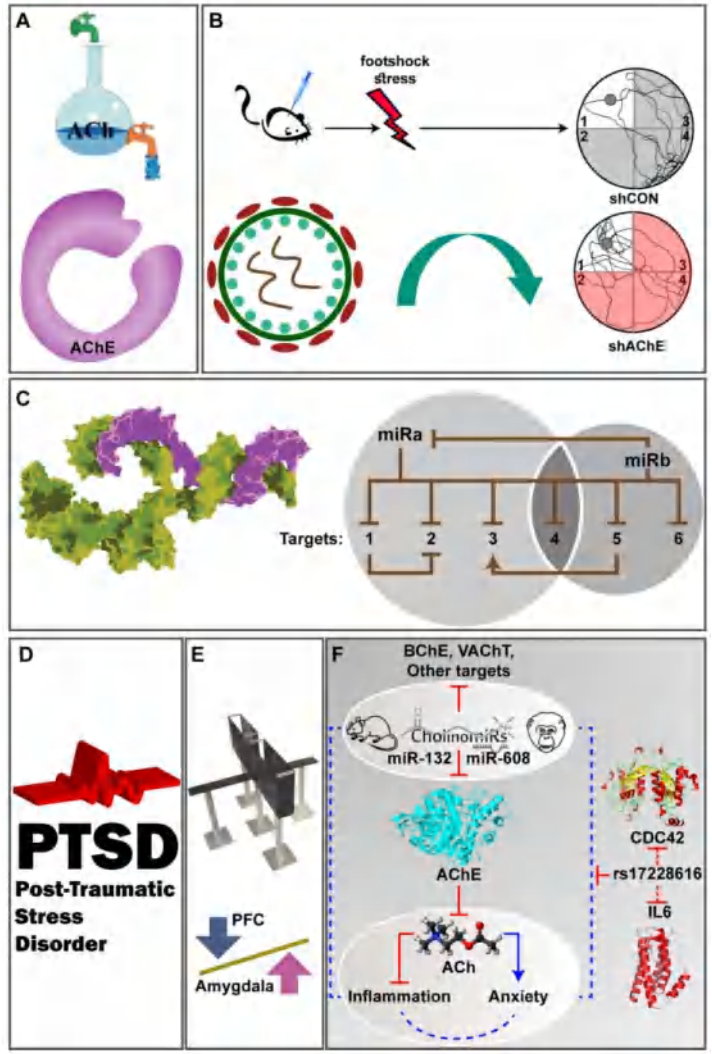




Anticipatory Category

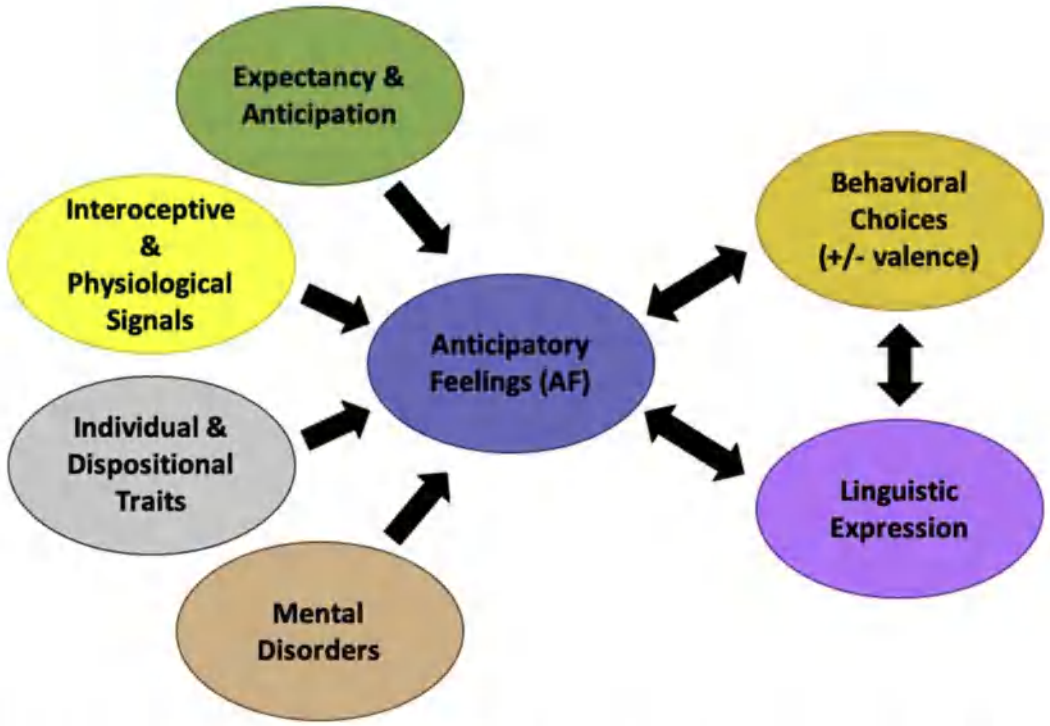
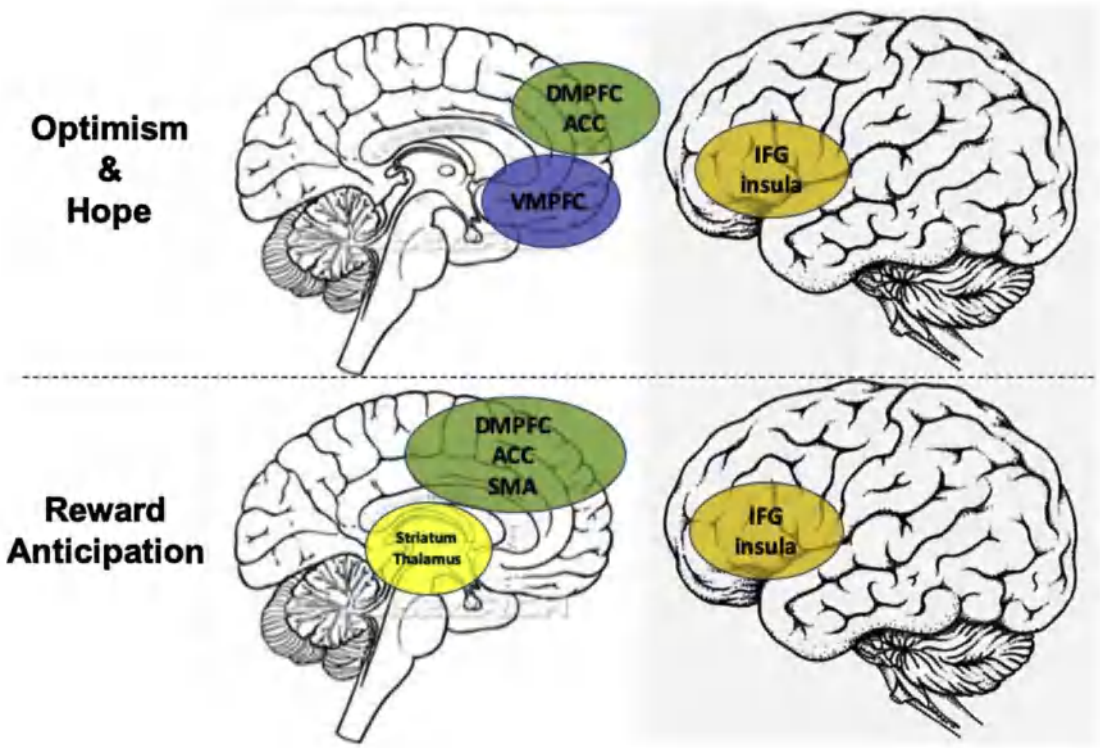


Fig. 1. The multifaceted components of AF (AFs). Expectancy and anticipation are key characteristics of AF. Additionally, interoceptive and physiological signals affect the sensation of AF and influence their presence. Building on that, individual traits and general disposition, partnered with emotional regulation strategies, will influence AF. Lastly, many mental disorders involve disruption to typical anticipatory regulation. All these lead to actions in response to behavioral choices, which could have either positive or negative valences, and linguistic expression, which, in turn, feed back into the AFs.

期待、希望、奖赏



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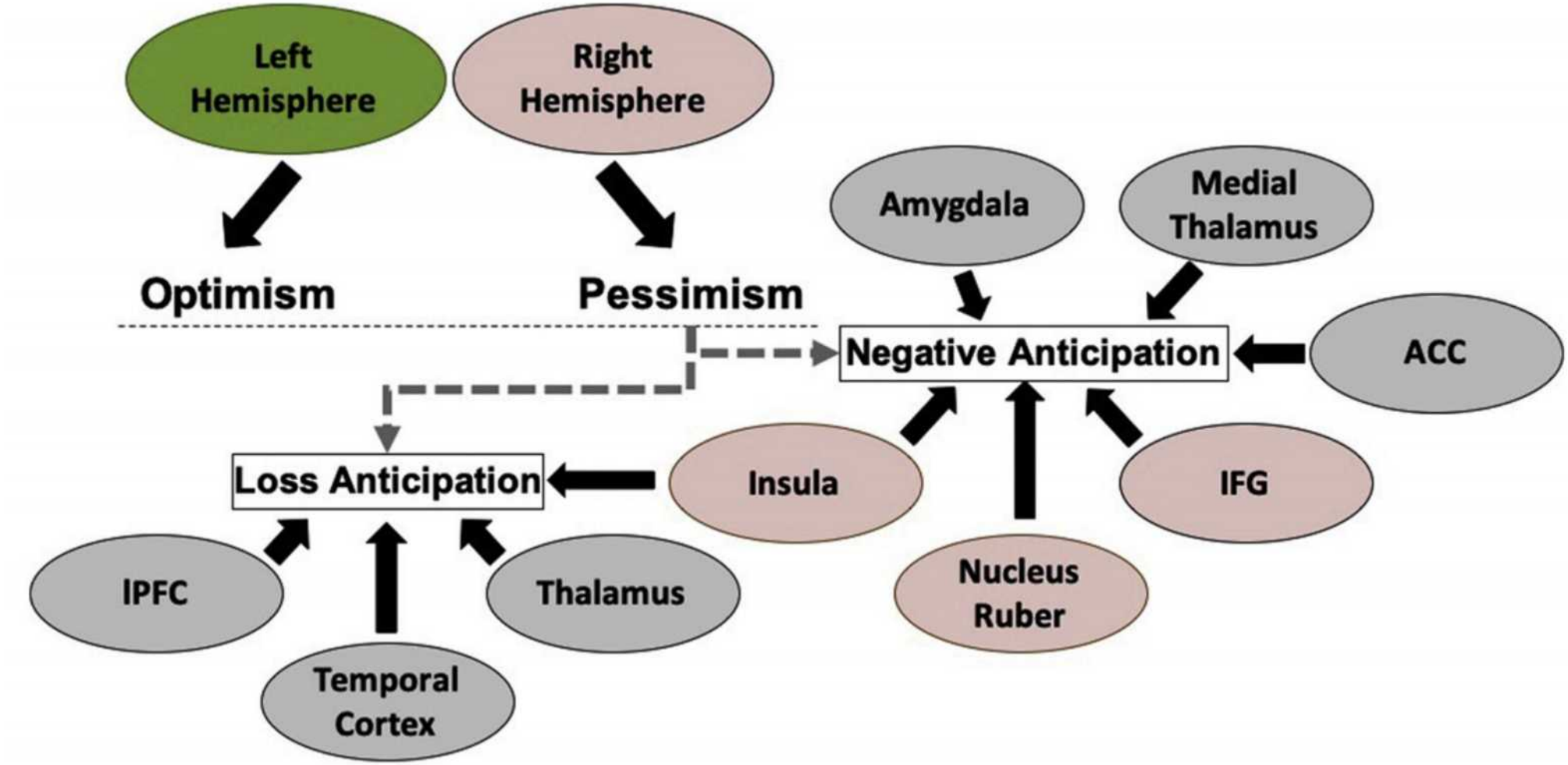

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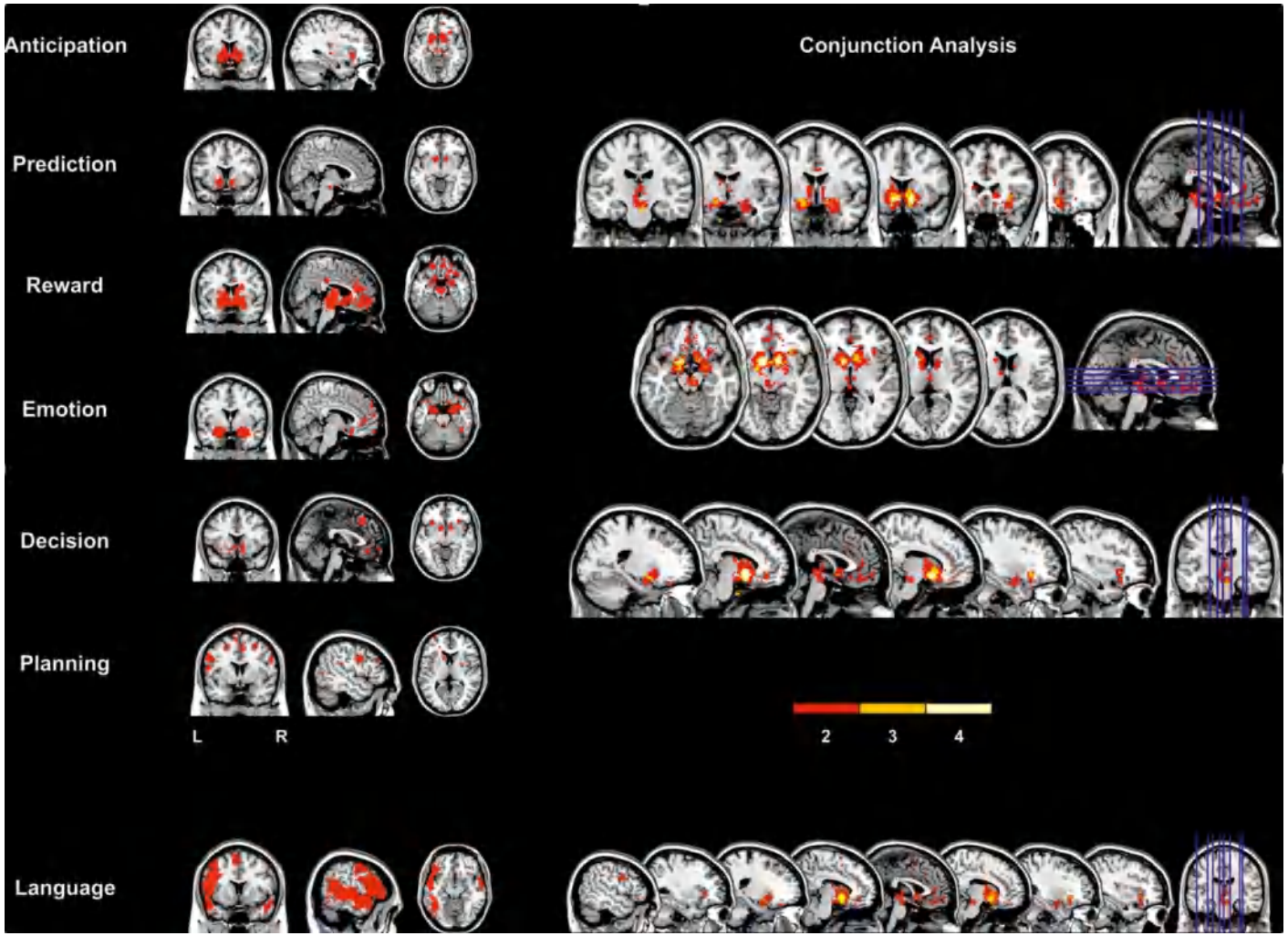
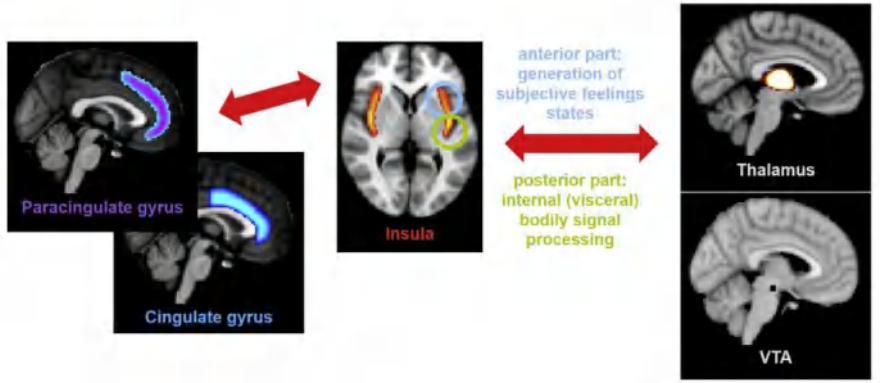
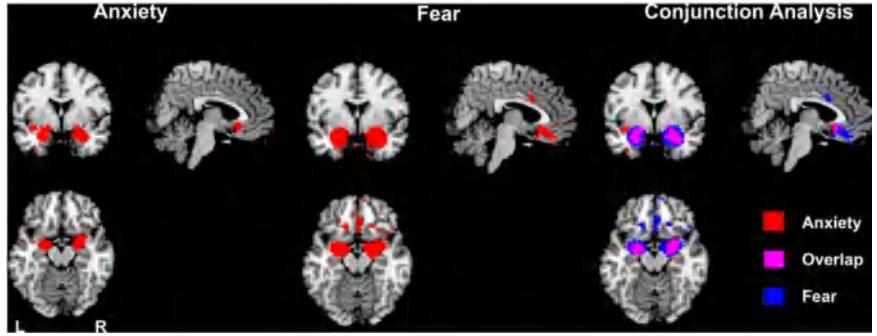
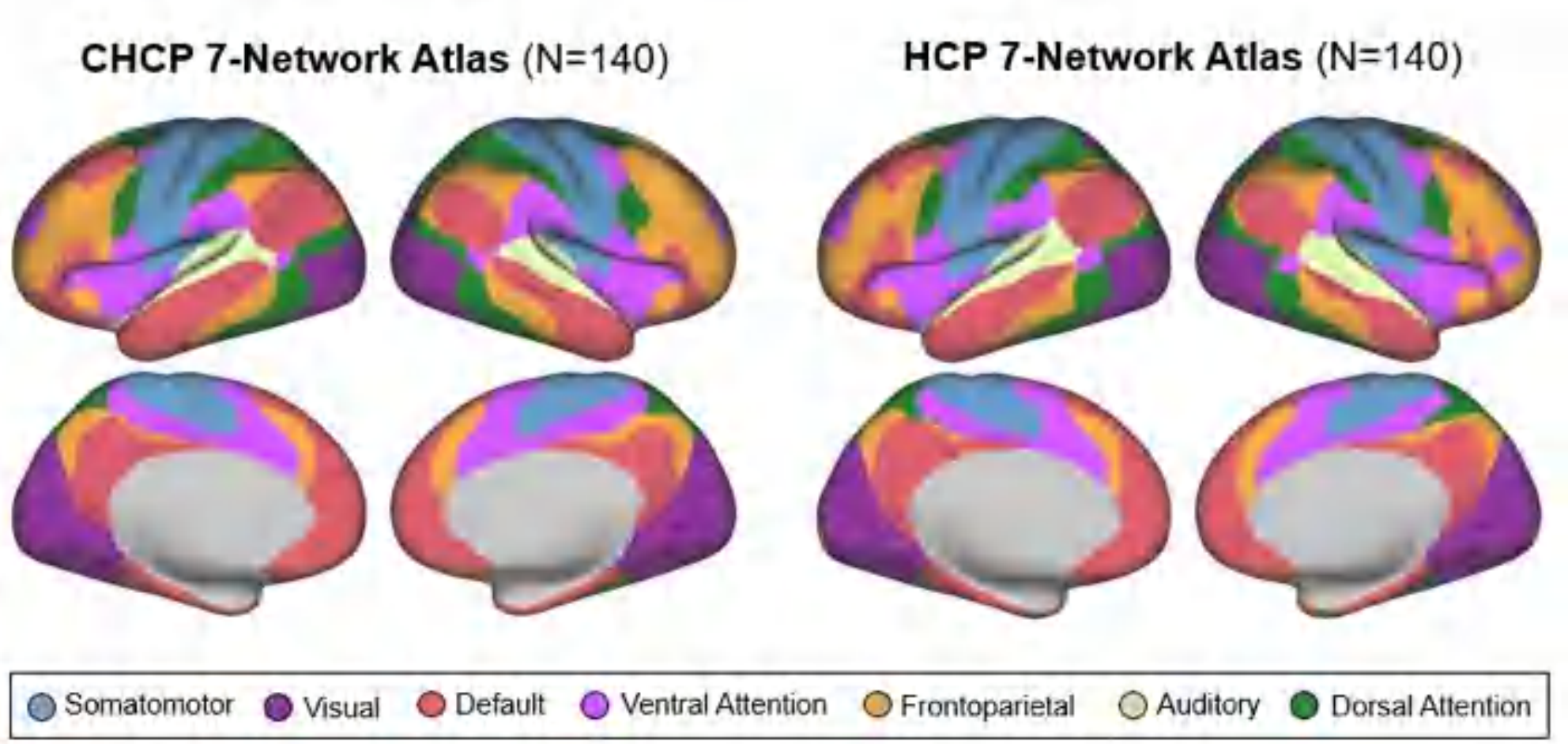




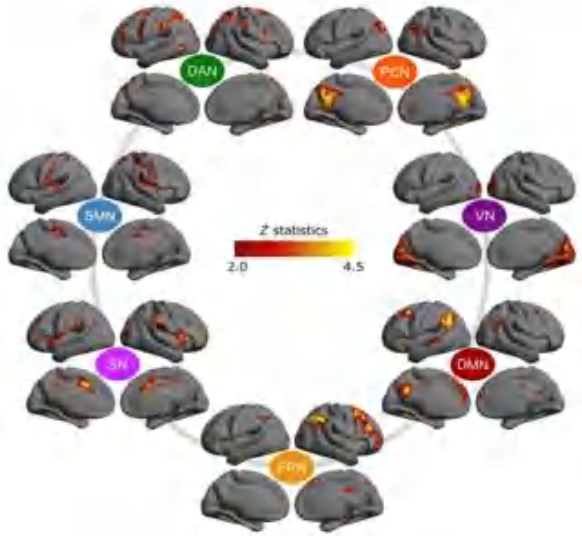
Category	Assigned Subcategories with Examples
General Arousal	Excited (*e.g.*, passionless, calm, serene, aroused, stirred, excited)
Factors Influencing Goals	Extreme need (*e.g.*, destitute, desperate, panicked) Duty-bound (*e.g.*, obligated, bound, consigned) Externally Influenced (*e.g.*, instigated, coerced, persuaded) Internal (*e.g.*, unselfish, covetous, emulous, fated)
Sense of Purpose	Purpose (*e.g.*, meaningless, adrift, empty, purposive, key)
Strategy	Creativity (*e.g.*, uninspired, uninventive, inspired, imaginative) Time allocated to decision (*e.g.*, spontaneous, impulsive)
Planning	Risk (*e.g.*, defenceless, unsafe, secure, steady) Readiness (*e.g.*, inexperienced, amateur, capable, qualified) Pessimism/Optimism (*e.g.*, uncertain, doomed, optimistic, upbeat, confident) Busy (*e.g.*, idle, busy) Logic (*e.g.*, irrational, sensible)
Decision to Act	Inclination (*e.g.*, timid, hesitant, undecided, predisposed, inclined)

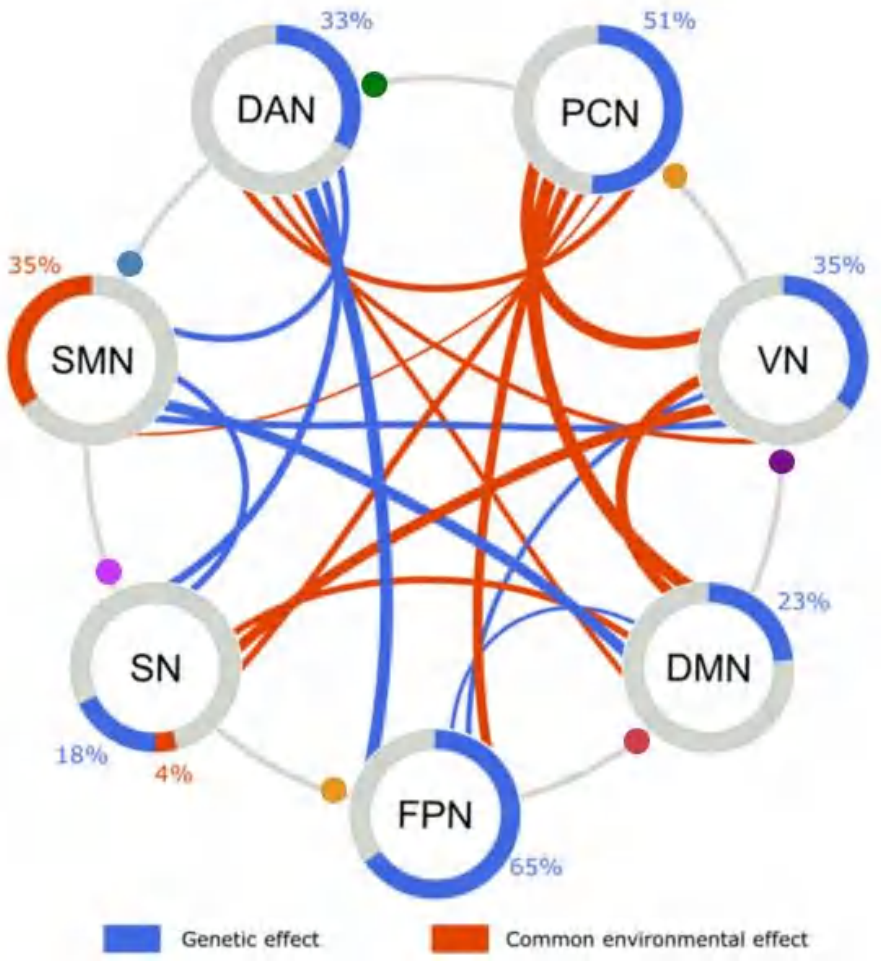


Brain-Feeling Development across The Human Lifespan



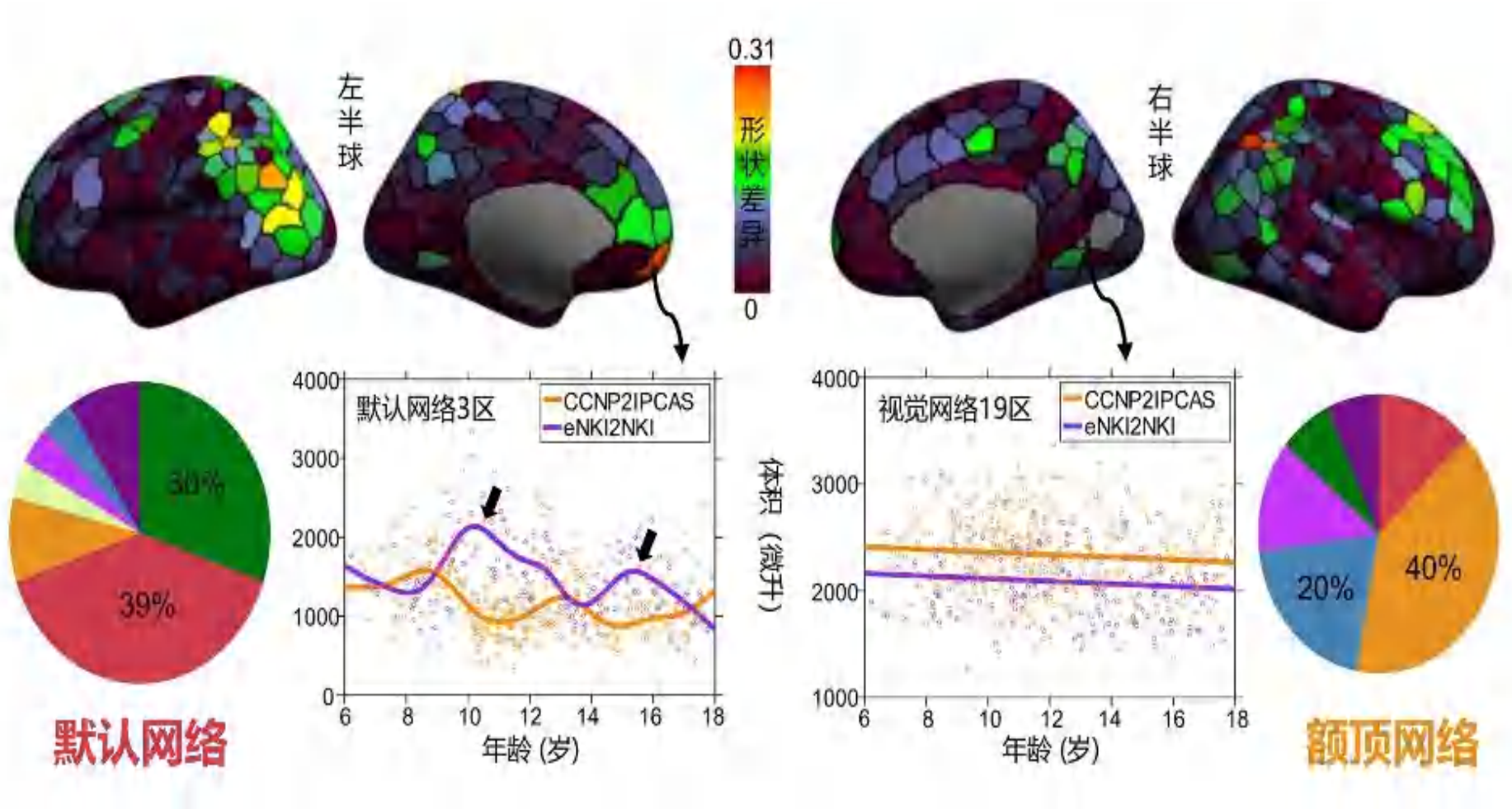
Brain-Feeling Development across The Human Lifespan





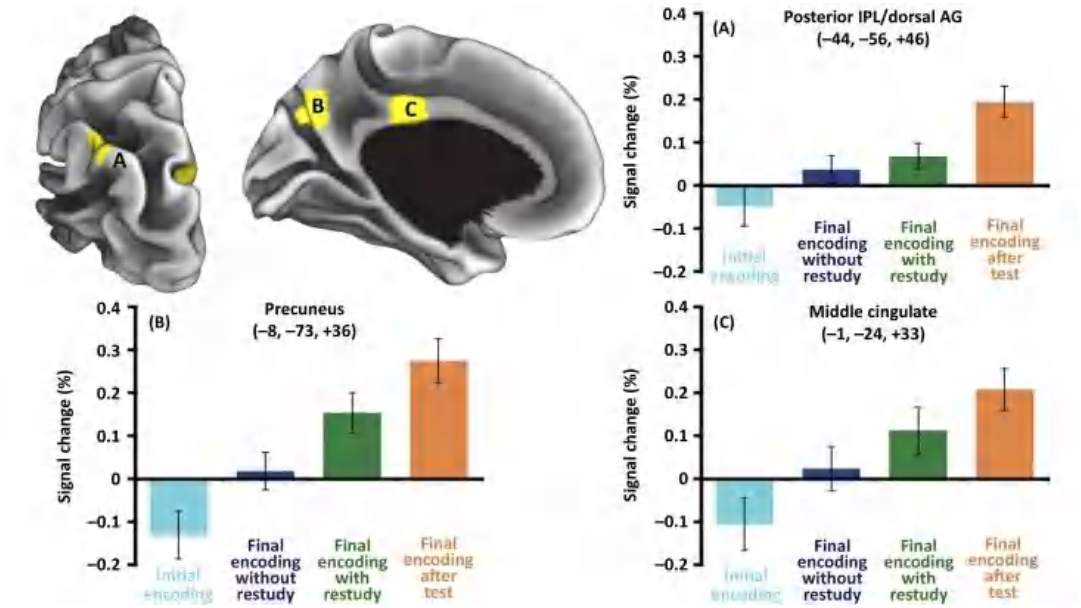
Cerebral Cortex (2016)

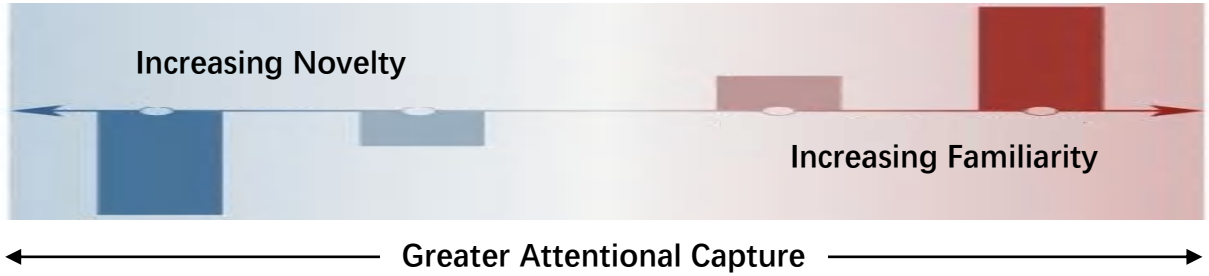
Brain-Feeling Development across The Human Lifespan

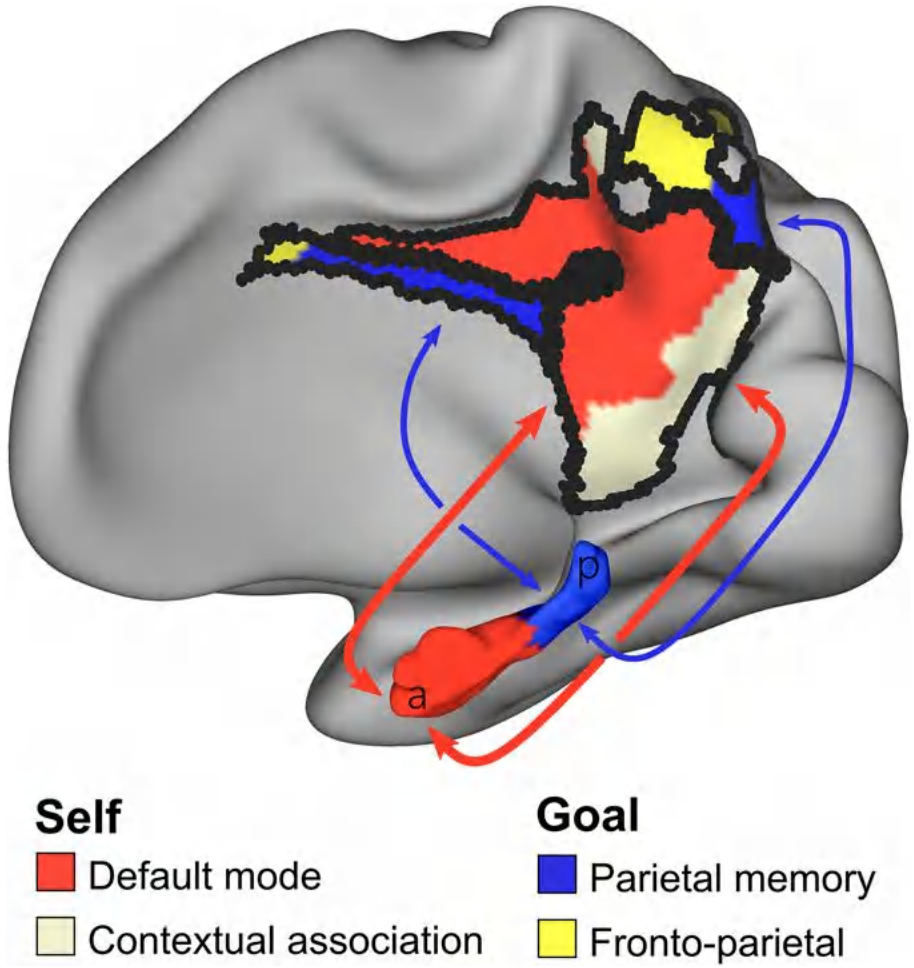


Science Bulletin (2020)

Brain-Feeling Development across The Human Lifespan







Trends in Cognitive Sciences (2015); ***PNAS*** (2021)

A Dev-Pop-Neurosci Solution for Affective Neuroscience

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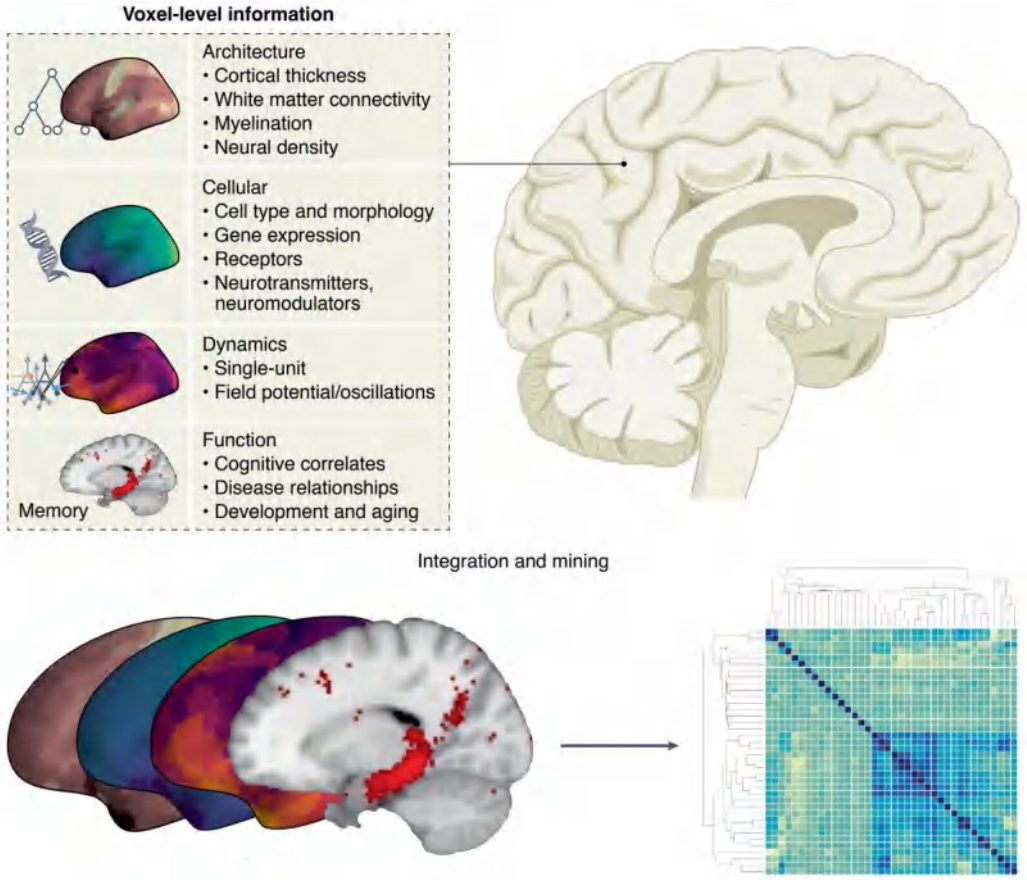

News & views

Neuroscience

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The data science future of neuroscience theory