心理学研究进展课程

认知神经科学的自然主义取向

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Part 1

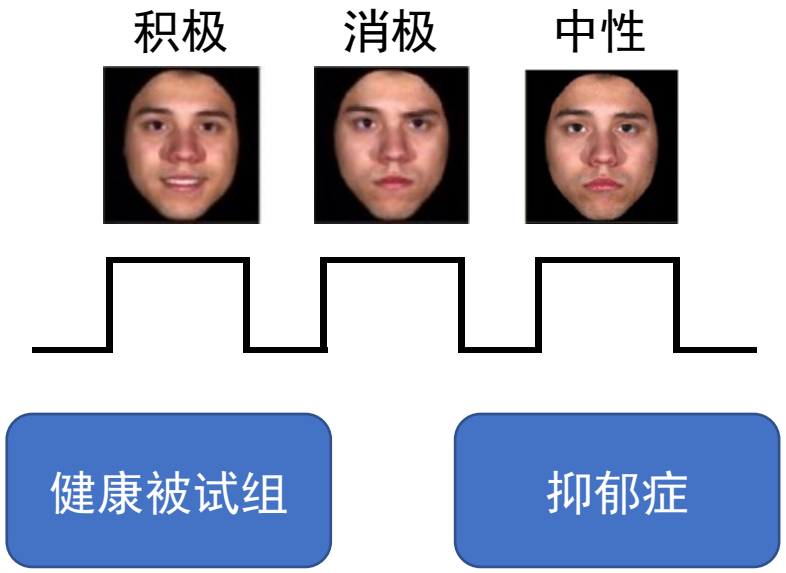
认知神经科学研究方法的发展与困境

讨论

如何开展一项认知神经科学研究？

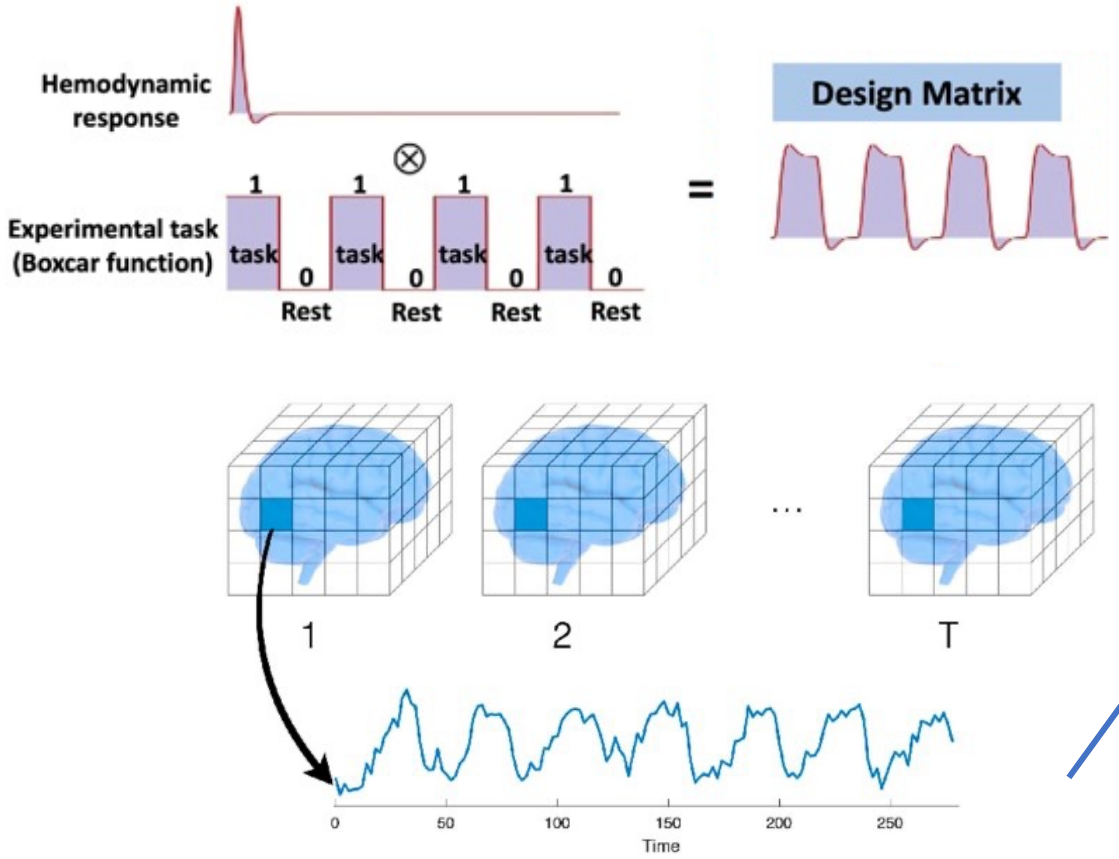
如果你是李华，你的老板让你研究“抑郁症个体加工情绪信息的认知神经机制”。请问你将如何开展实验回答他的问题？

实验设计



BU-3DFE dataset

分析思路

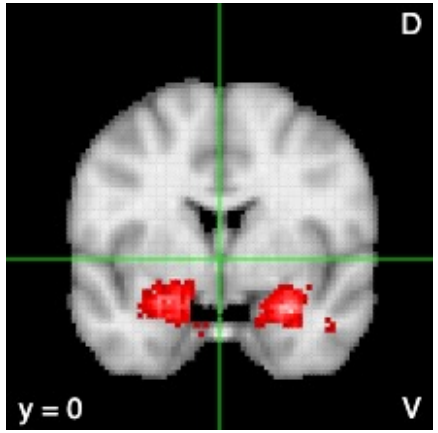


$$Y = \beta_0 + \beta_1 X + \epsilon$$

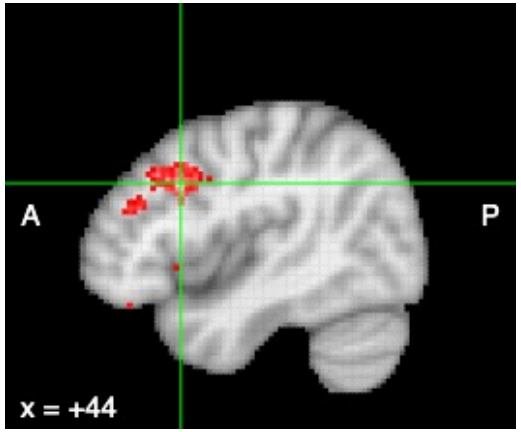
General Linear Model

重复四万次

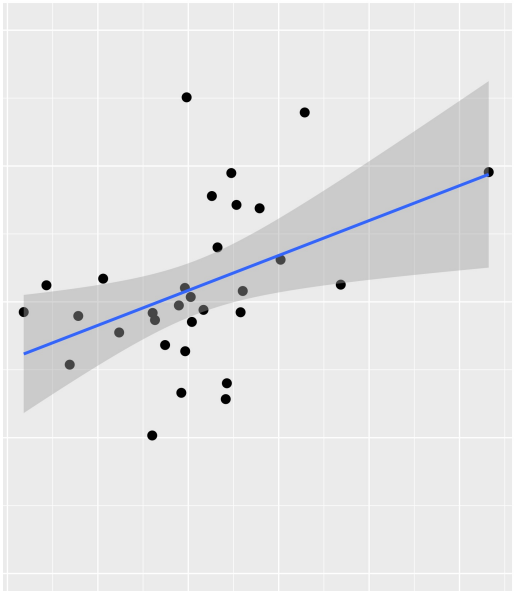
预期结果



消极刺激



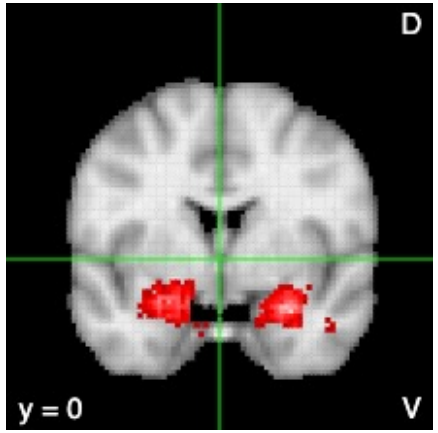
积极刺激



抑郁症 > 健康被试

- 抑郁症加工消极刺激时杏仁核激活更强，反映了对消极刺激更强的响应
- 而在加工积极刺激时额顶网络激活更强，反映了需要更多的注意控制

你的结果真的能支撑这些结论嘛？



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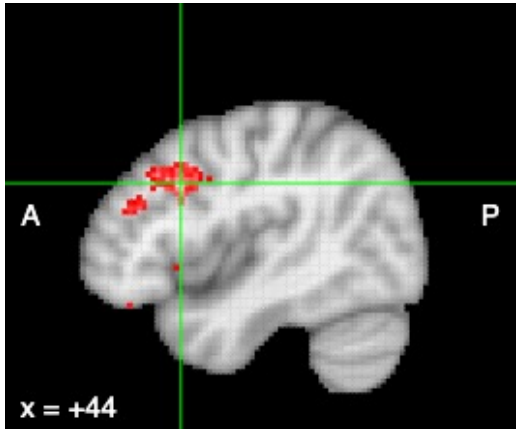
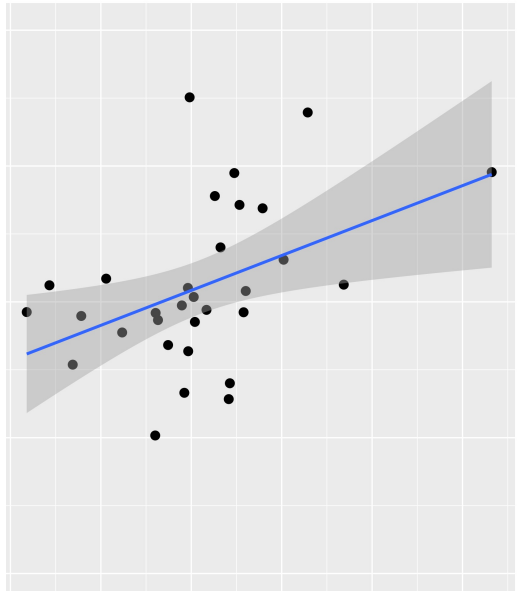


积极刺激



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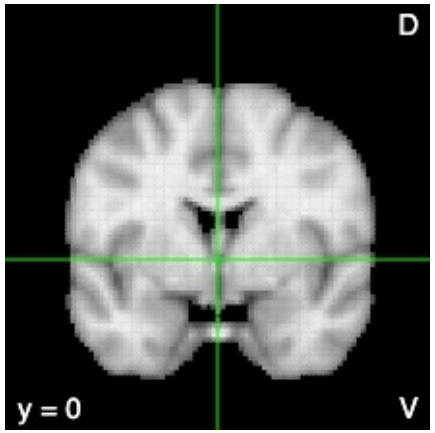
- 而在加工积极刺激时额顶网络激活更强，反映了需要更多的注意控制

？

演示数据，仅供参考

Even worse，更有可能的世界线……



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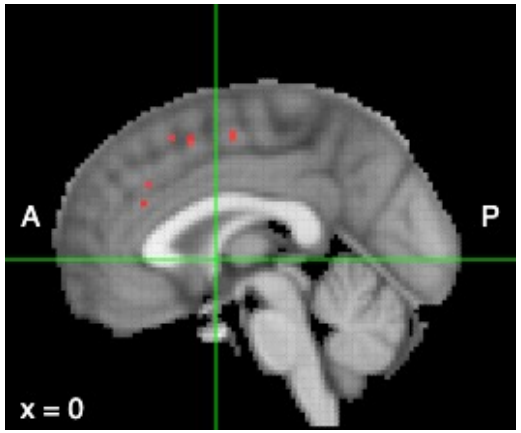
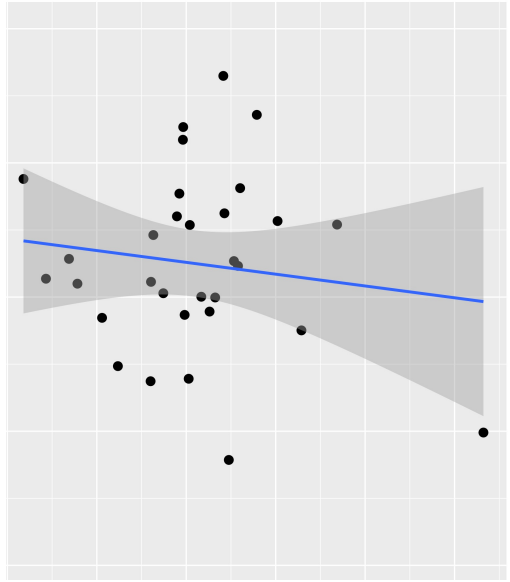
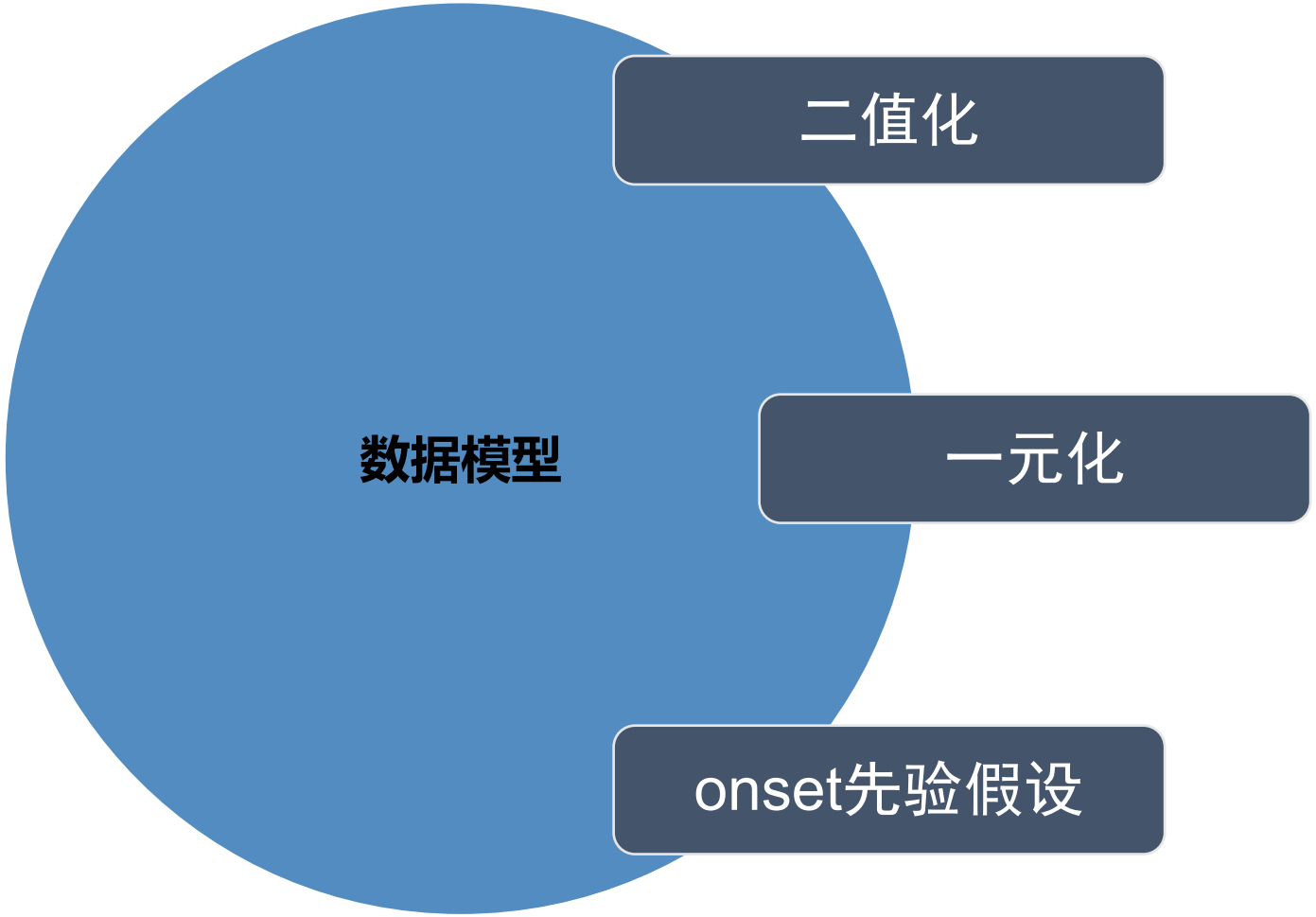


积极刺激

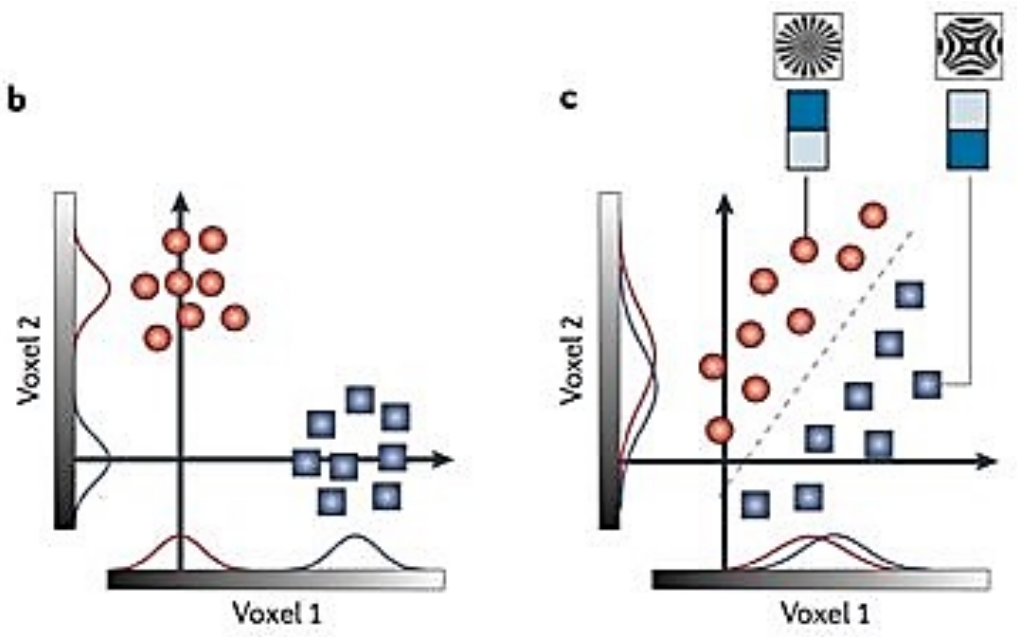


抑郁症 > 健康被试

认知减法的困境

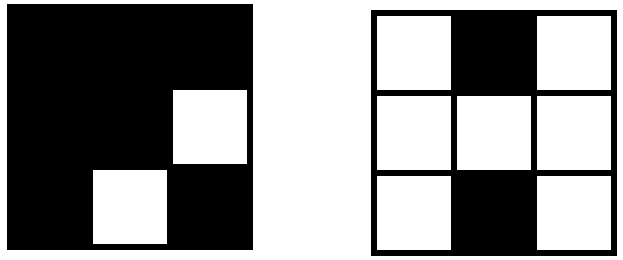


认知减法过度简化的数据模型



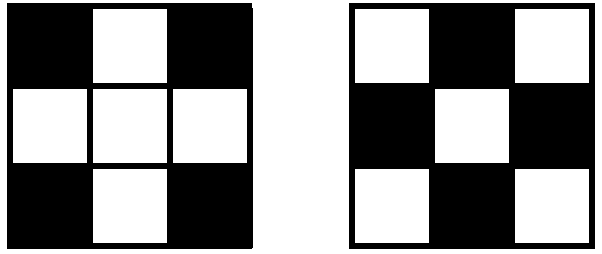
二值化比较与大脑底层机制不完全兼容

认知减法假设的



健康个体　　抑郁症

实际可能的



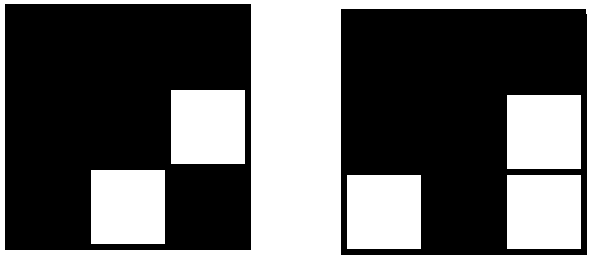
健康个体　　抑郁症

Haynes NRN 2006

认知减法过度简化的数据模型

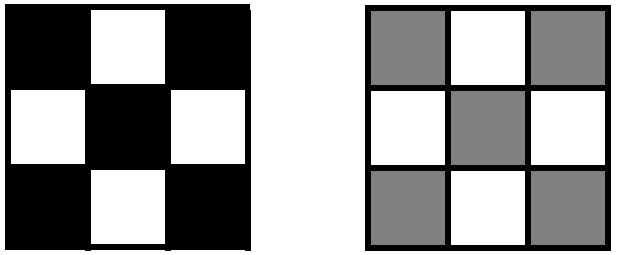
- 从方法上基于认知减法的认知神经科学实验，对实验设计剥离的认知成分“是否干净”提出了极高的要求。
- 但即使是被证明效果良好的实验设计，当应用在不同刺激、人群时，其仍然可能表现出较差的检验力和延展性

实验设计不良



实验条件　　对照条件

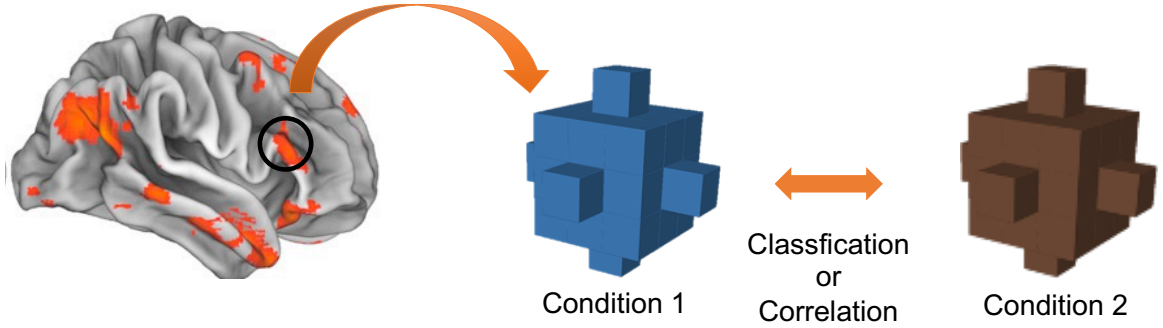
跨群体跨模态检验力弱

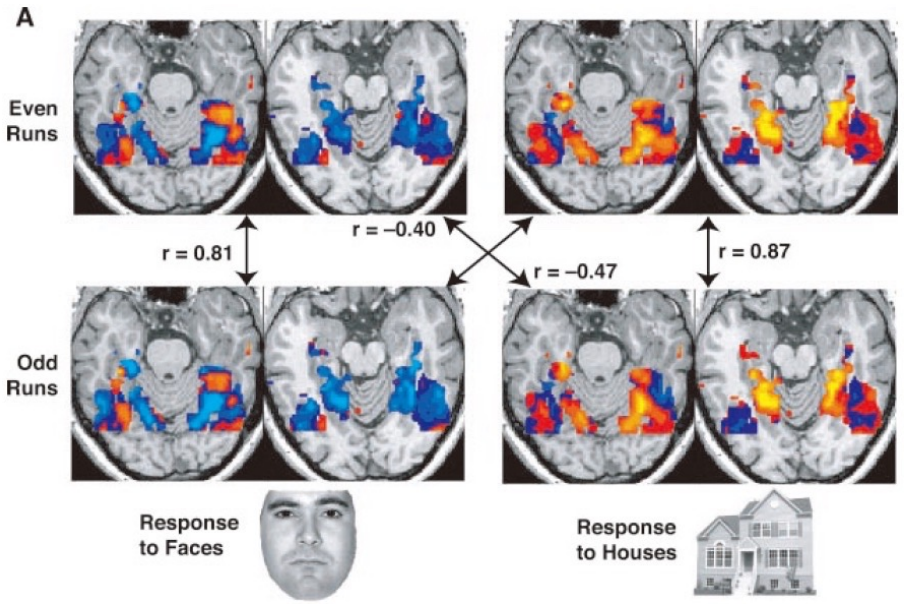


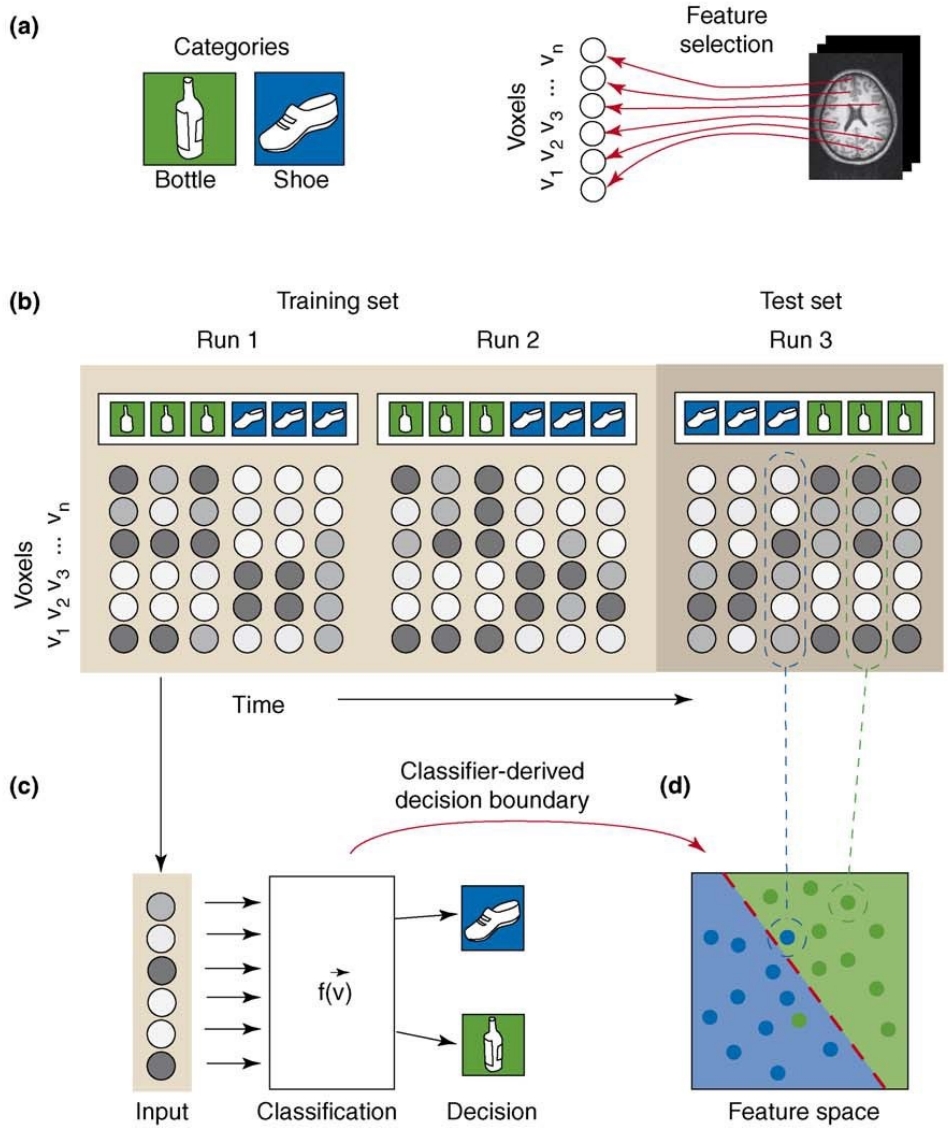
健康个体　　抑郁症

基于多变量模式分析的研究思路

Multivariate Pattern Analysis(MVPA)

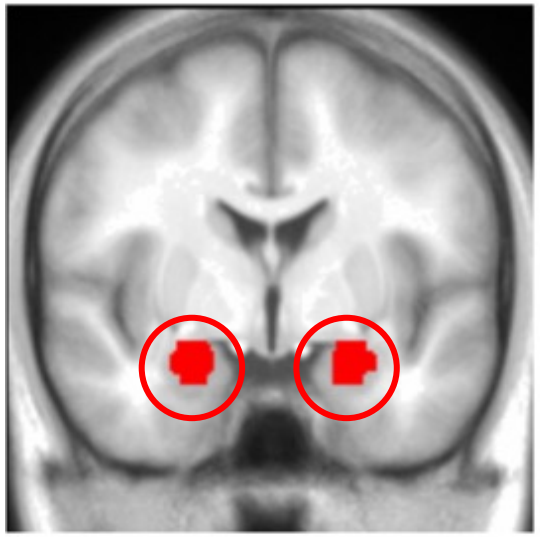




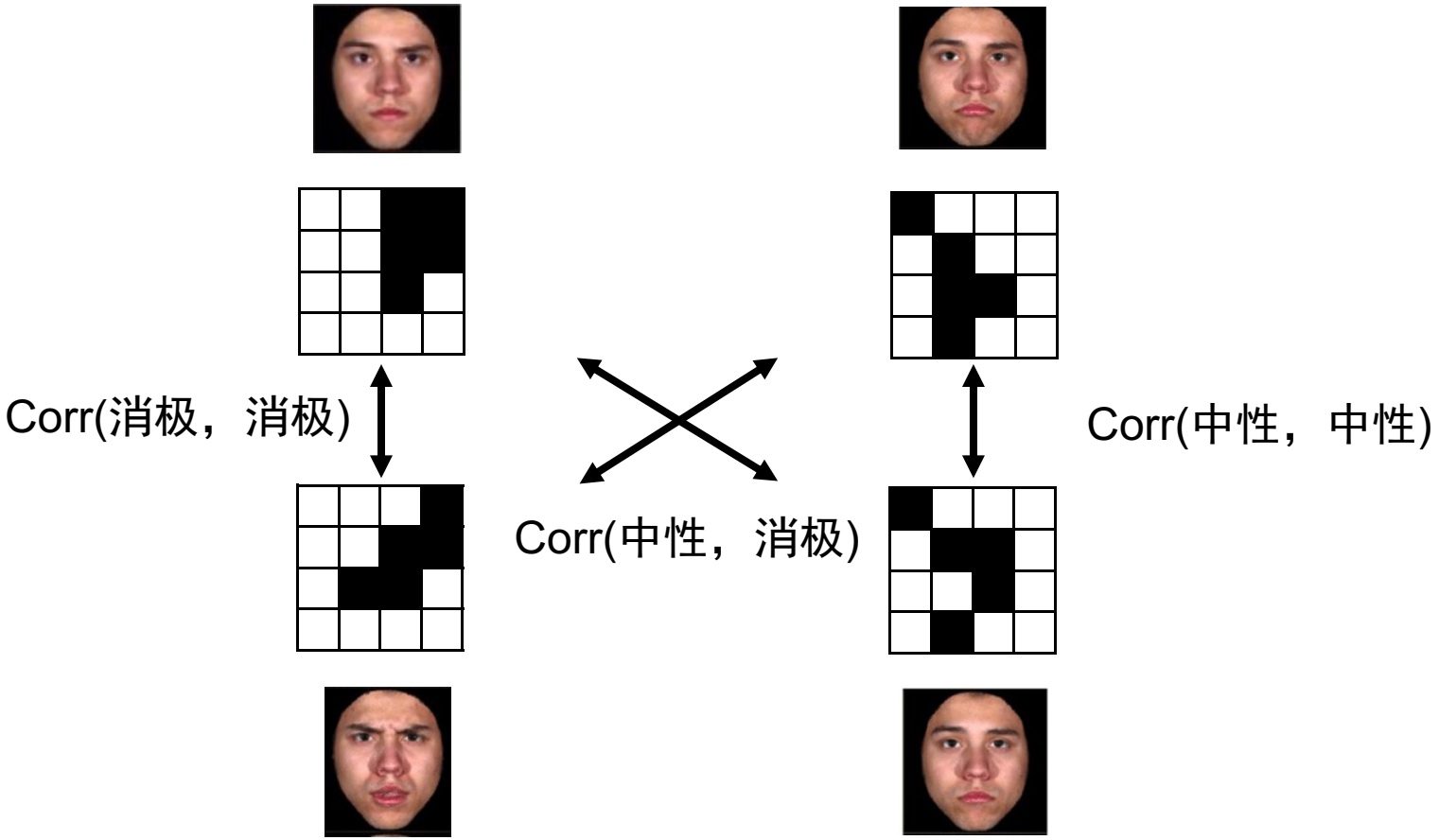


Haxby Science 2001; Norman TICS 2006

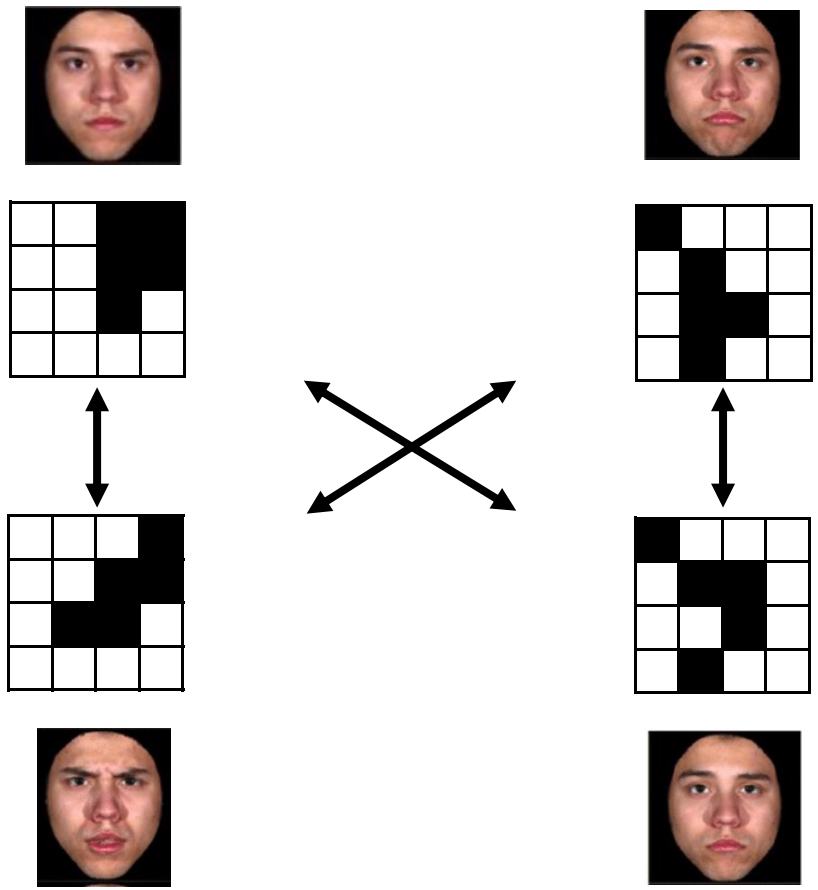
分析思路

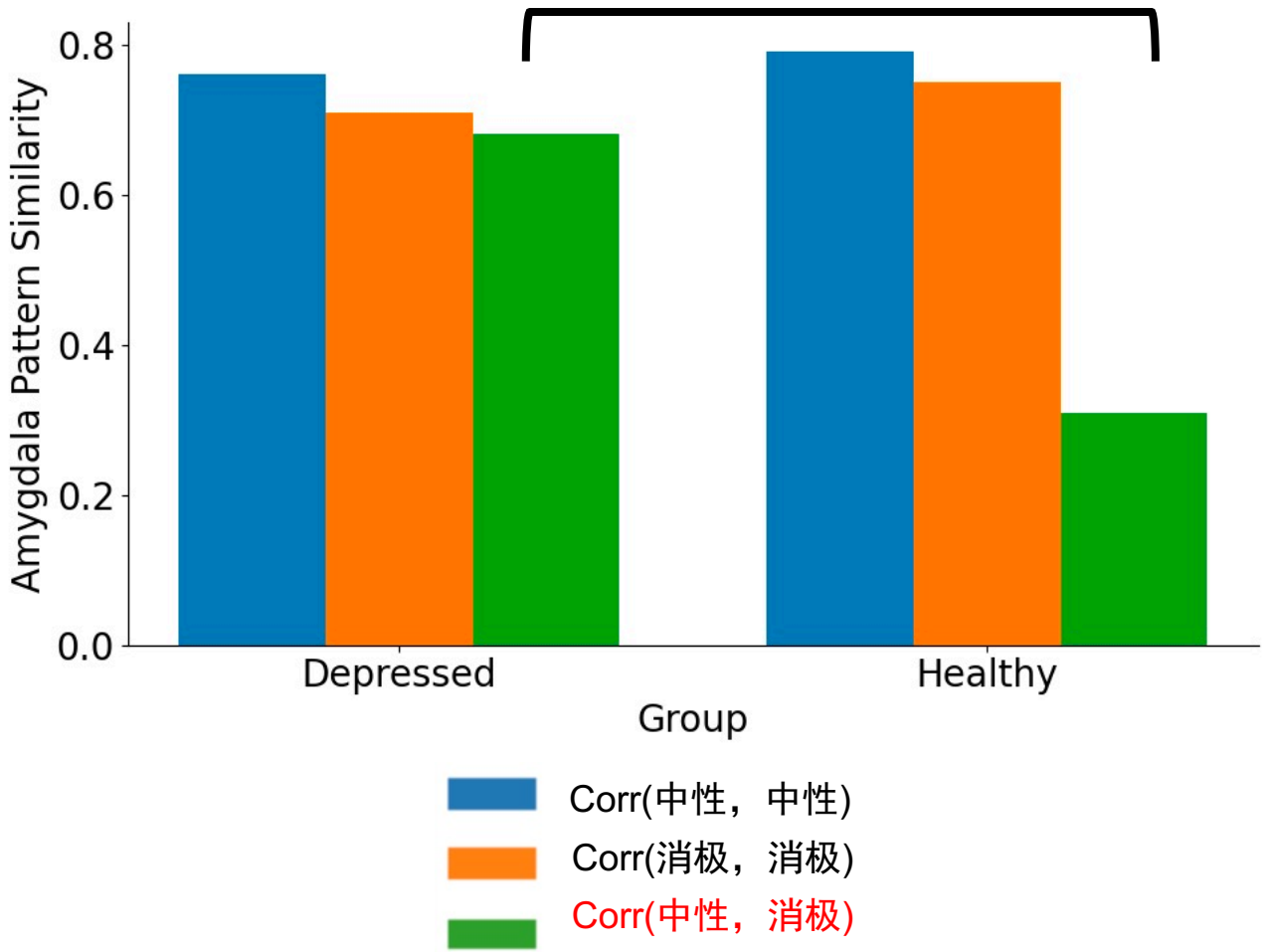


ROI Amygdala



结果预期

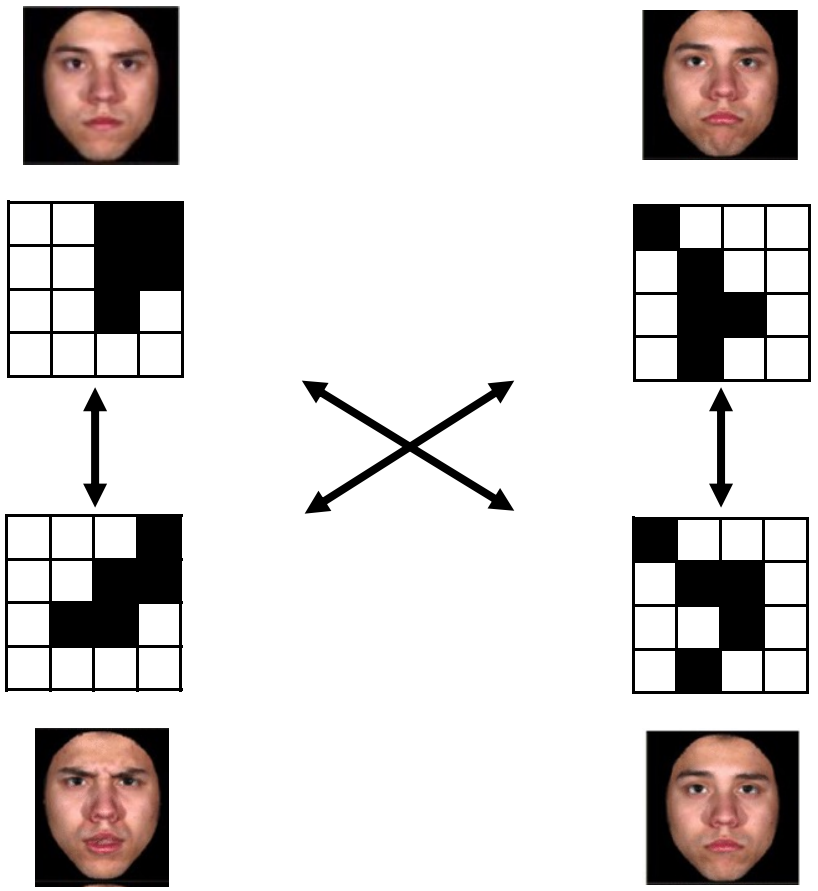


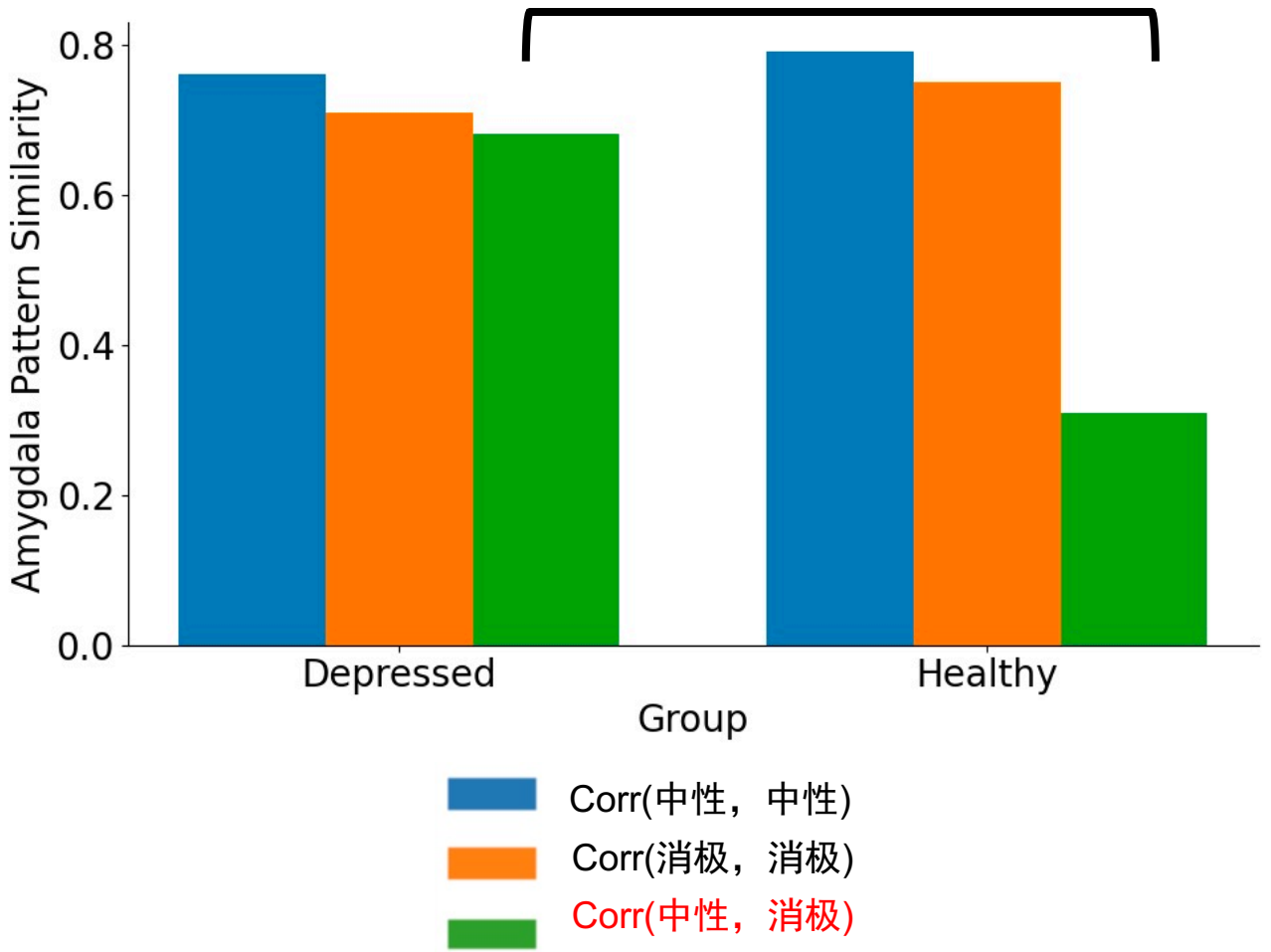


- 抑郁症群体中性和消极刺激模式相似性显著高于健康群体，反映了抑郁症个体对消极刺激编码的泛化

基于多变量模式分析的研究思路

MVPA也不是万能的





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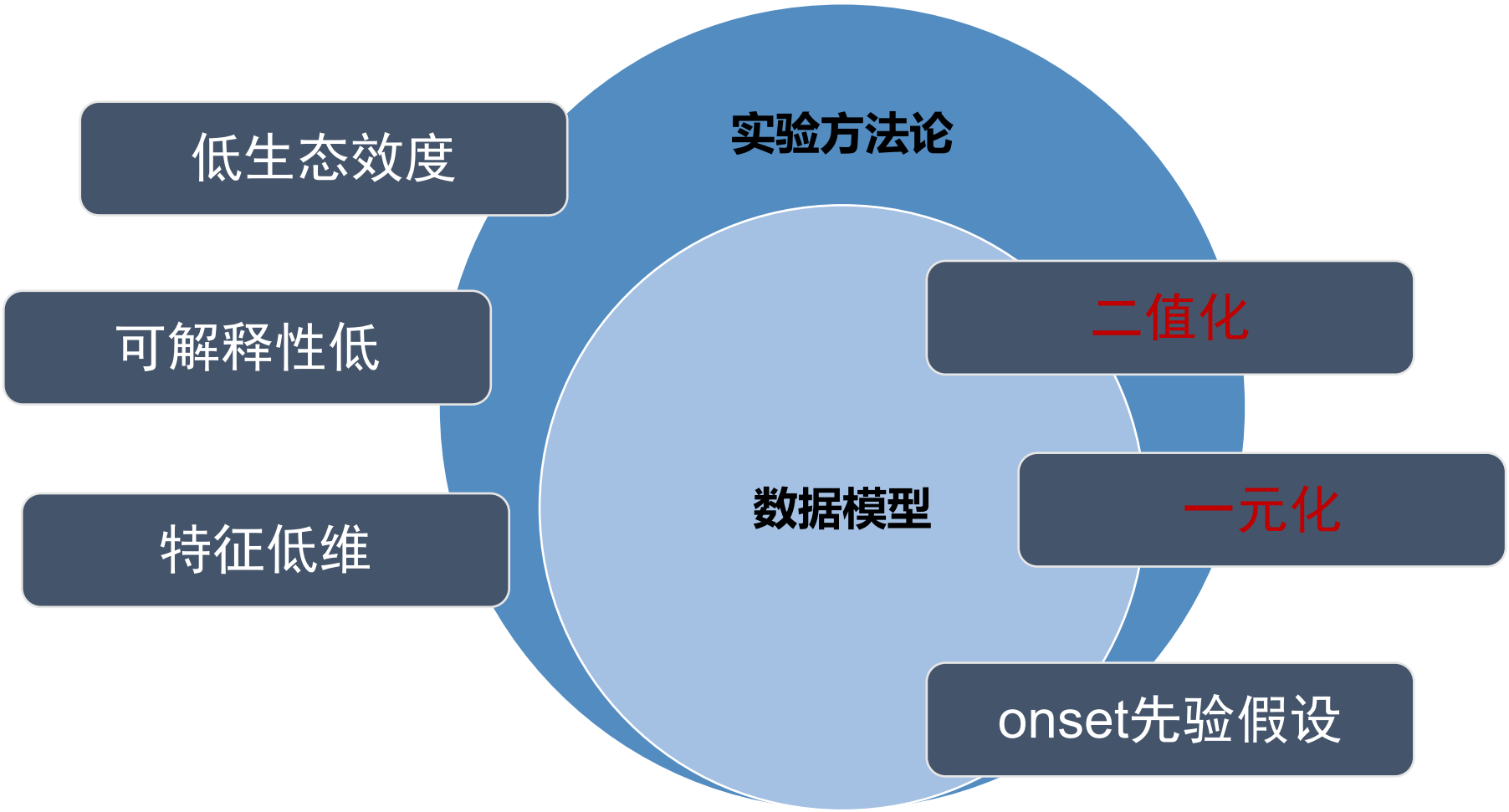
？泛化了什么？

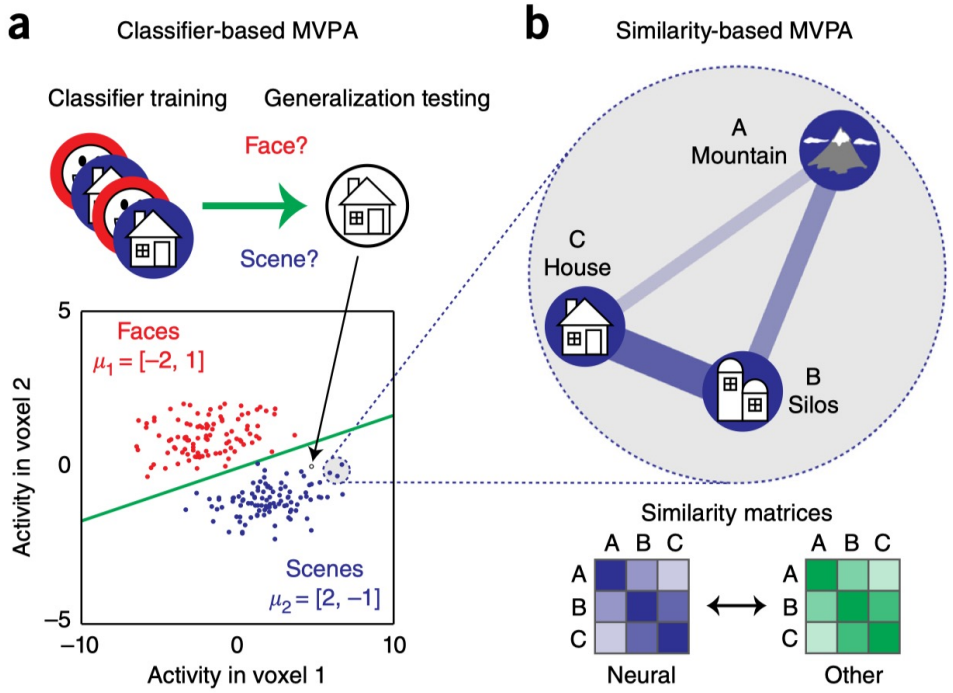
演示数据，仅供参考

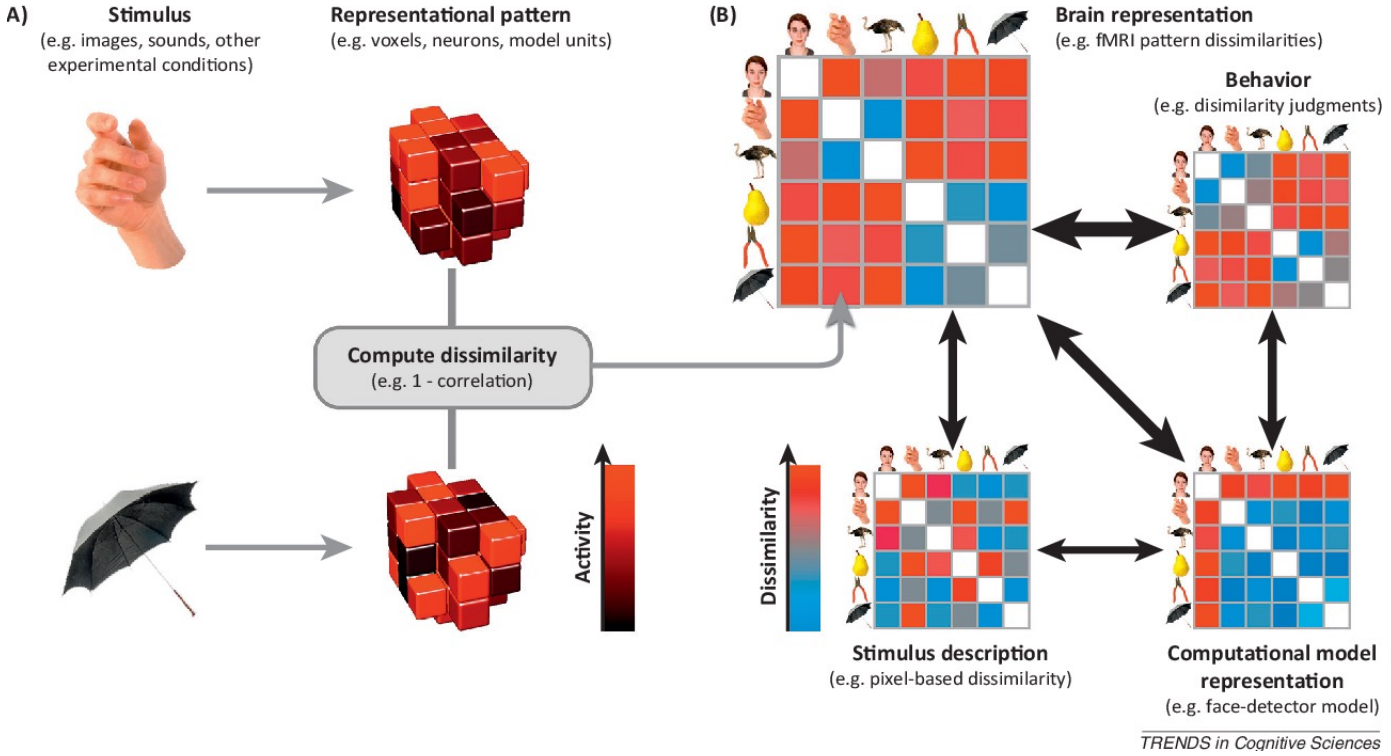
多变量模式分析的困境



基于多变量模式分析的研究思路

Representational Similarity Analysis(RSA)

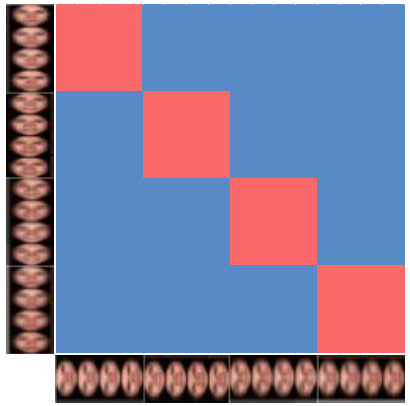




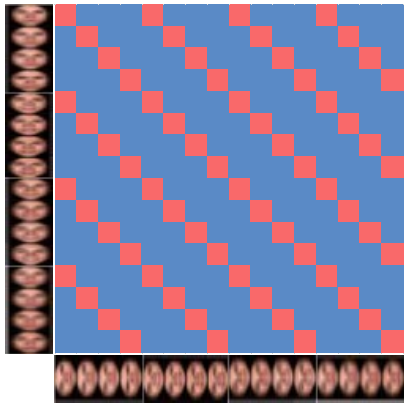
Cohen NRN 2017; Kriegeskorte TICS 2013

分析思路

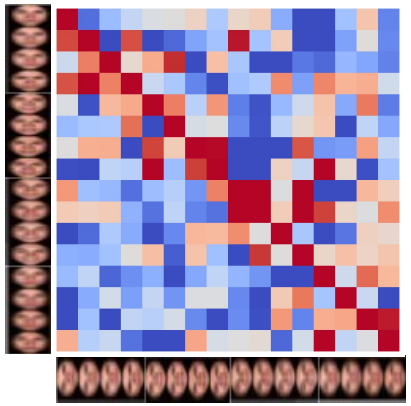
分析思路



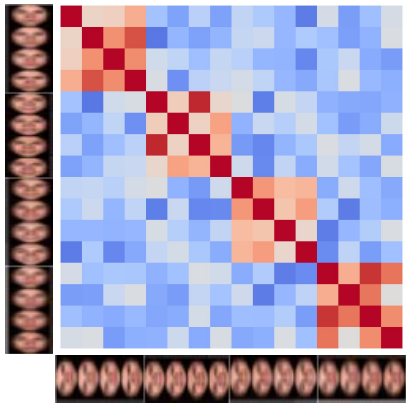
效价类别



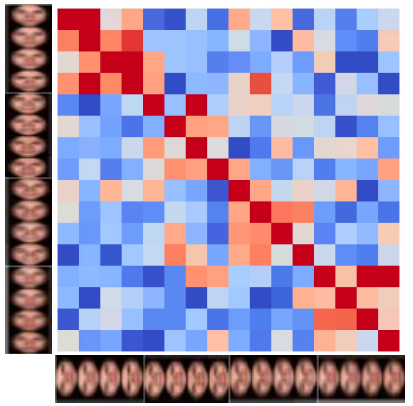
强度类别



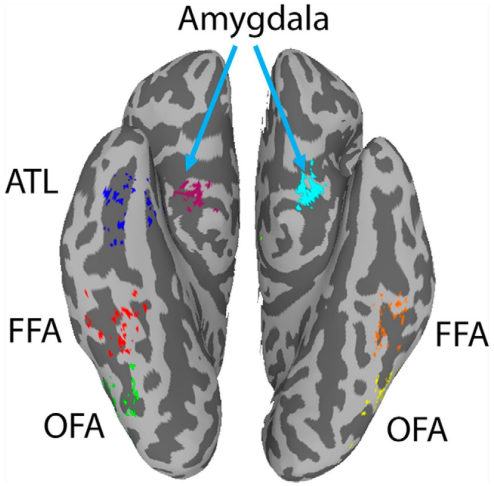
图片像素
相似性

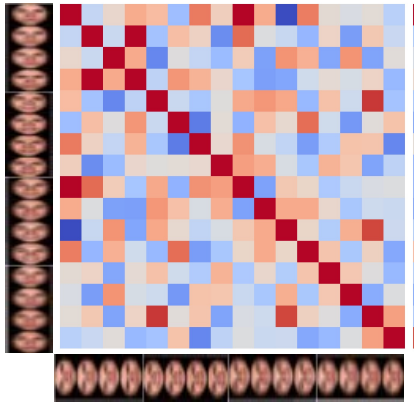


人类评价
面孔相似性

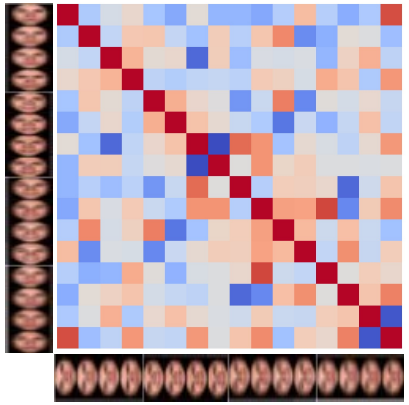


人类平均
诱发感受相似性

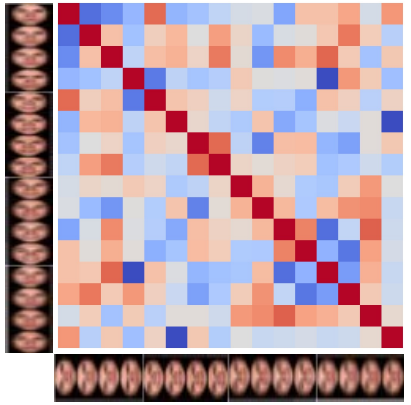




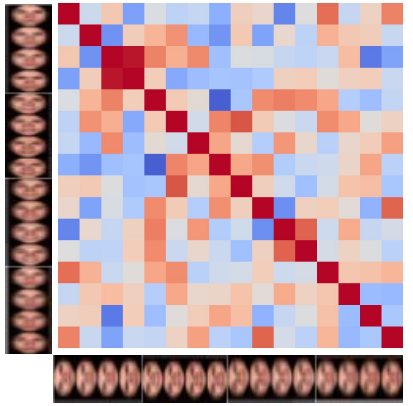
OFA神经相似性



FFA神经相似性



ATL神经相似性

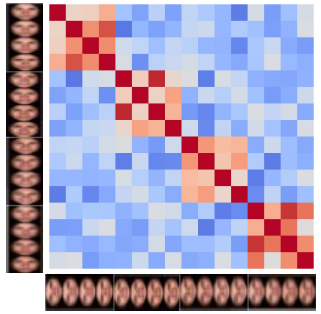


Amygdala神经相似性

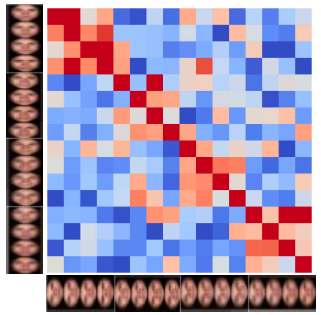
演示数据，仅供参考

基于多变量模式分析的研究思路

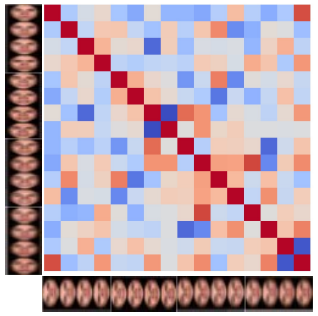
结果预期



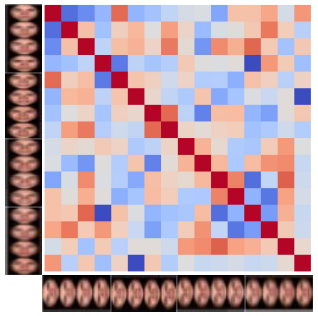
人类评价
面孔相似性



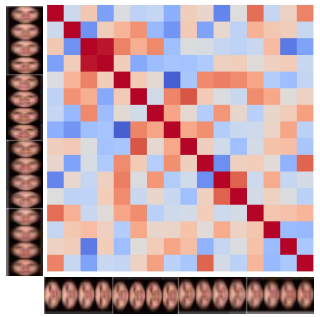
人类平均
诱发感受相似性



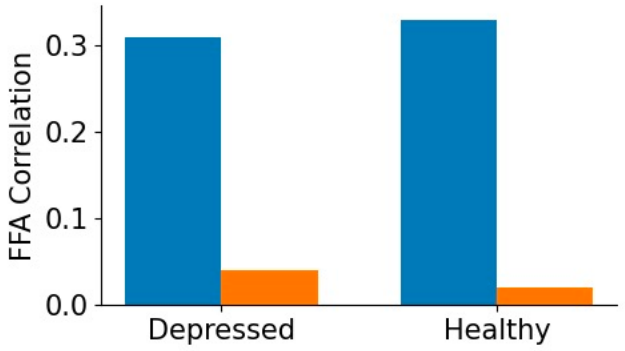
FFA神经相似性

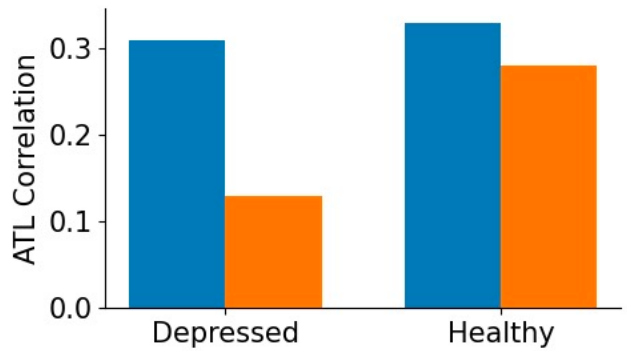


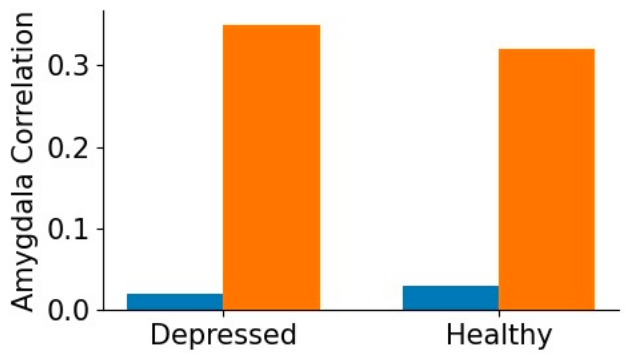
ATL神经相似性

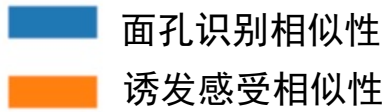


Amygdala神经相似性









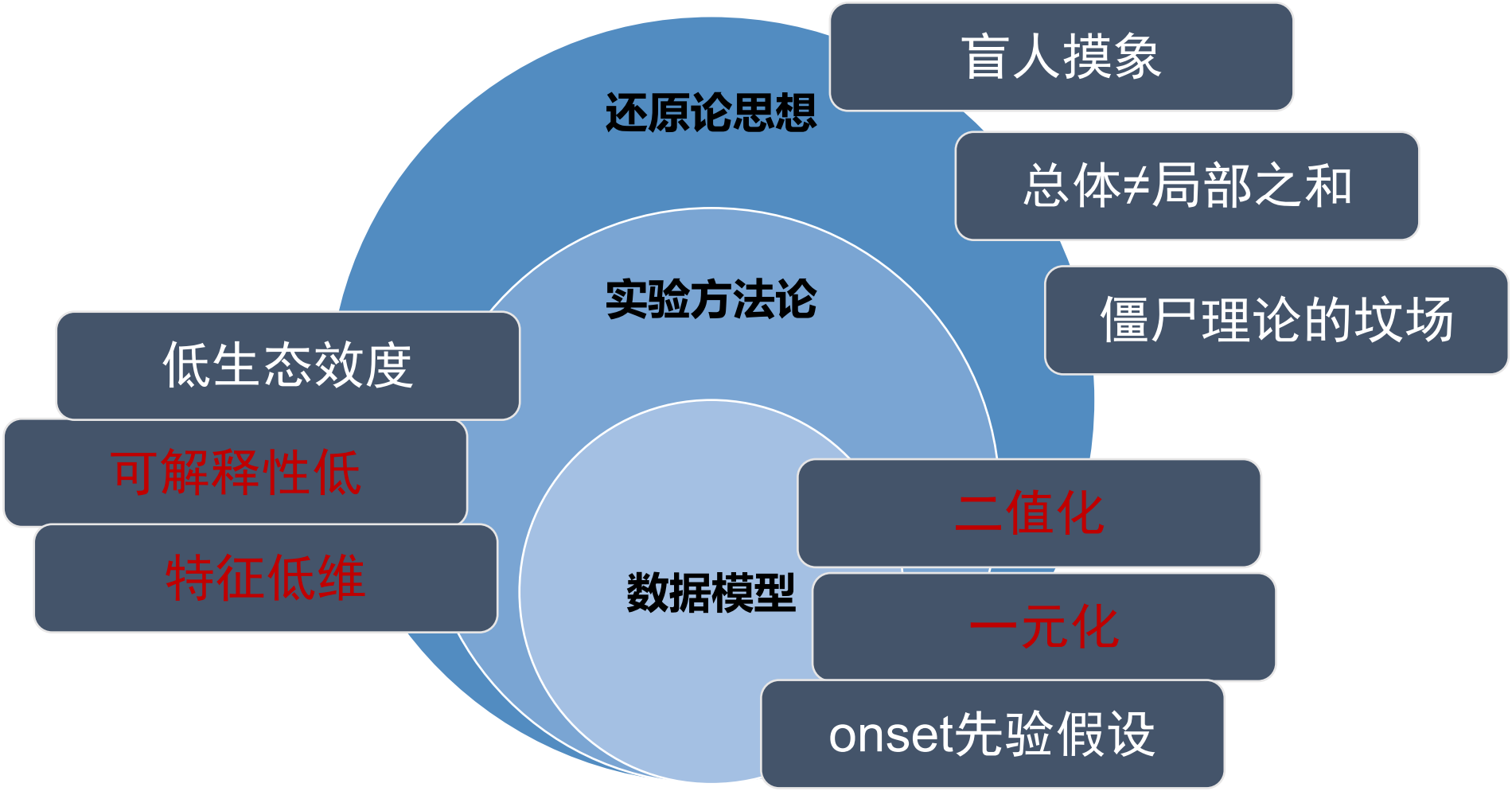
- 抑郁症和健康人群都可以准确编码面孔信息
- 抑郁症只能通过面孔信息识别面孔情绪
- 健康人群综合面孔信息和诱发感知综合地识别面孔情绪
- 抑郁症和健康群体都能准确表征面孔所诱发的感受

- 抑郁症的情绪理解而非情绪感受出现了问题

一切看起来很完美了，但是……

抑郁症真的是这样认识世界的吗？

仍然存在的困境


还原论思想
盲人摸象
总体≠局部之和
僵尸理论的坟场
实验方法论
低生态效度
可解释性低
特征低维
数据模型
二值化
一元化
onset先验假设

作为人工智能的起源学科，神经科学正在逐渐被人工智能抛弃

Part 2

认知神经科学的自然主义趋势

日常生活中接收到的刺激是高度复杂的

语气

措辞

面部表情

手势

空间距离

说话内容

各自的反应

两个人的性格

最近发生了什么

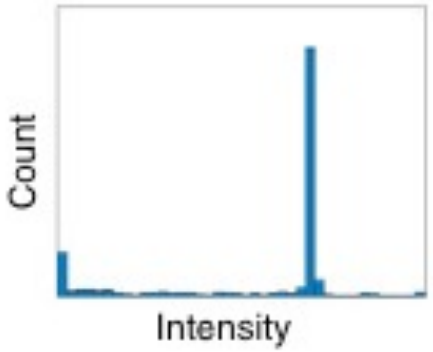
刚才发生了什么

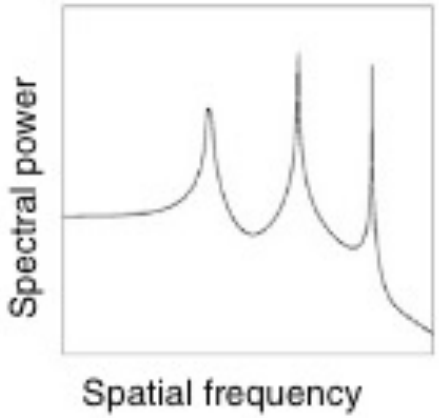
这两个人的关系

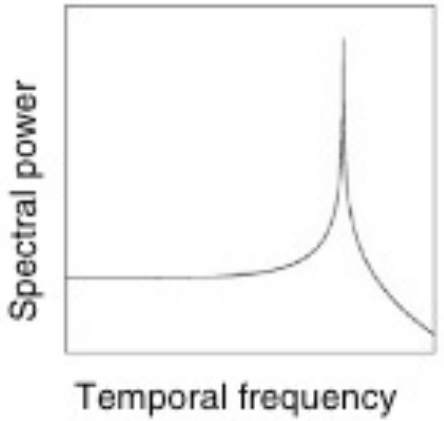
当下的物理环境

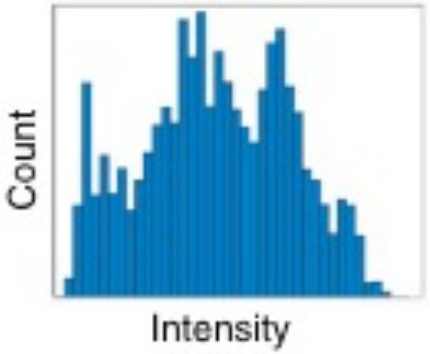
几点了

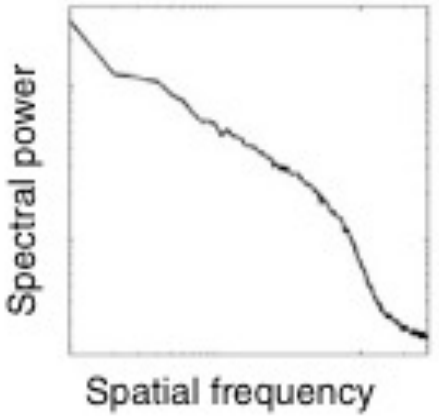
心理学的真空球形鸡？

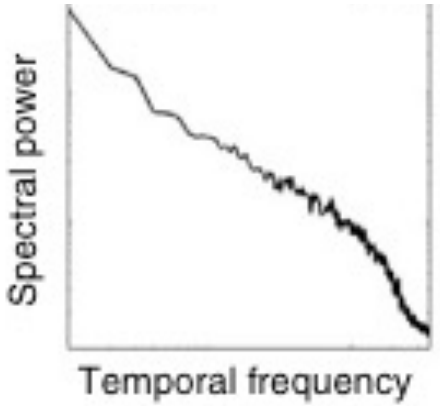








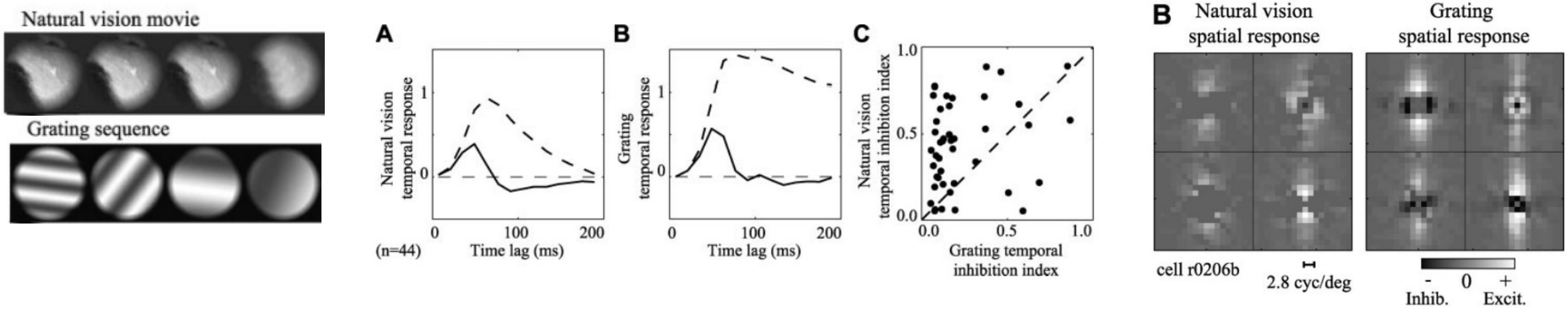




实验室情景下严格控制的刺激与日常生活所经验的相去甚远

Sonkusare TICS 2019

自然刺激下的神经响应模式与实验室刺激相去甚远



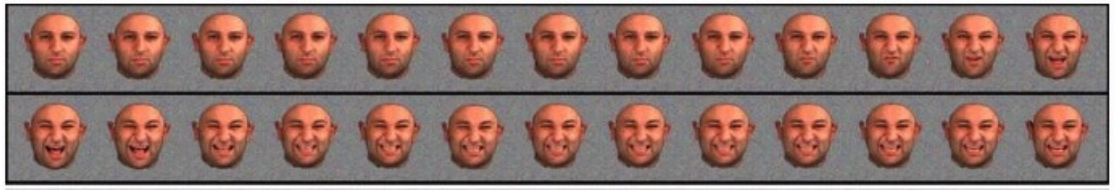
David JN 2004

即使如V1这样经典又简单的脑区，加工自然刺激时的模式也与实验室刺激相去甚远

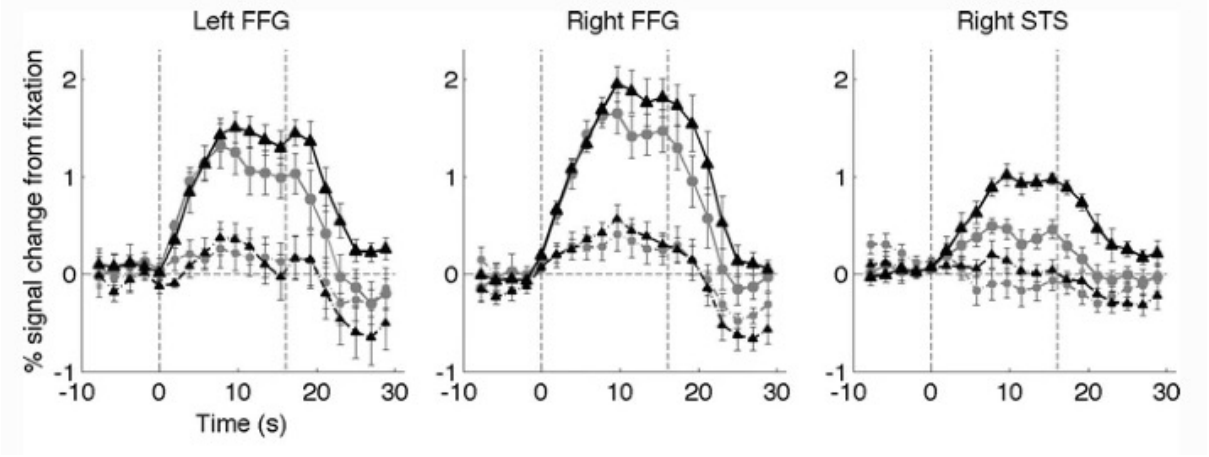
We can rightfully claim to understand only 10% to 20% of how V1 actually operates under normal conditions.

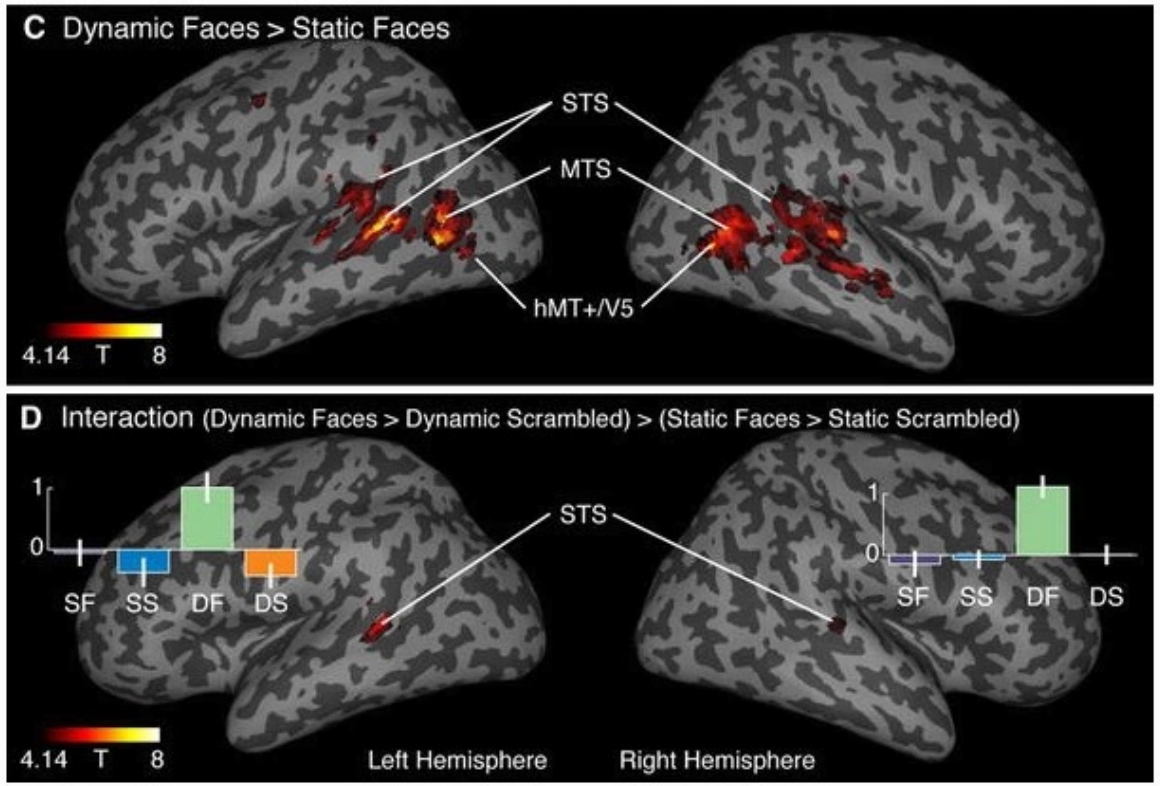
——Bruno A. Olshausen

大脑对复杂刺激的神经调制可能比人工刺激更强



Dynamic Faces vs. Static Faces





Schultz Exp. Brain Res 2009

自然主义范式开山之作

Science

HOME > SCIENCE > VOL. 303, NO. 5664 > INTERSUBJECT SYNCHRONIZATION OF CORTICAL ACTIVITY DURING NATURAL VISION

RESEARCH ARTICLES

Intersubject Synchronization of Cortical Activity During Natural Vision

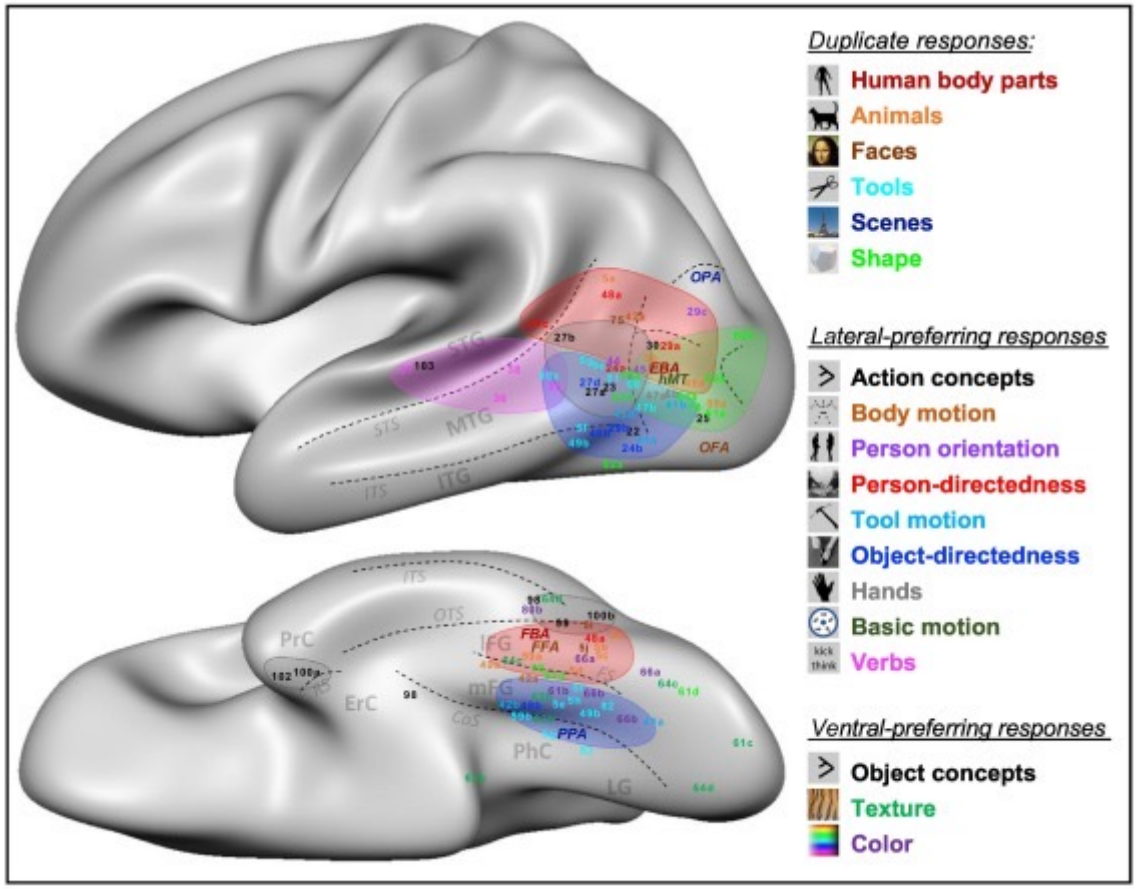
URI HASSON, YUVAL NIR, IFAT LEVY, GALIT FUHRMANN, AND RAFAEL MALACH Authors Info & Affiliations

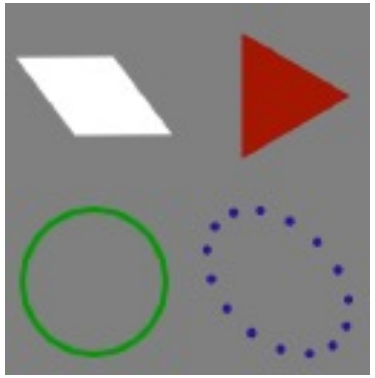
SCIENCE · 12 Mar 2004 · Vol 303, Issue 5664 · pp. 1634-1640 · DOI: 10.1126/science.1089506

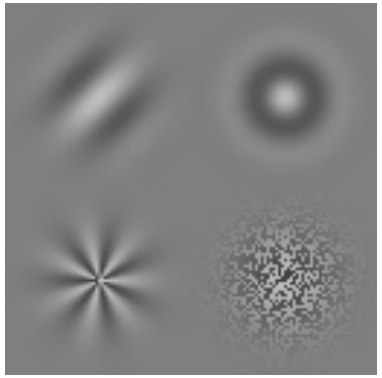
Citation: 1847

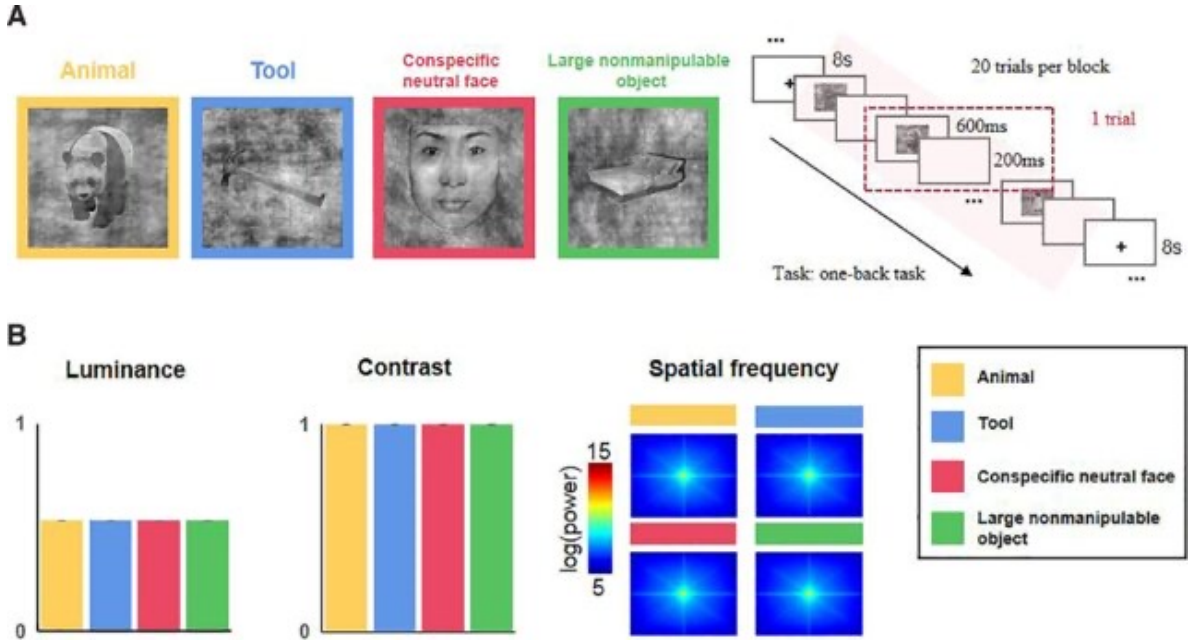
如何开展一项基于自然主义方法的研究

传统视觉研究的实验刺激与方法









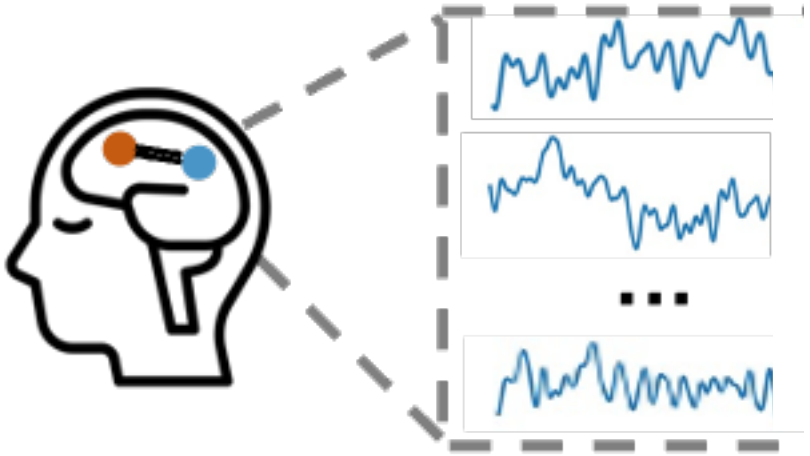
Wen JN 2023; Wurm TICS 2022

还原论方法的局限性

- 现实生活中不存在这样孤立于背景和其他客体的客体
- 现实生活中的客体总是处于运动或相对运动的情景
- 现实生活中个体可以自由地选择注意对象
- 现实生活中的视觉加工总是与其他模态同时进行

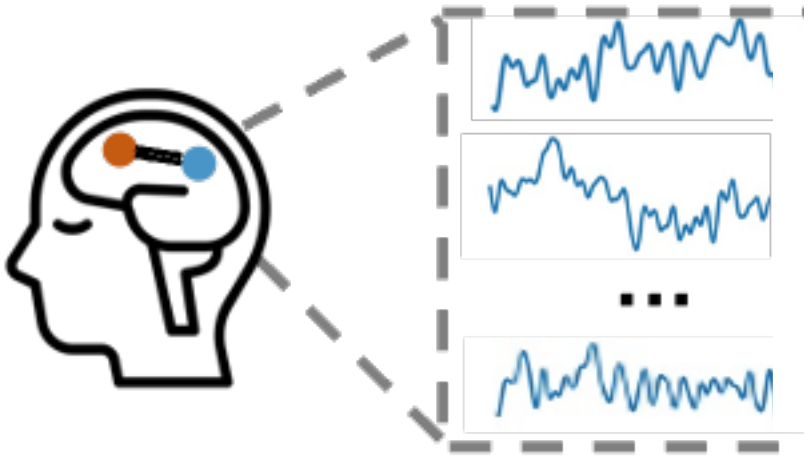
换而言之，神经系统是为了应对“复杂的、运动的、多模态的外部环境”而综合进化的。并不是分别进化出孤立的客体、运动、注意系统后再组装。

研究问题



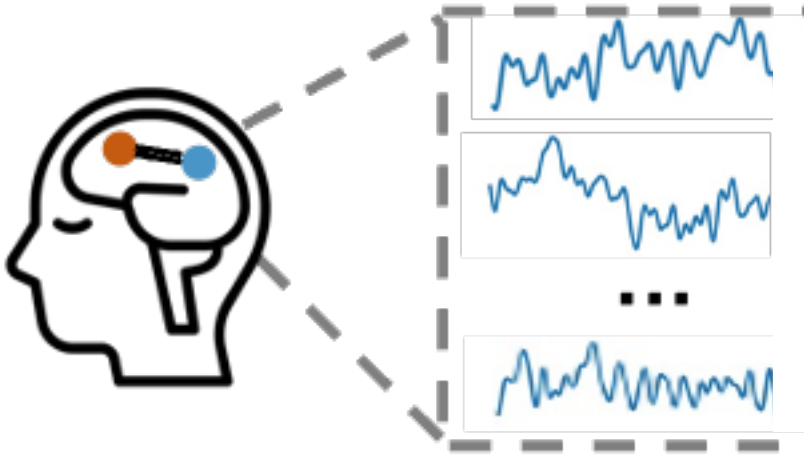
个体在加工真实的(real-world)、复杂的(complex)、自然的(naturalistic)视觉刺激时的神经活动模式是什么？

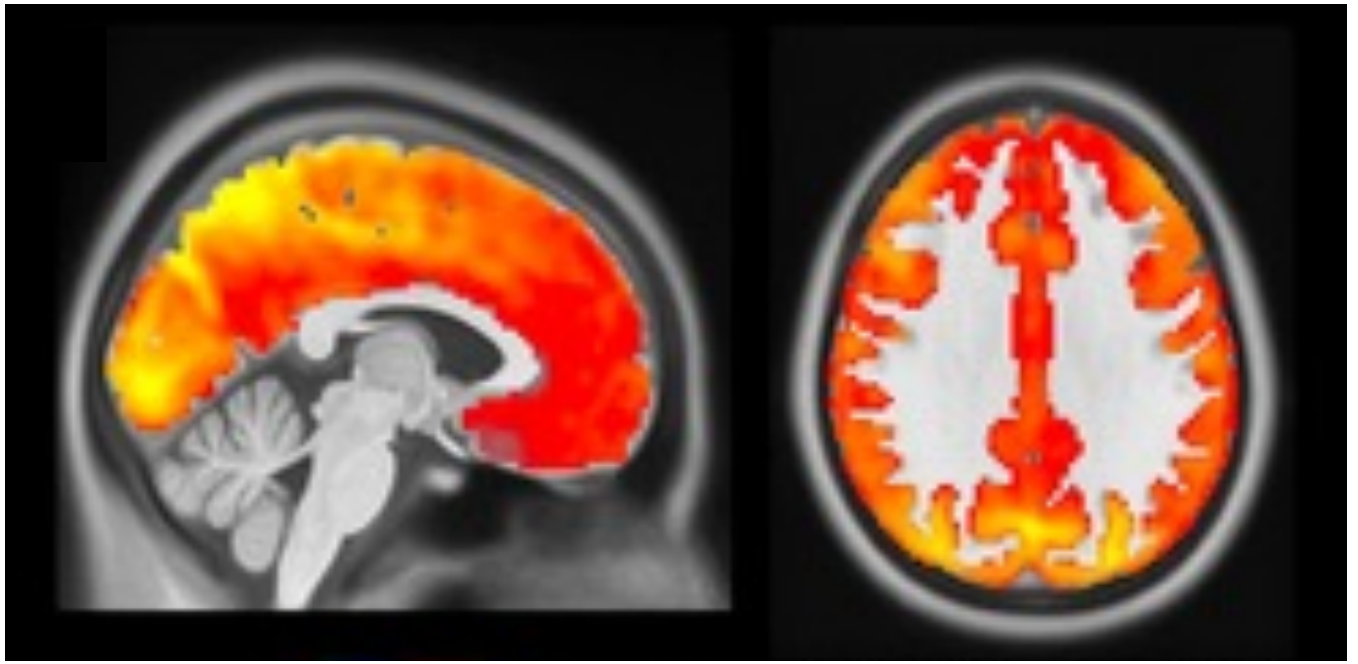
但是，没有实验设计矩阵的情况下该如何分析数据？



假设被试观看的是一部默片，我们能否通过比较激活强度发现V1的激活比A1更高？

很不幸地是并不能

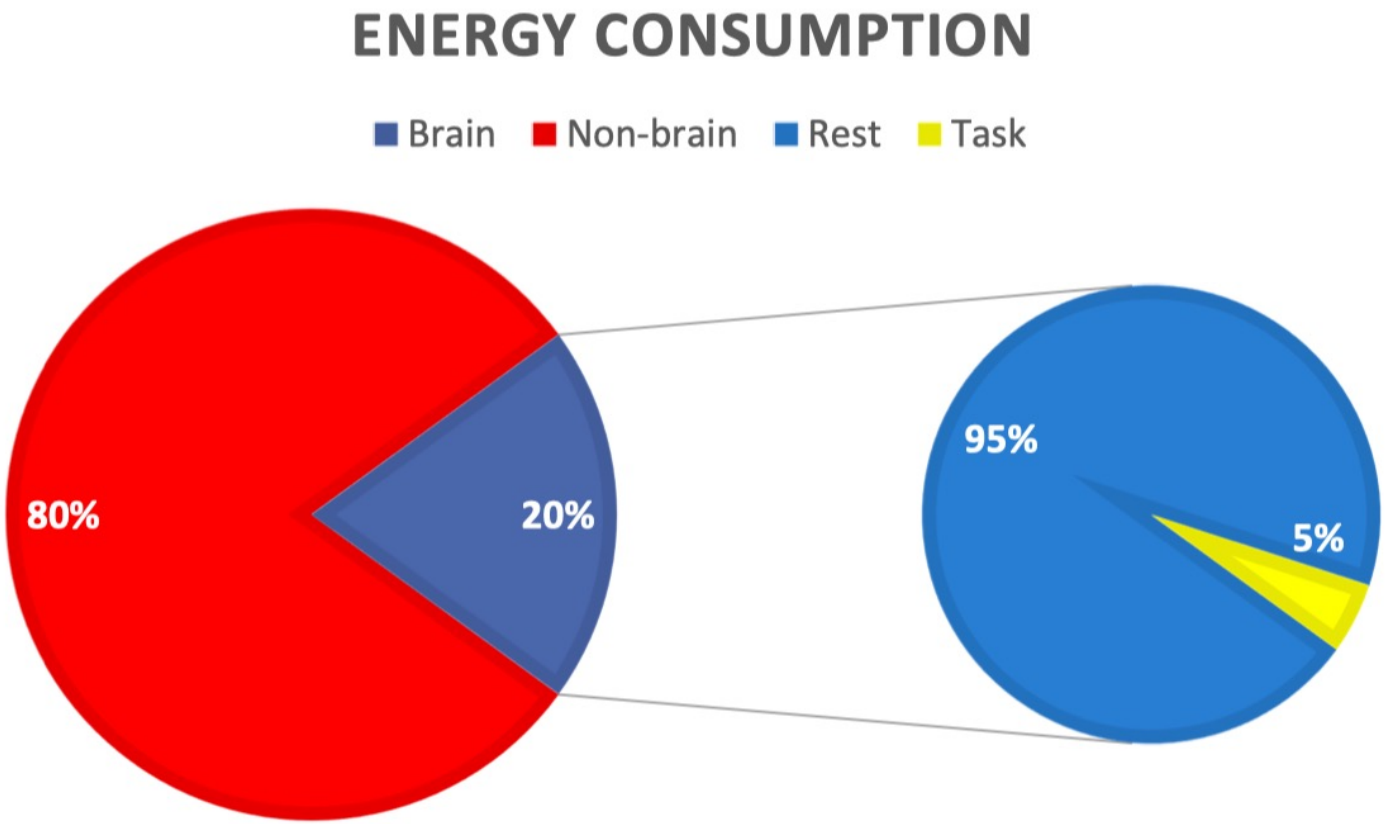


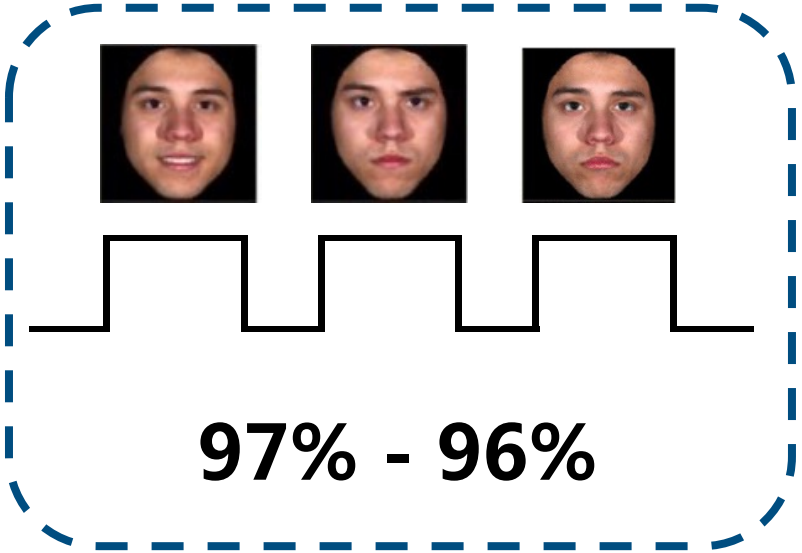


为什么不能呢？

如何开展一项基于自然主义方法的研究

神经信号的组成





Science

Current Issue First release papers

HOME > SCIENCE > VOL. 314, NO. 5803 > THE BRAIN'S DARK ENERGY

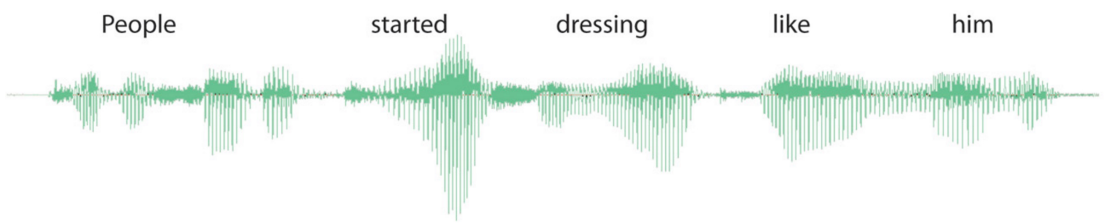
PERSPECTIVES

The Brain's Dark Energy

MARCUS E. RAICHLE Authors Info & Affiliations

SCIENCE · 24 Nov 2006 · Vol 314, Issue 5803 · pp. 1249-1250 · DOI: 10.1126/science.1134405

神经信号的组成

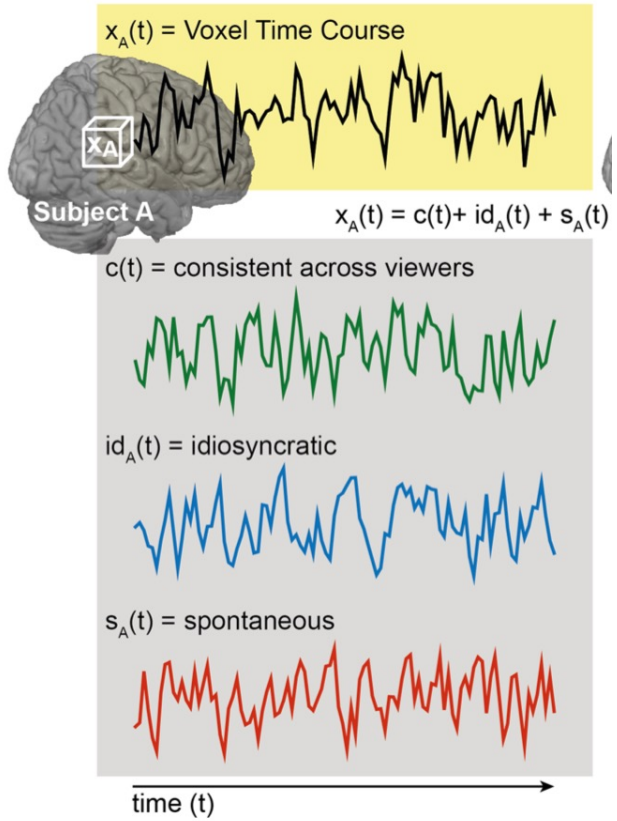


Observed signal

Consistent stimulus-evoked signal

Idiosyncratic stimulus-evoked signal

Stimulus-unrelated signal

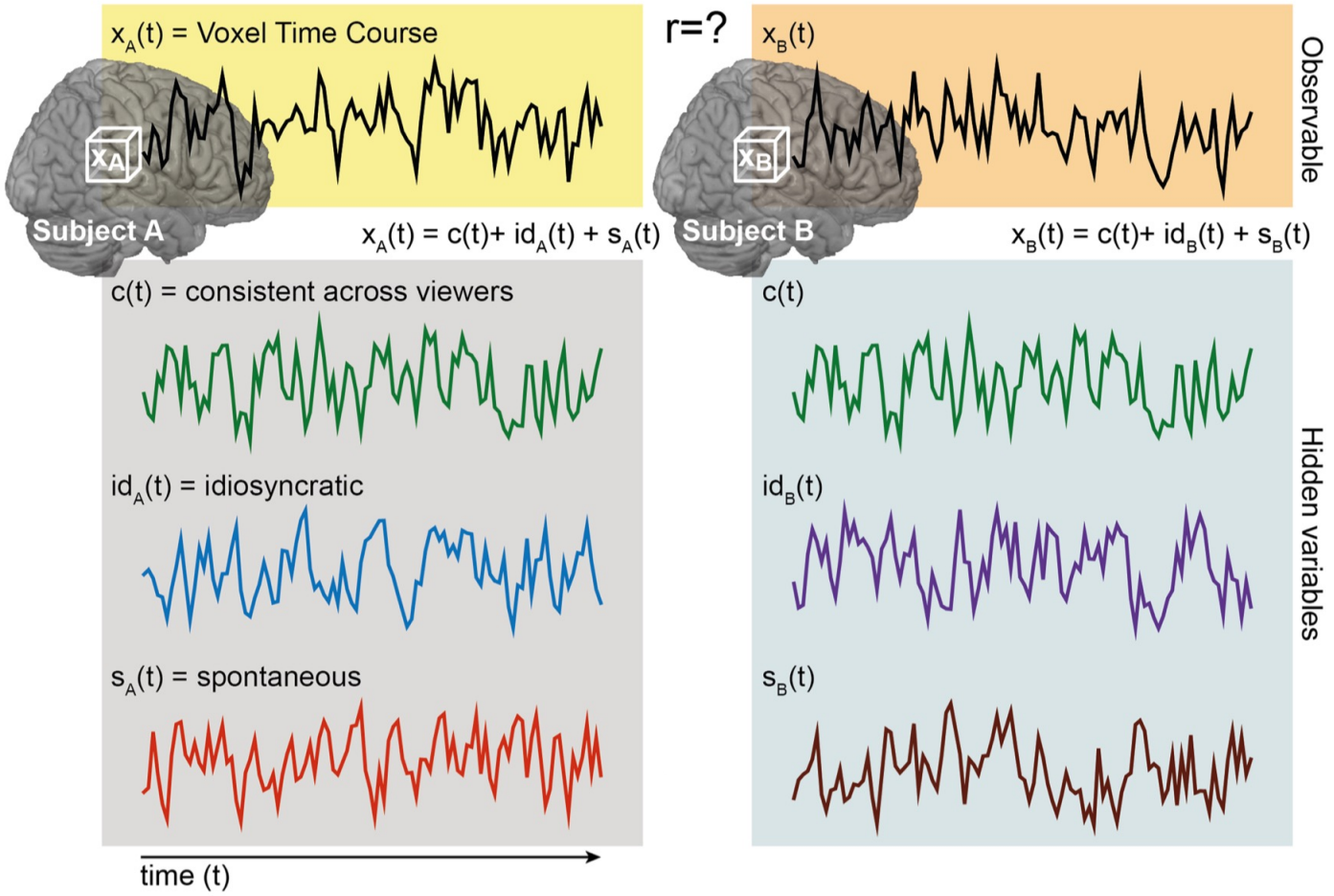


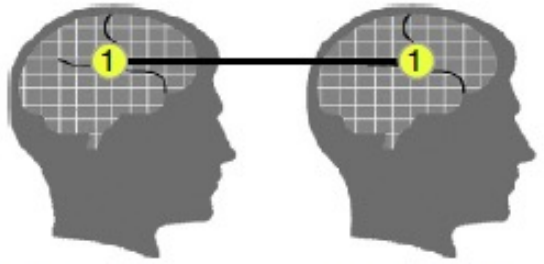
$$x_A(t) = c(t) + id_A(t) + s_A(t)$$

Nastase SCAN 2019

如何开展一项基于自然主义方法的研究

Intersubject Correlation (ISC)





$x_A(t) = c(t) + id_A(t) + s_A(t)$ $x_B(t) = c(t) + id_B(t) + s_B(t)$

$$E[C_A(t), C_B(t)]$$

$$+$$

$$E[id_A(t), id_B(t)] = E[X_A(t), X_B(t)]$$

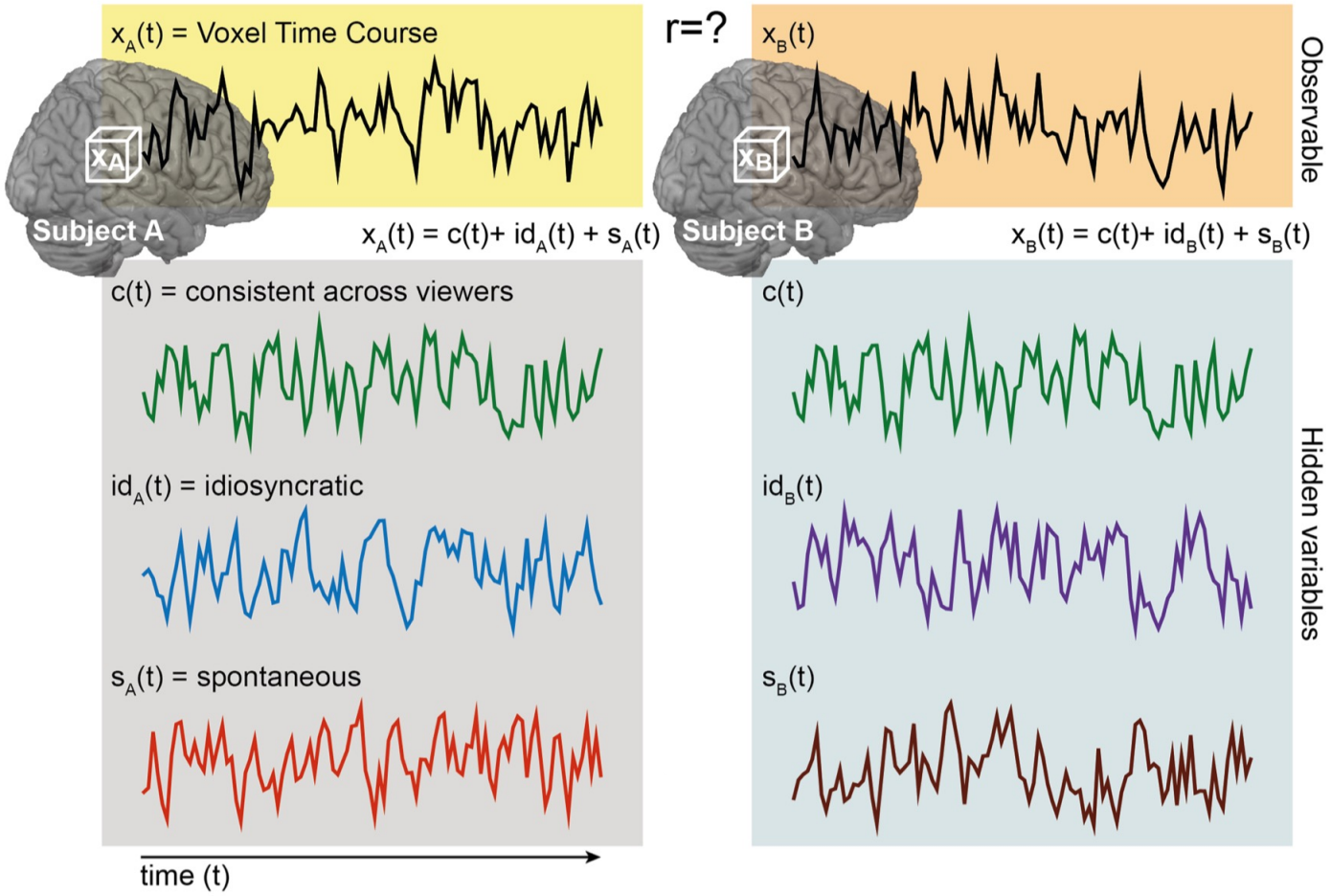
$$+$$

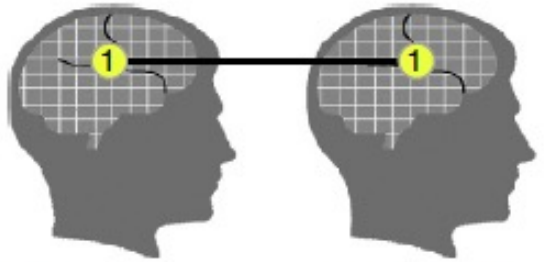
$$E[S_A(t), S_B(t)]$$

理论相关值？

如何开展一项基于自然主义方法的研究

Intersubject Correlation (ISC)



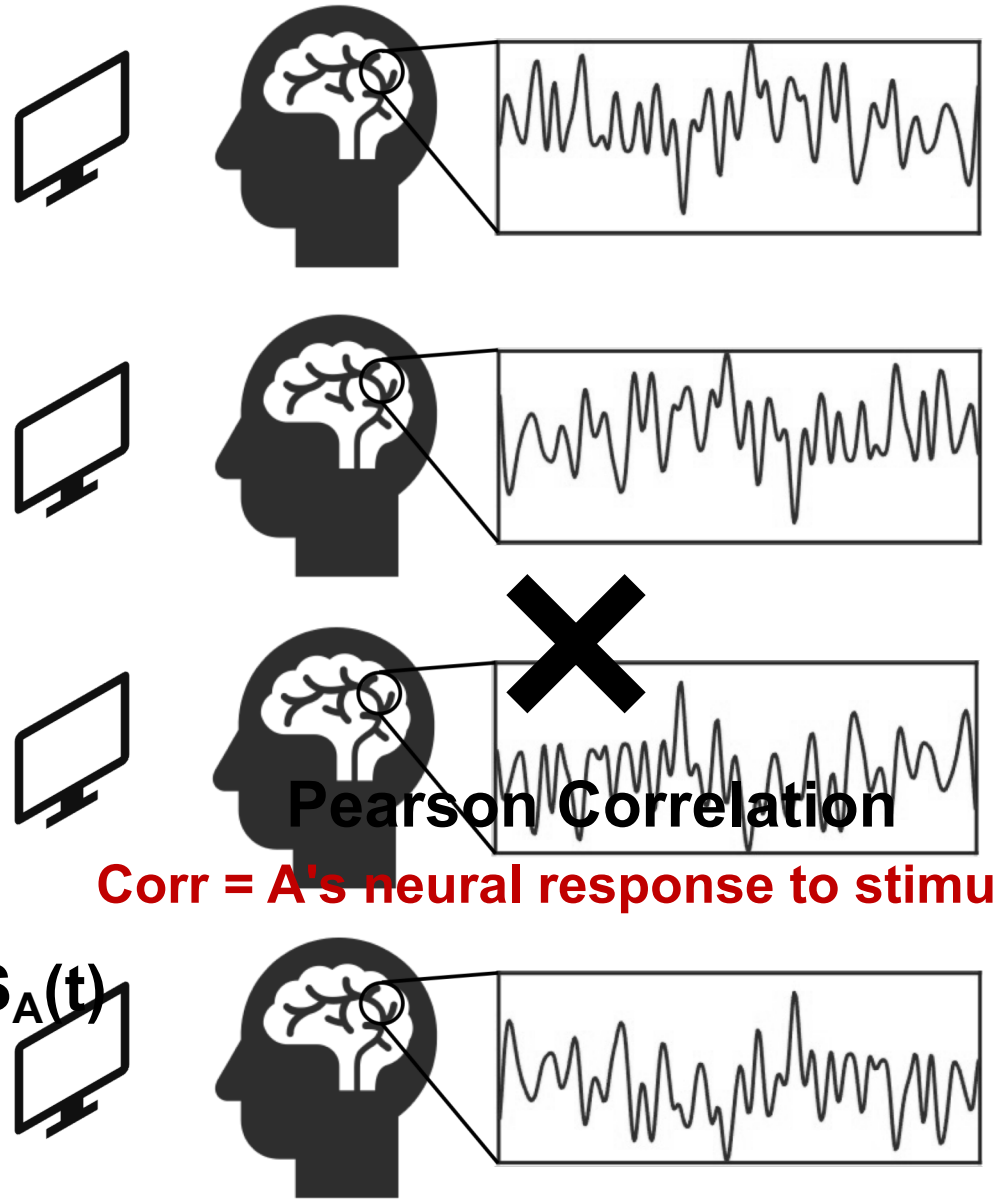


$x_A(t) = c(t) + id_A(t) + s_A(t)$ $x_B(t) = c(t) + id_B(t) + s_B(t)$

$$E[C_A(t), C_B(t)] \; 1 \; + \; E[id_A(t), id_B(t)] \; 0 \; + \; E[S_A(t), S_B(t)] \; 0 = E[X_A(t), X_B(t)]$$

理论相关值

$$E[C_A(t), C_B(t)] \cong E[X_A(t), X_B(t)]$$

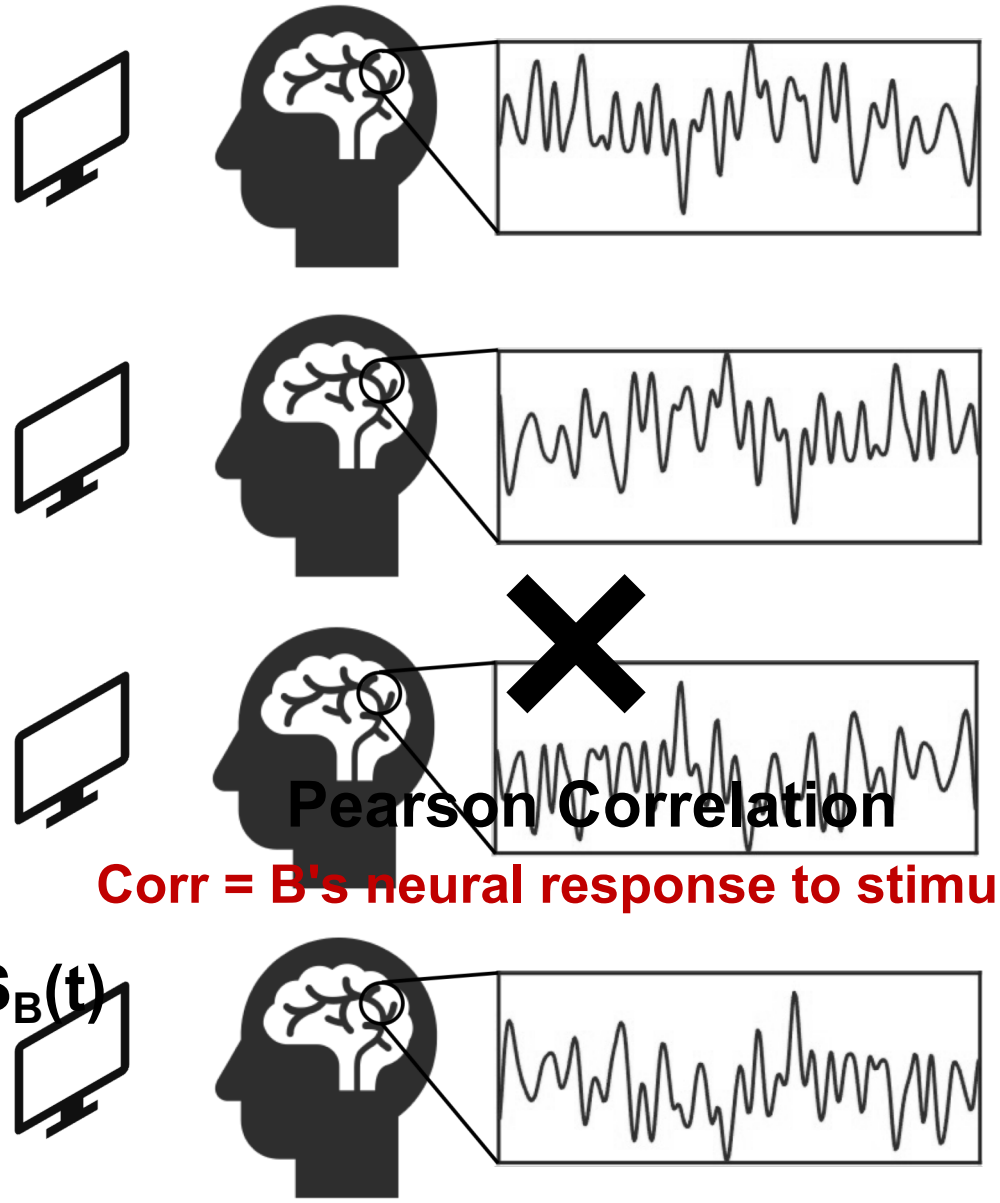


Pearson Correlation

Corr = A's neural response to stimulus

$X_A(t) = C(t) + id_A(t) + S_A(t)$

Average neural course
≈ C(t)



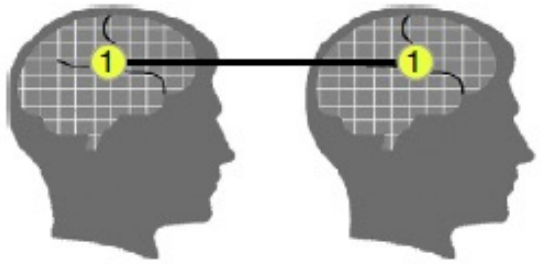
Pearson Correlation

Corr = B's neural response to stimulus

$X_B(t) = C(t) + id_B(t) + S_B(t)$

Average neural course ≈ C(t)

ISC反映不同脑区对刺激的响应程度



$x_A(t) = c(t) + id_A(t) + s_A(t)$ $x_B(t) = c(t) + id_B(t) + s_B(t)$

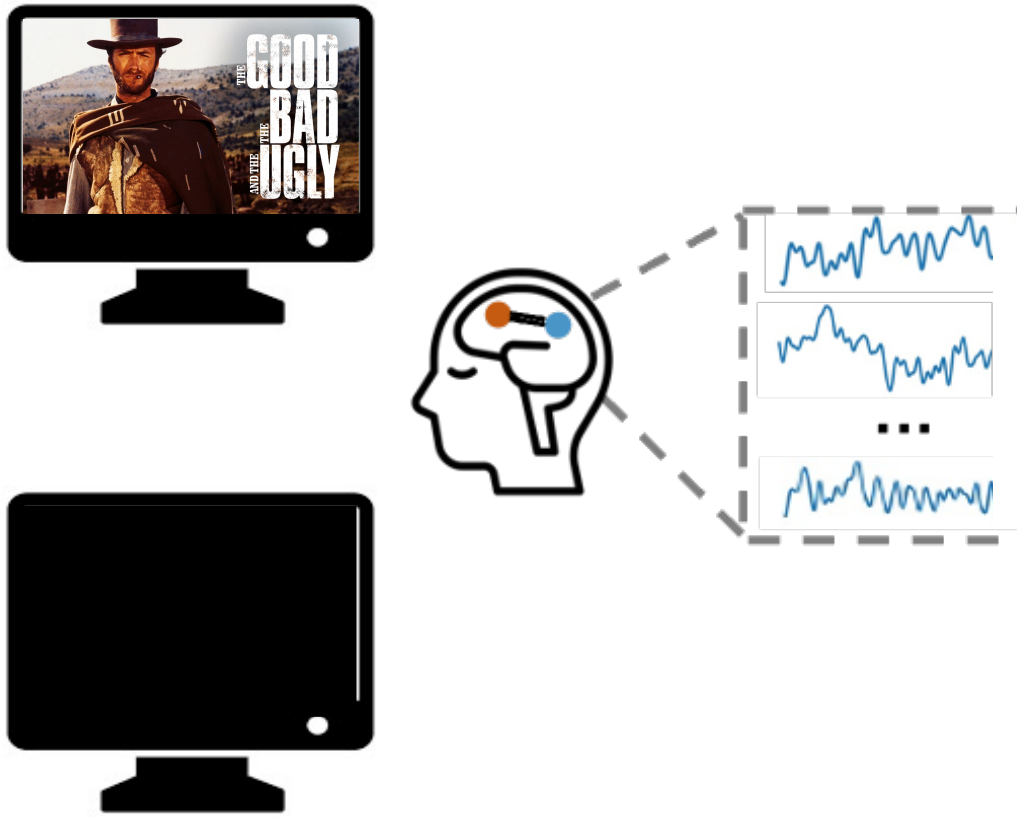
$$E[C_A(t), C_B(t)] + E[id_A(t), id_B(t)] + E[S_A(t), S_B(t)] = E[X_A(t), X_B(t)]$$

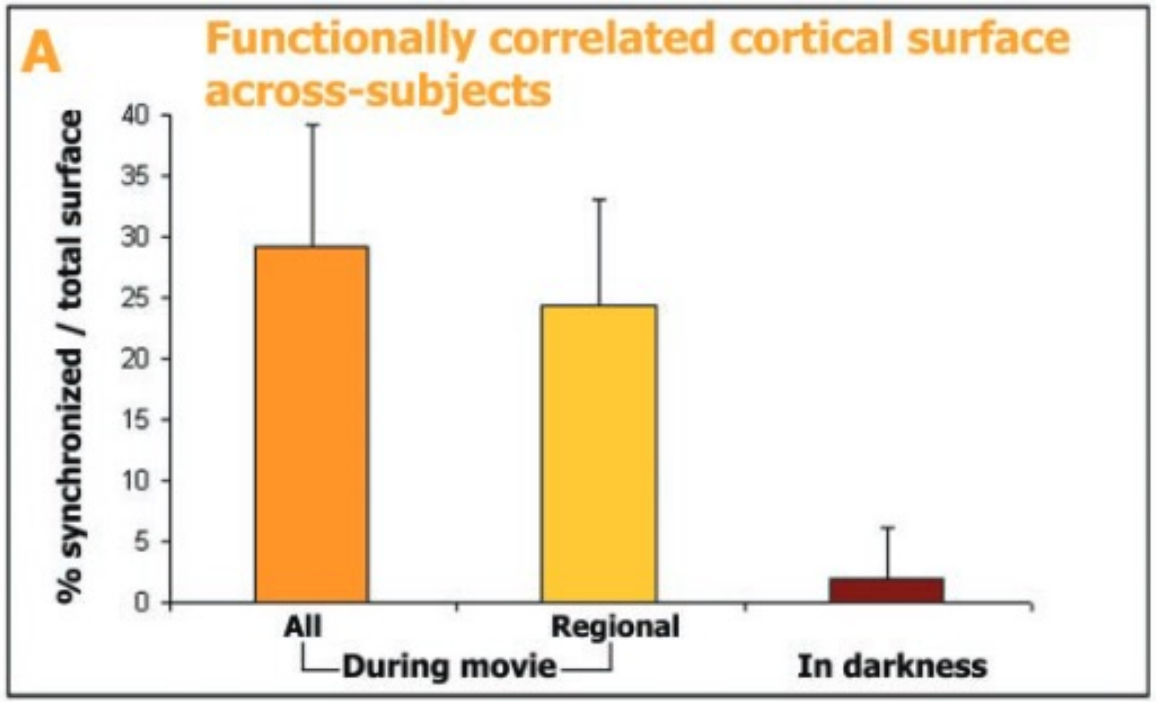
理论相关值？

理论相关值？

如何开展一项基于自然主义方法的研究

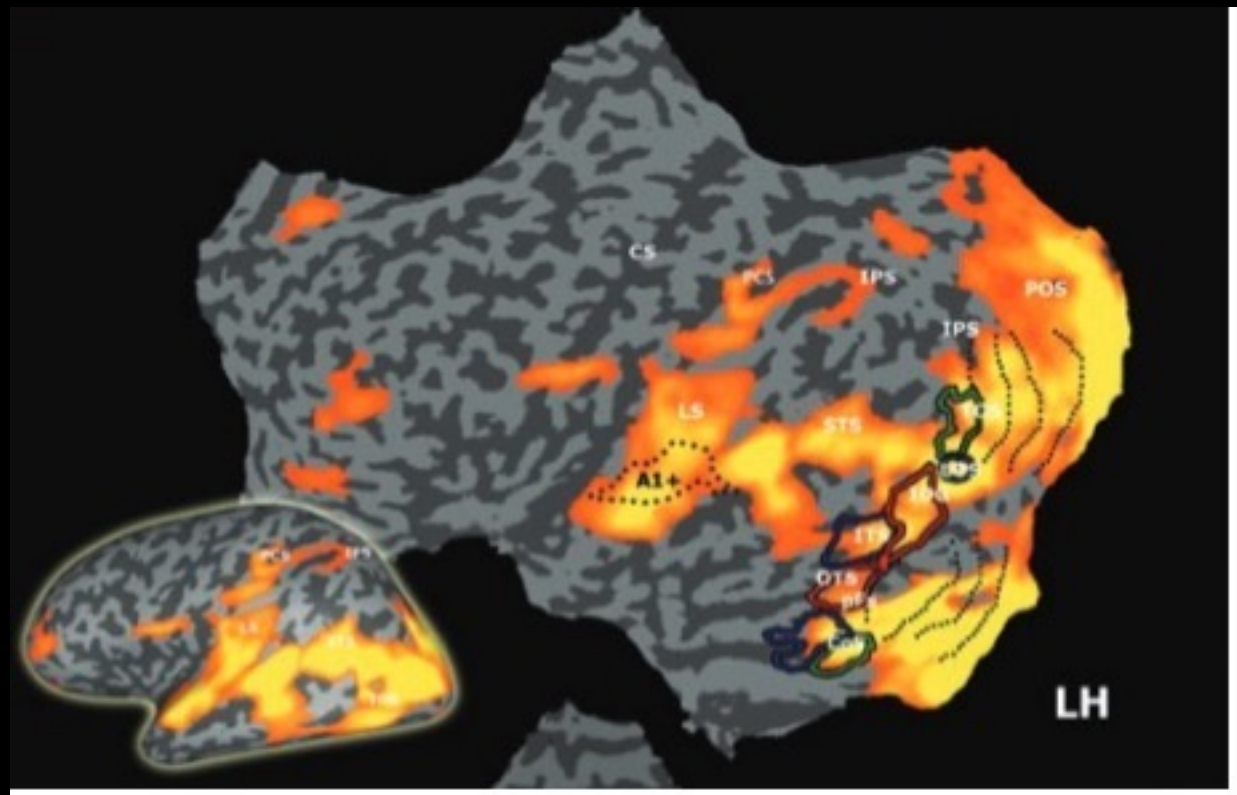
ISC反映不同脑区对刺激的响应程度

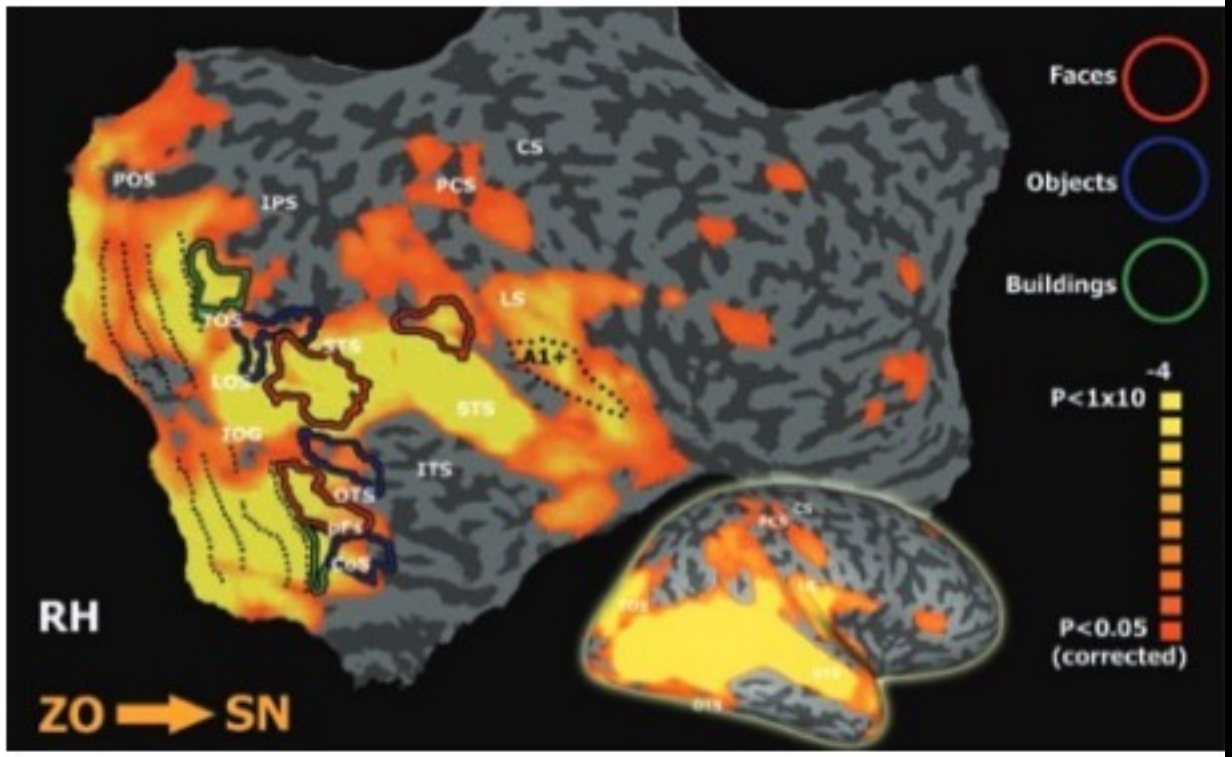




如何开展一项基于自然主义方法的研究

腹侧通路对自然刺激存在显著的神经响应，并延伸到涉及内容理解的区域

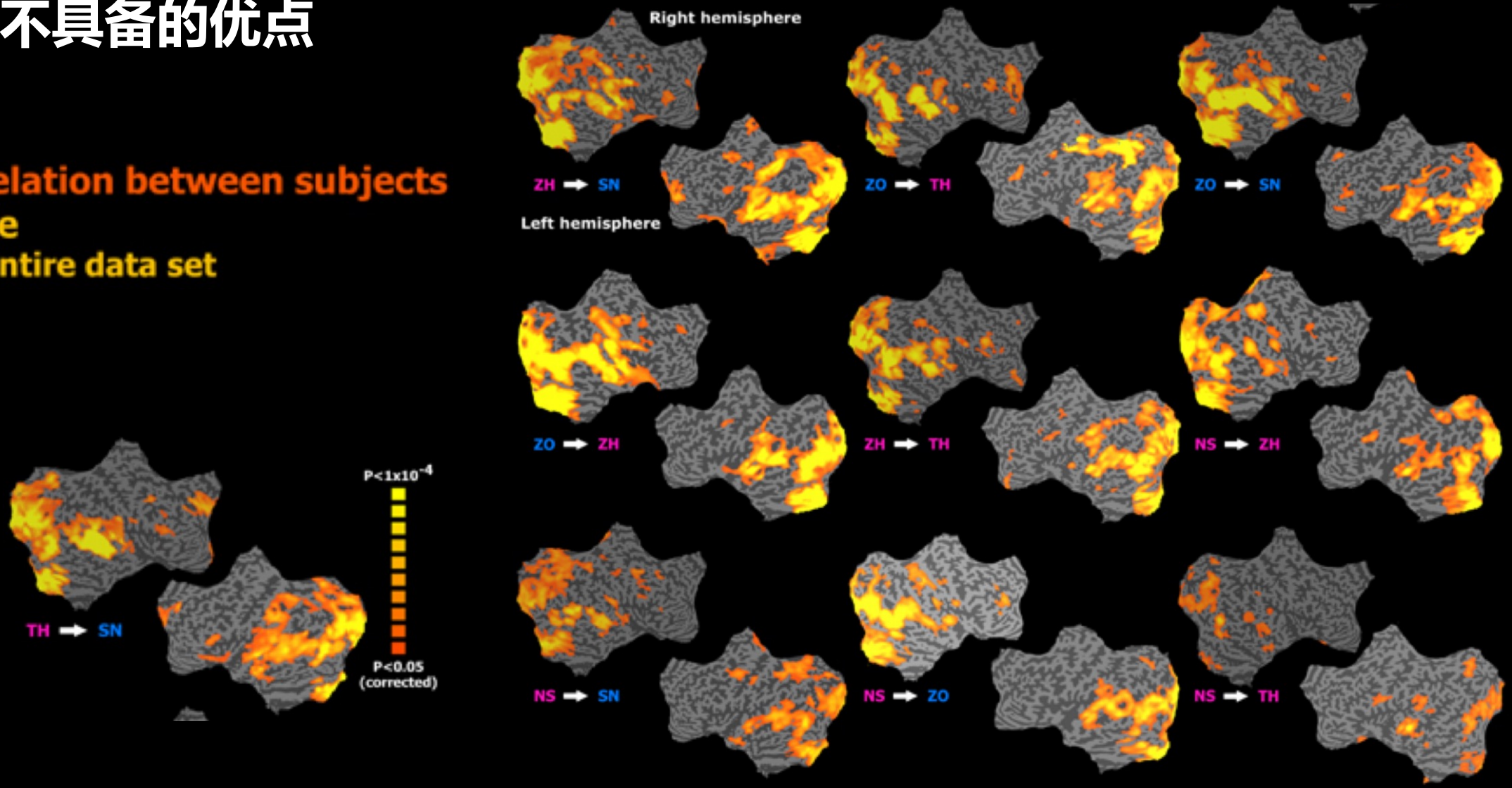




Correlation between subjects

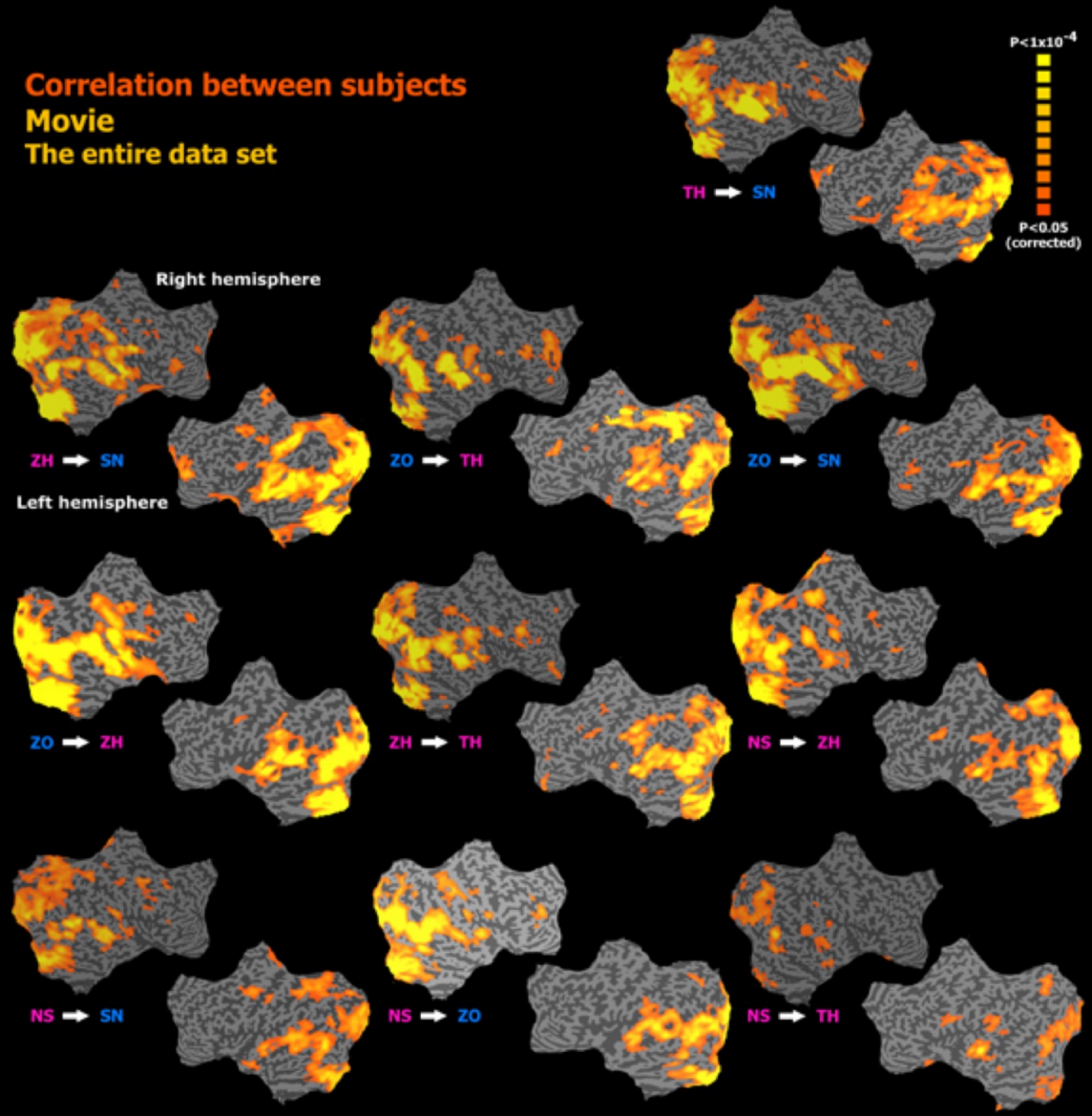
如何开展一项基于自然主义方法的研究

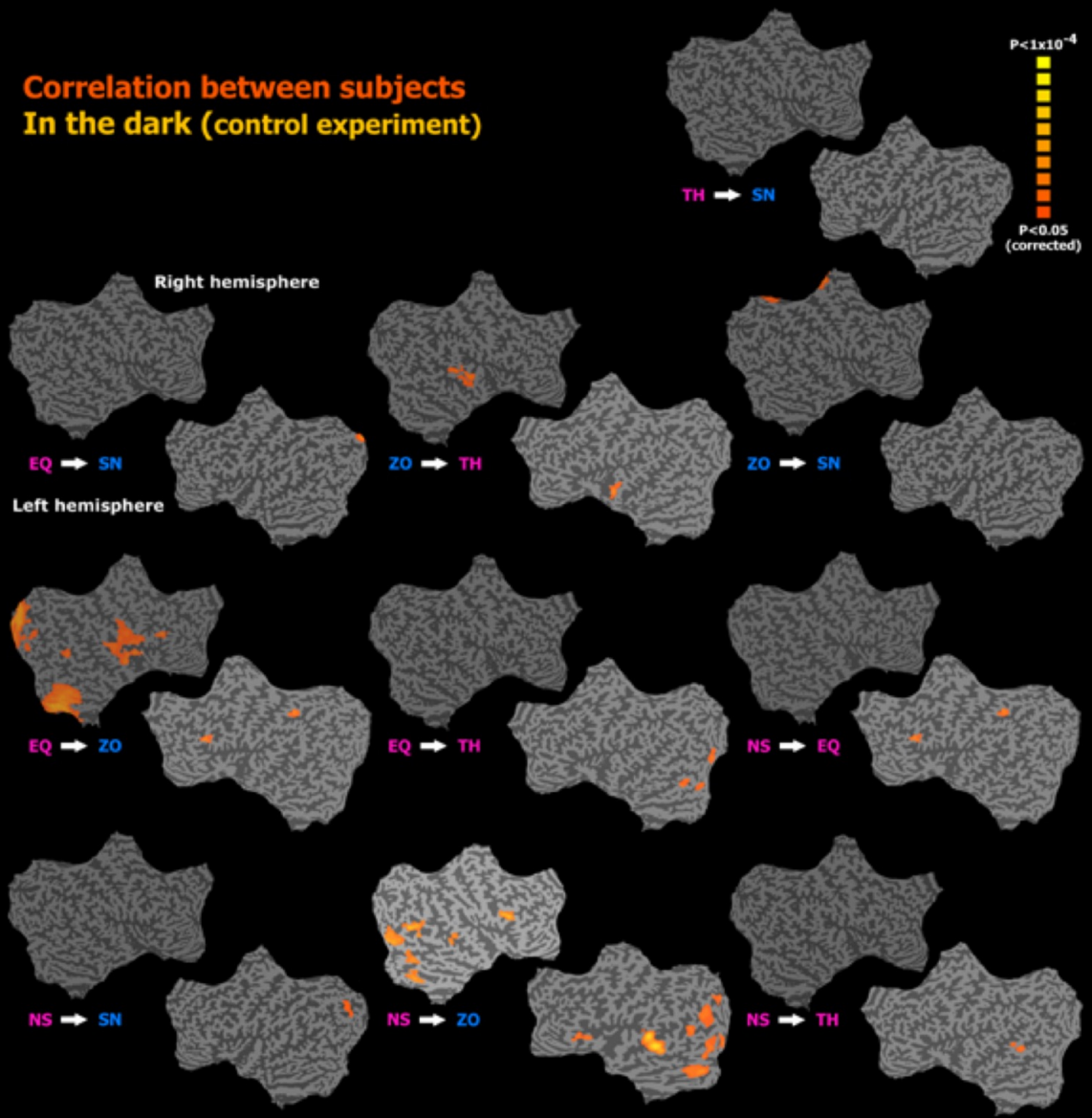
自然刺激任务下的ISC具有高度的跨被试一致性，这是传统基于叠加平均范式所不具备的优点



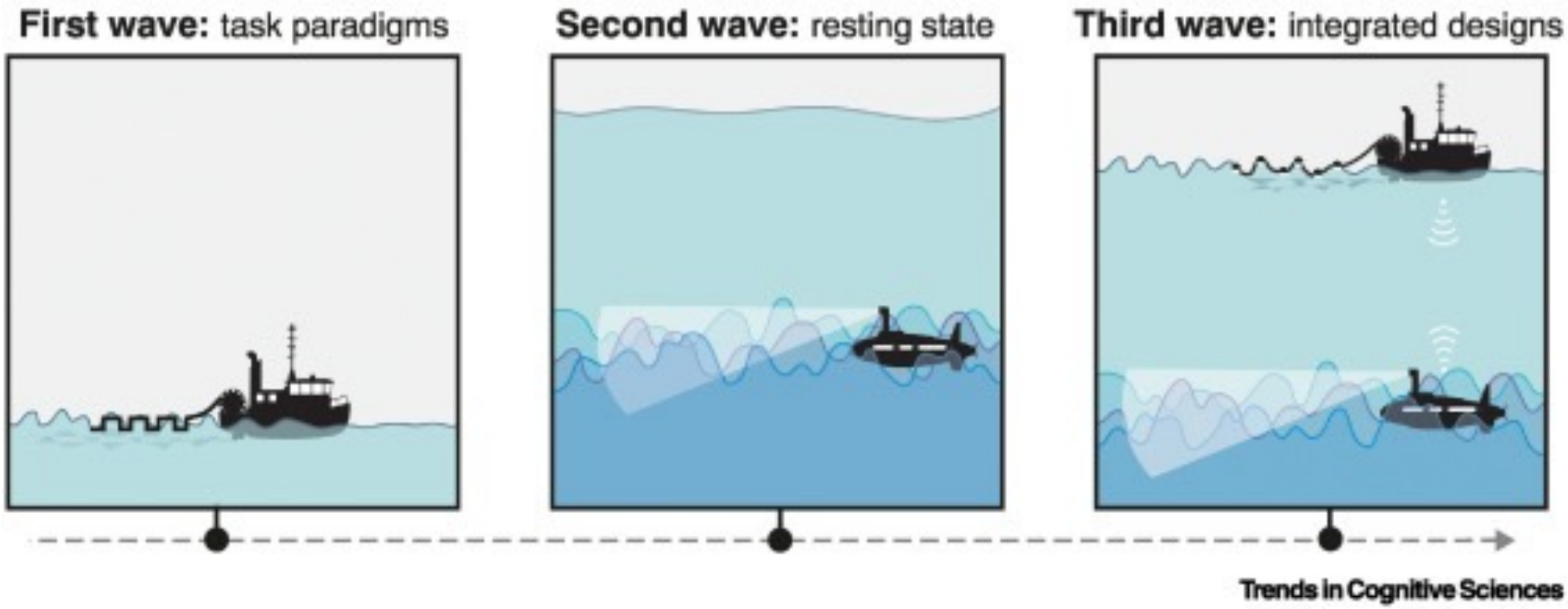
如何开展一项基于自然主义方法的研究

没有刺激的情况下，所有脑区的ISC几乎为0





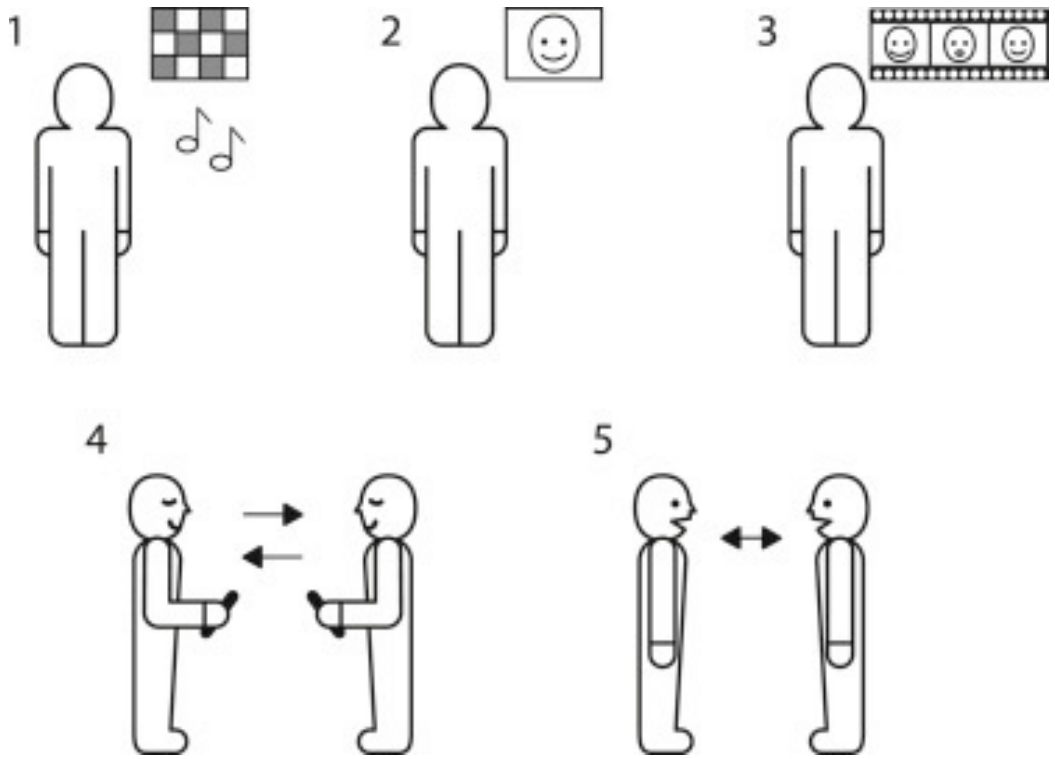
自然主义范式被认为是认知神经科学的第三波浪潮

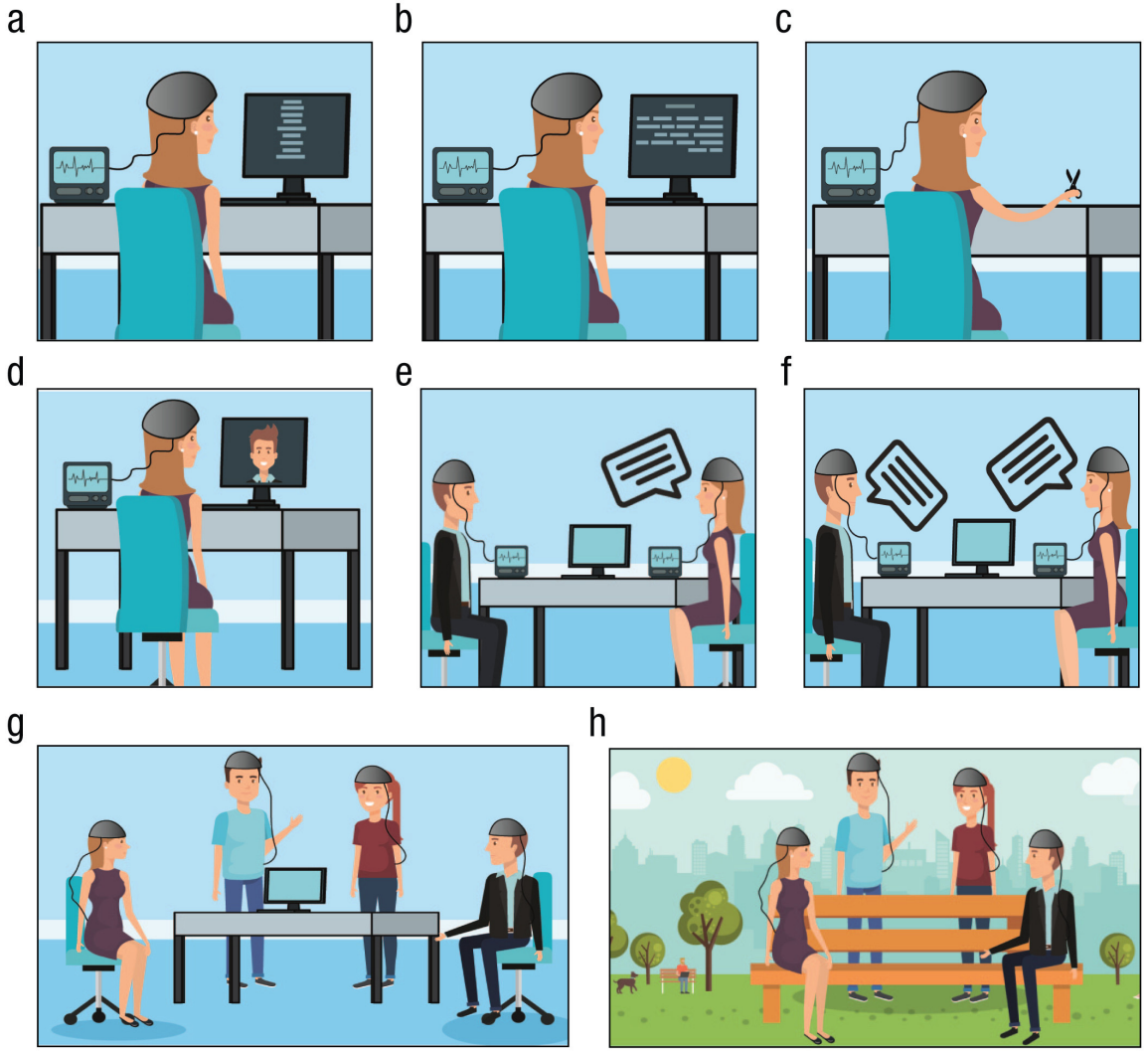


只要开动创造力，几乎所有的研究问题都可以通过自然主义范式来回答

Finn TICS 2021

认知神经科学思想和方法变革





Hari et al., 2015 Neuron; Kingsbury et al., 2020 TICS; Shamay-Tsoory et al., 2019 Perspect Psychol Sci

认知神经科学的自然主义趋势

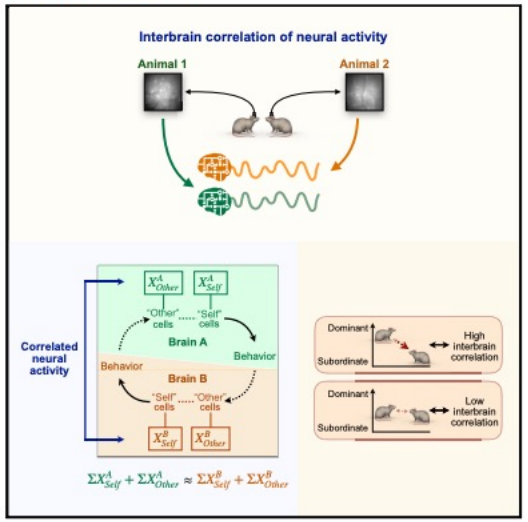
甚至拓展到了动物模型领域研究

Article

Cell

Correlated Neural Activity and Encoding of Behavior across Brains of Socially Interacting Animals

Graphical Abstract



Authors

Lyle Kingsbury, Shan Huang, Jun Wang, Ken Gu, Peyman Golshani, Ye Emily Wu, Weizhe Hong

Correspondence

whong@ucla.edu

In Brief

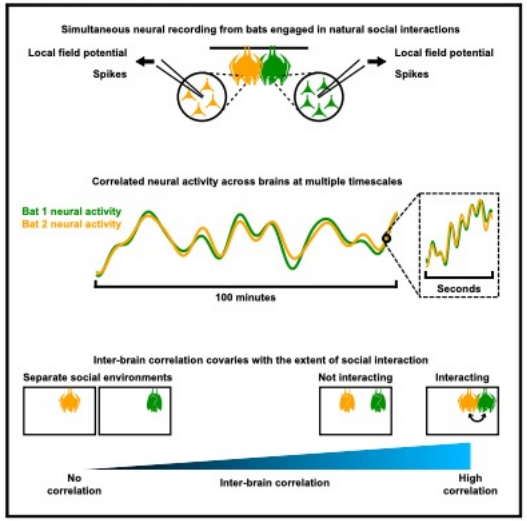
When two animals interact, neural activity across their brains synchronizes in a way that predicts how they will behave and how they form social dominance relationships.

Article

Cell

Correlated Neural Activity across the Brains of Socially Interacting Bats

Graphical Abstract



Authors

Wujie Zhang, Michael M. Yartsev

Correspondence

myartsev@berkeley.edu

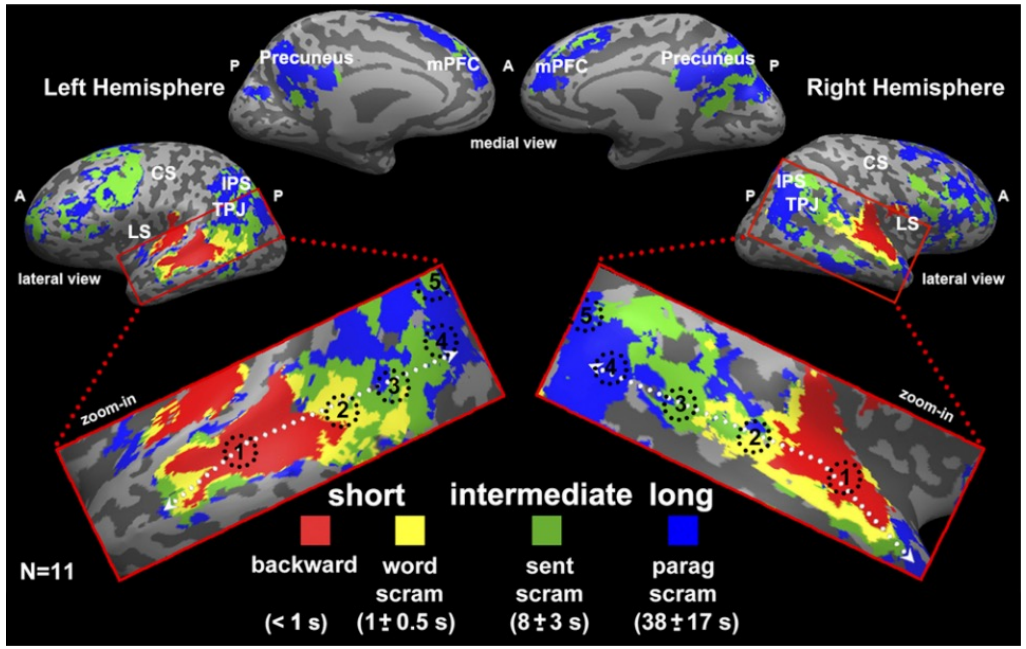
In Brief

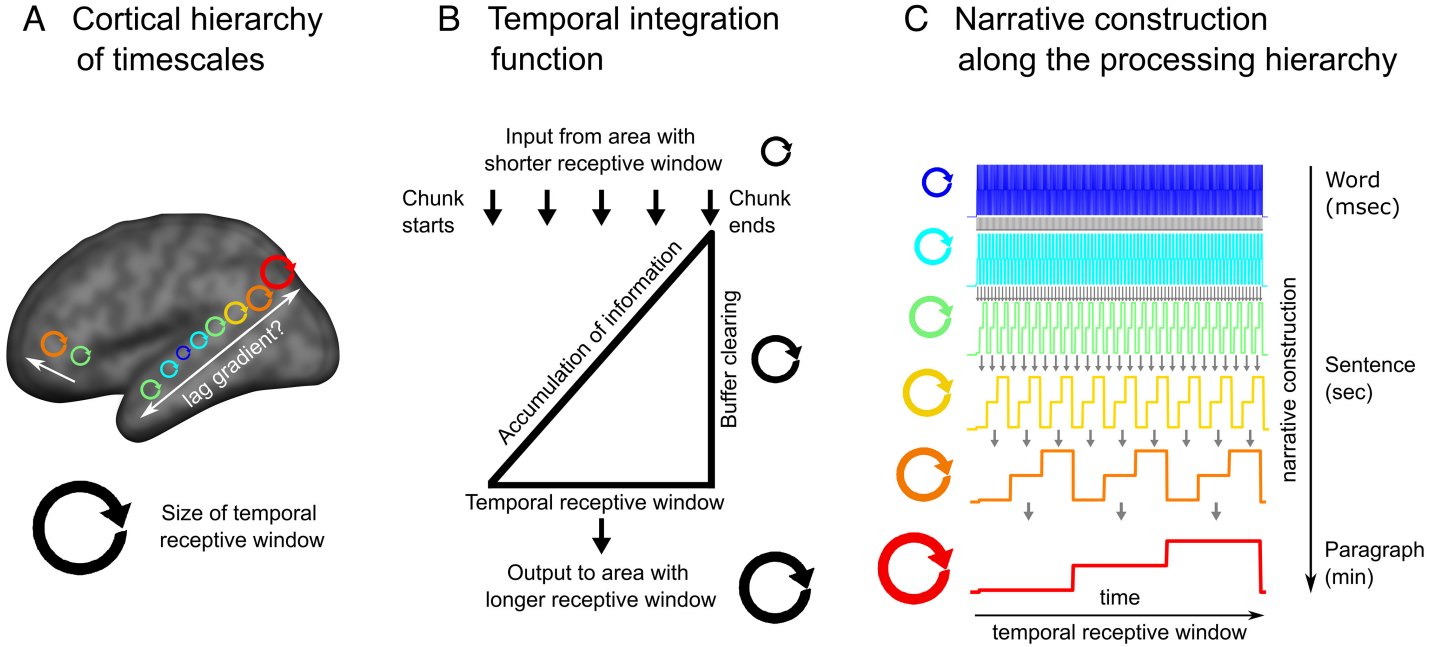
Social interactions involve complex animal behaviors. In socially interacting bats, there is inter-brain correlation of neural activity, reflecting current and future states of social behavior.

Part 3

自然主义范式研究进展

众多领域在过去二十年通过自然刺激范式取得了突破性进展

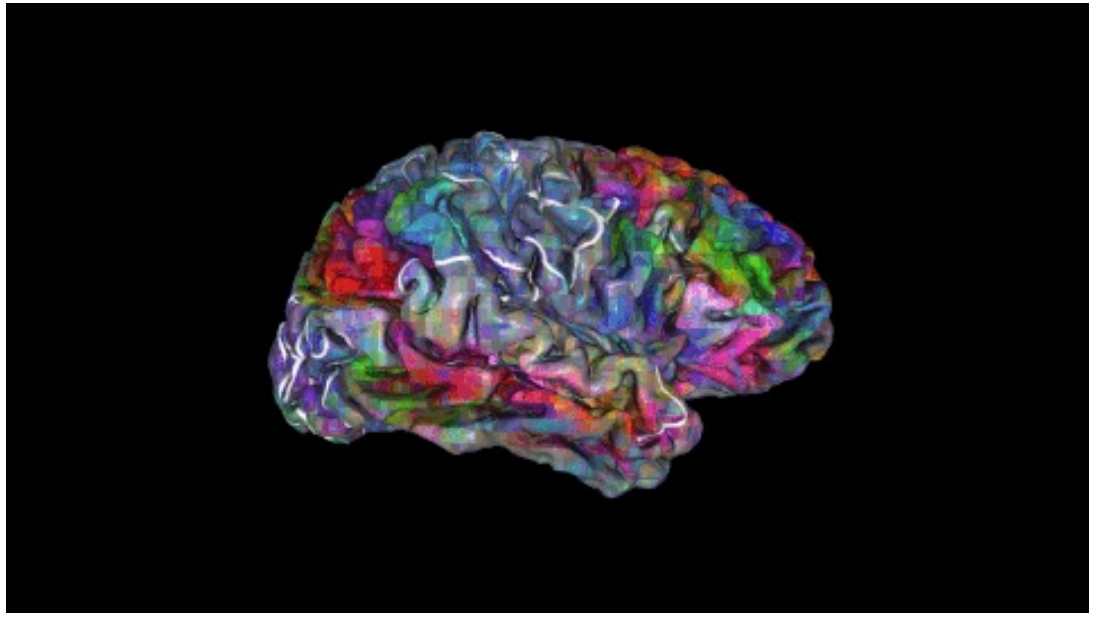




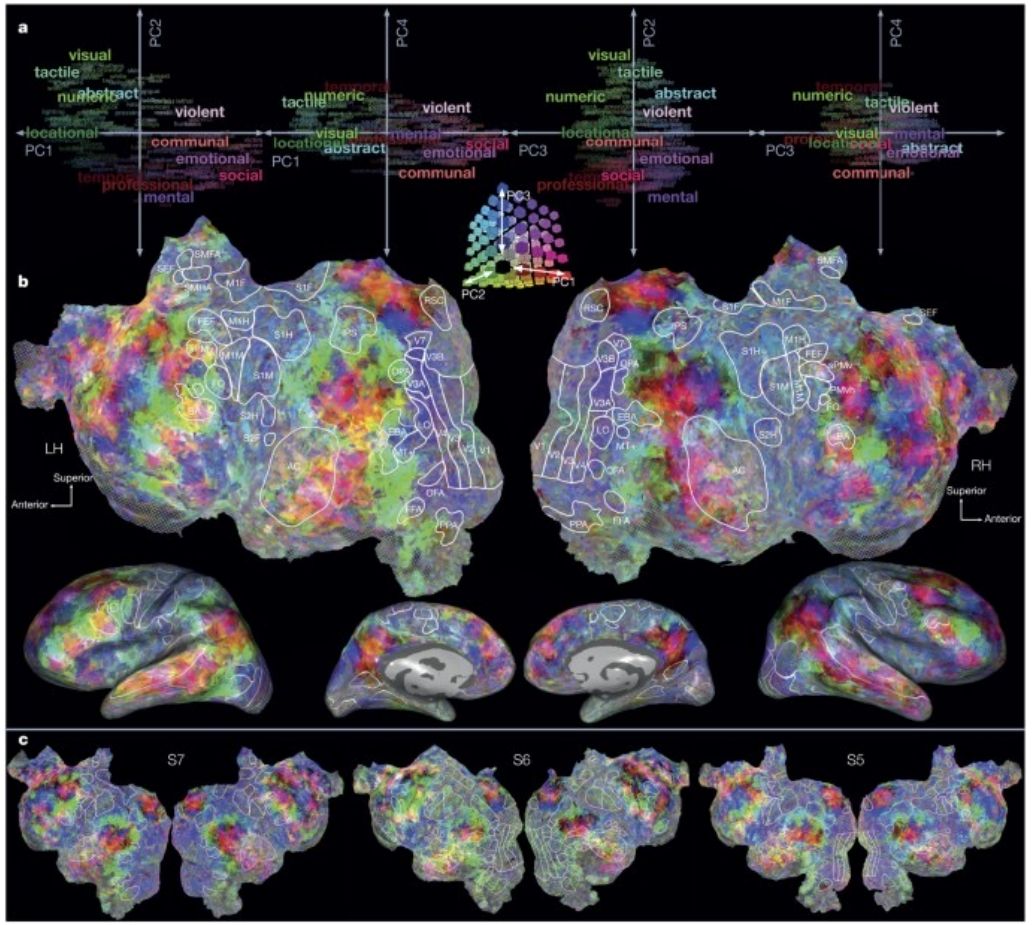
Lerner et al., 2011 JN; Chang et al.,2023 PNAS

发现大脑的层级累积加工机制

众多领域在过去二十年通过自然刺激范式取得了突破性进展

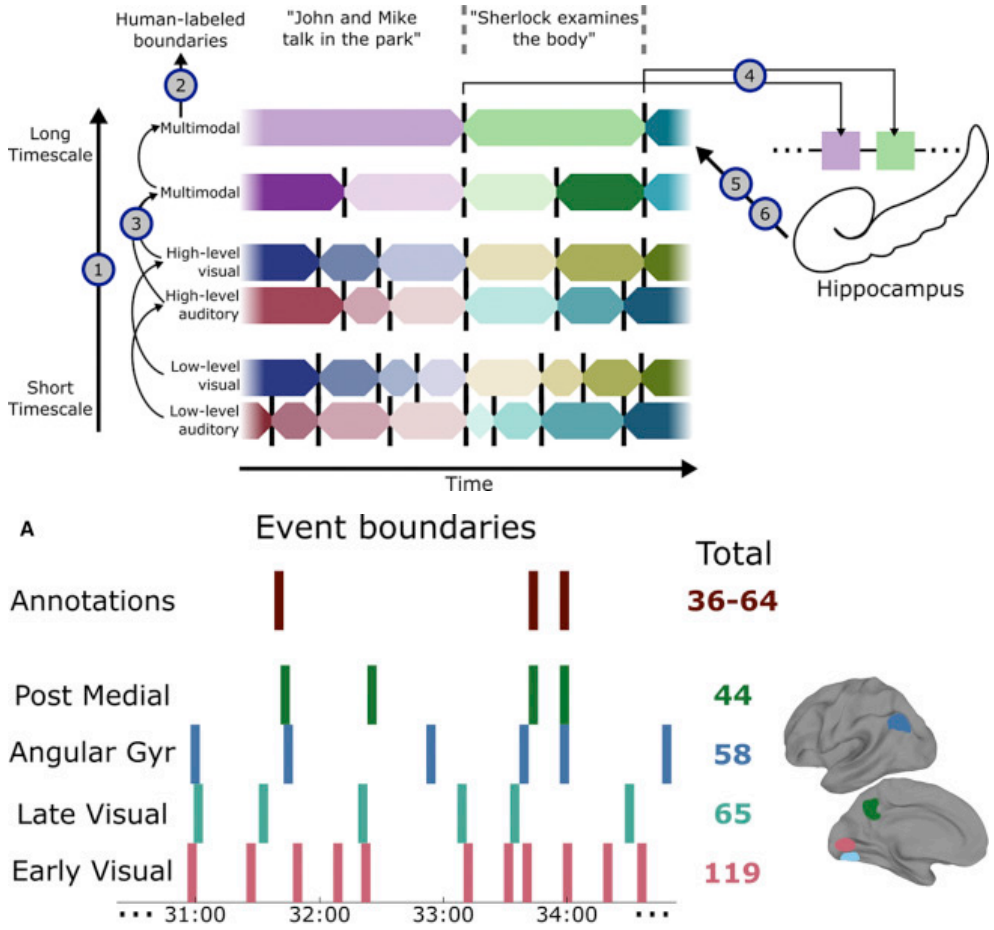


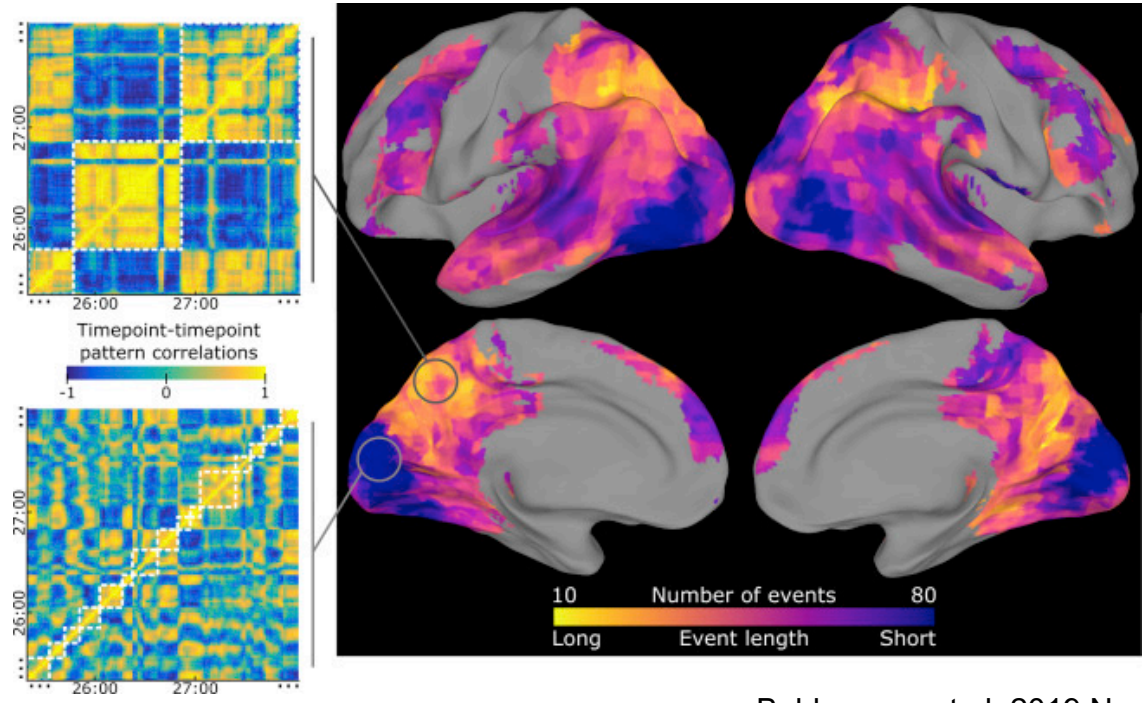
Huth et al.,2016 Nature



发现大脑的语义投影地图

众多领域在过去二十年通过自然刺激范式取得了突破性进展

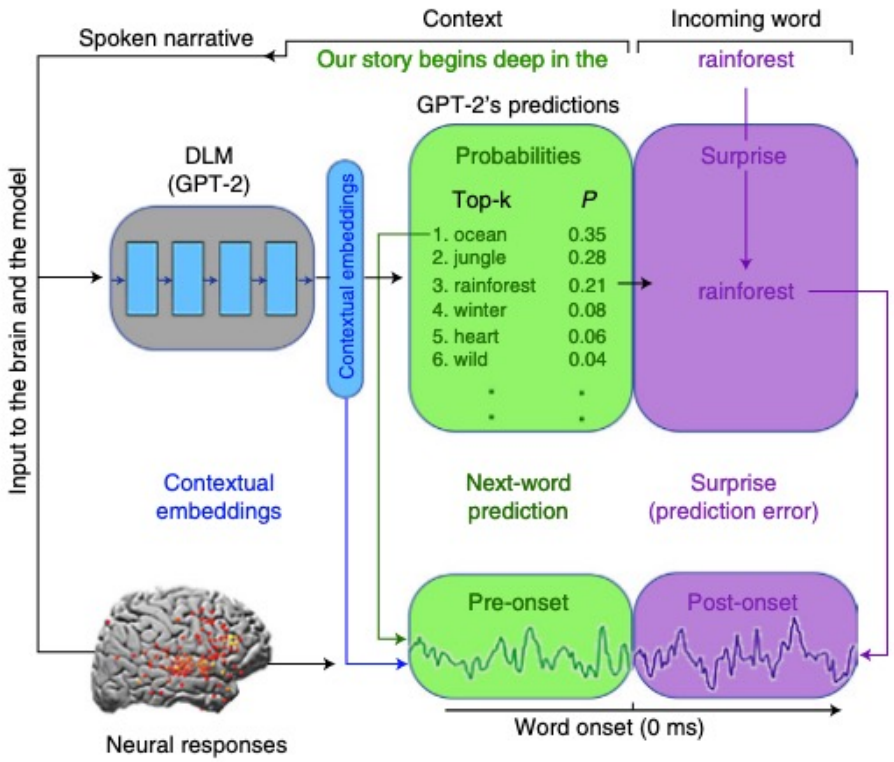


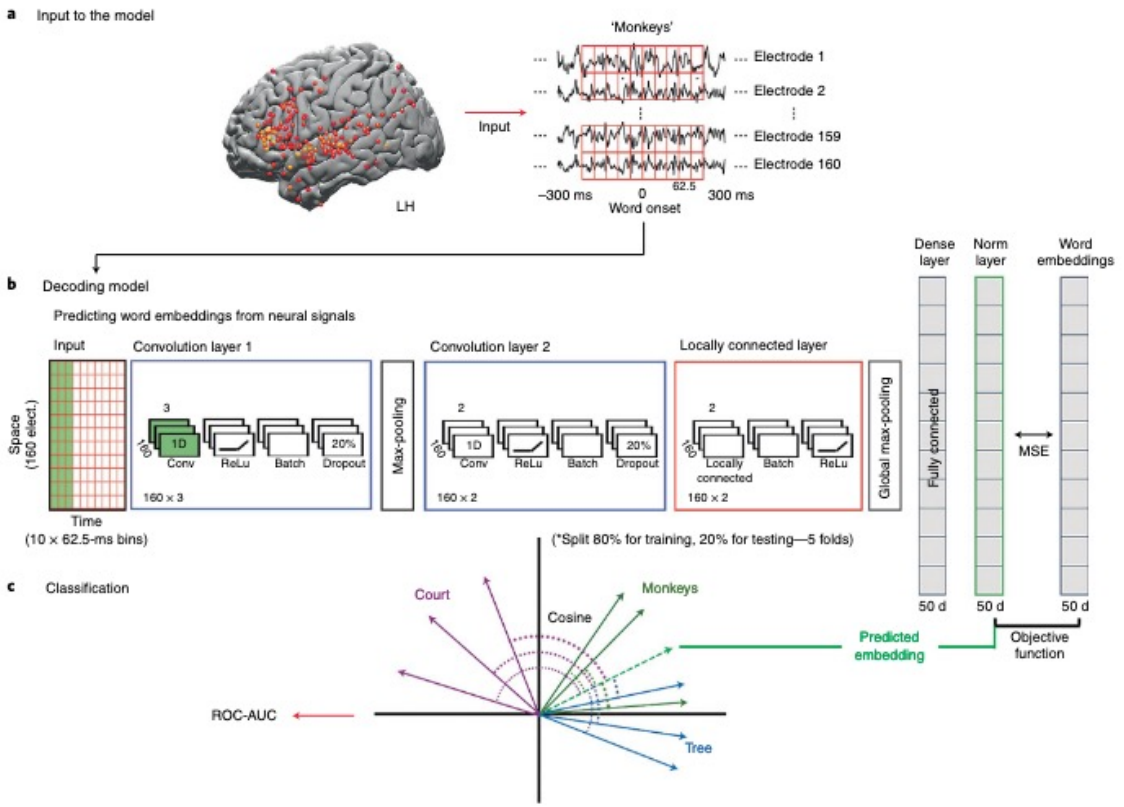


Baldassano et al.,2019 Neuron

揭示了事件加工的认知神经机制，为图式(schema)这一认知心理学“皇冠上的明珠” 提供直接的实在性证据

众多领域在过去二十年通过自然刺激范式取得了突破性进展

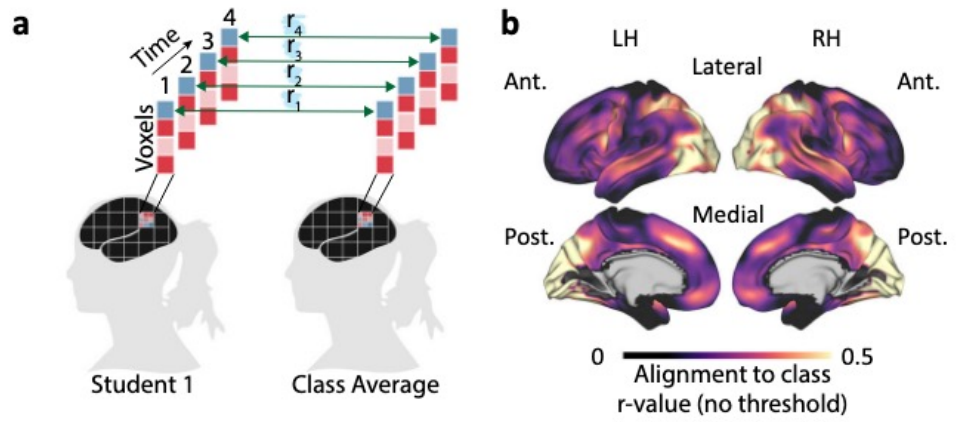


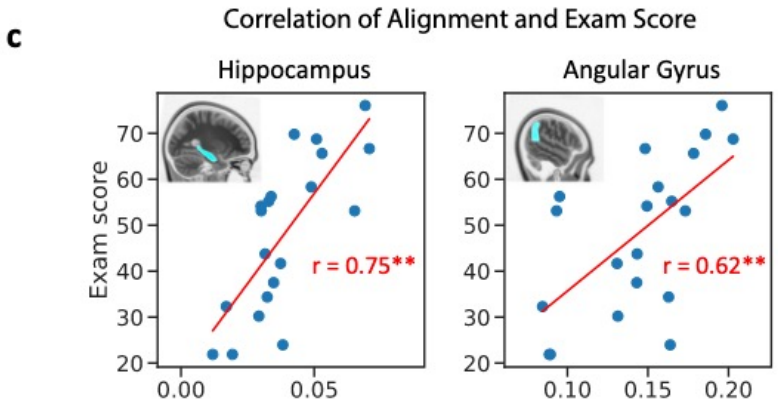


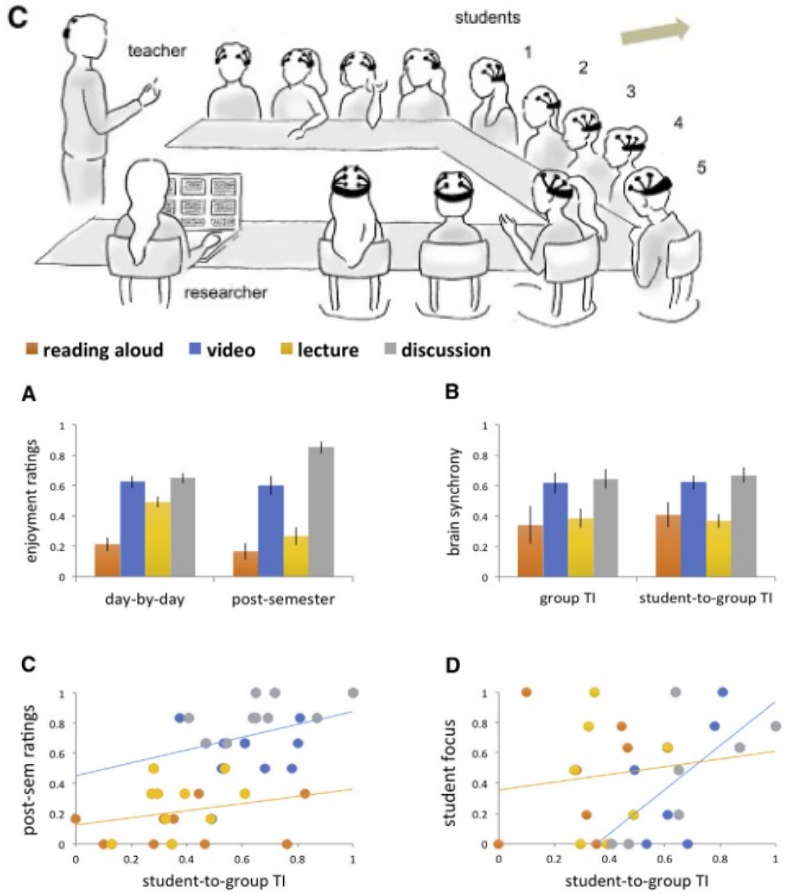
Goldstein et al.,2022 NN

结合GPT揭示了人工智能与人类语言加工的普遍性预测机制

众多领域在过去二十年通过自然刺激范式取得了突破性进展





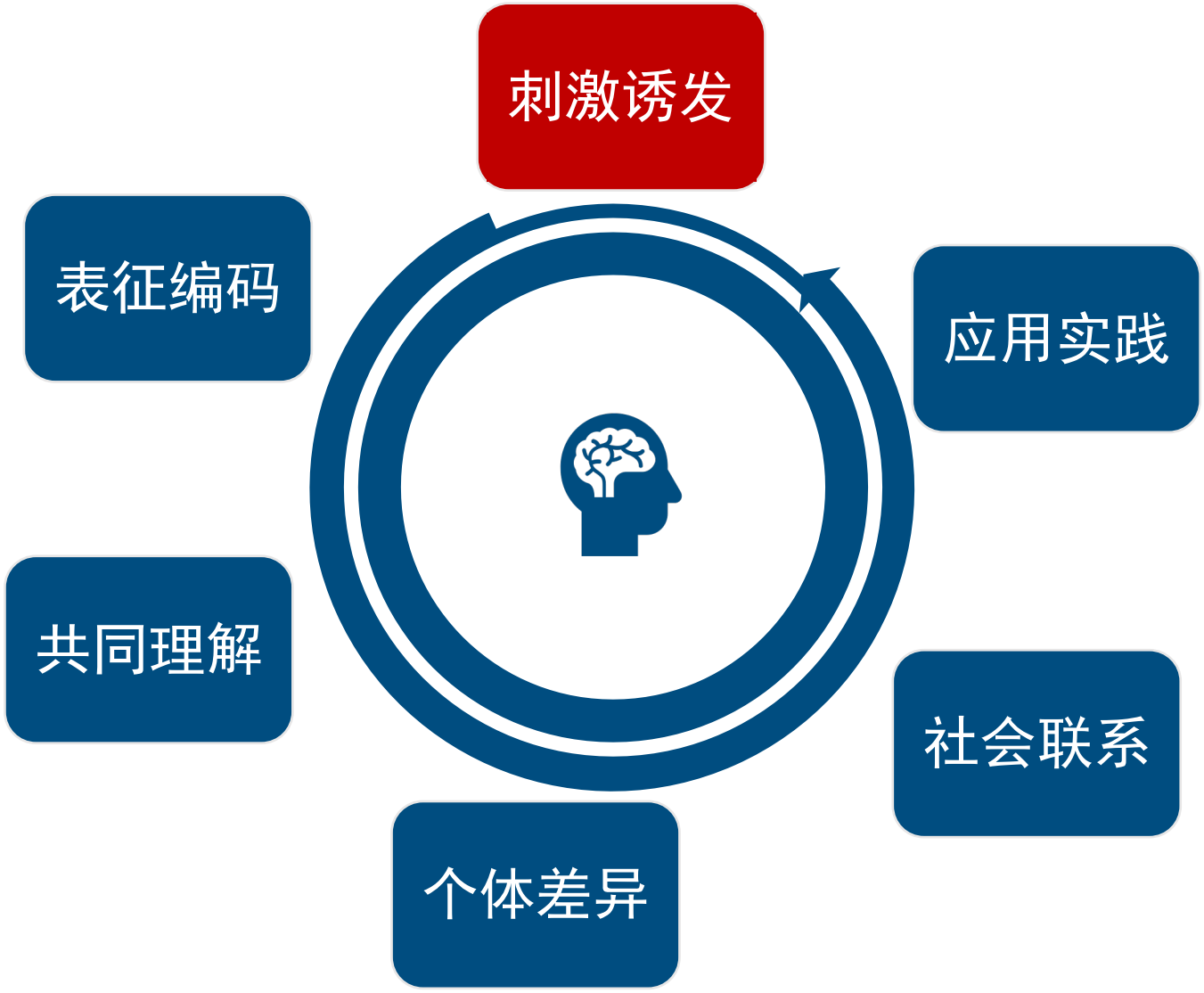


Meshulam et al., 2021 NC;Dikker et al.,2017 CB

应用在课堂教学，成为有效的教学神经标记

使用自然刺激能开展怎样的研究？

使用自然刺激探讨不同属性刺激诱发的神经响应模式



日常生活中，口语和文字所诱发的神经活动模式有什么异同之处？

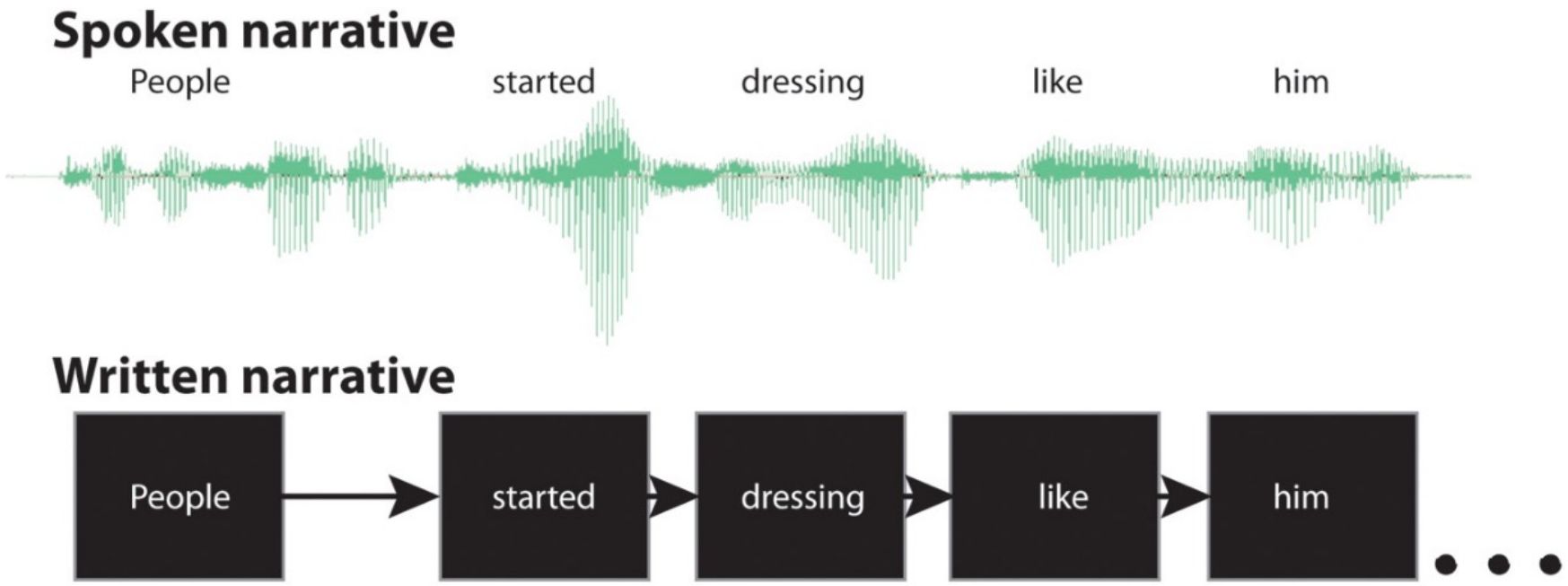
15978 • The Journal of Neuroscience, October 2, 2013 • 33(40):15978–15988

Behavioral/Cognitive

Selective and Invariant Neural Responses to Spoken and Written Narratives

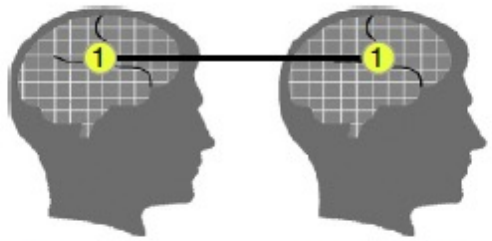
Mor Regev,[1,2] **Christopher J. Honey,**[1,2] **Erez Simony,**[1,2] **and Uri Hasson**[1,2]
[1]Department of Psychology and [2]Princeton Neuroscience Institute, Princeton University, Princeton, New Jersey 08540

实验设计


Spoken narrative
People
started
dressing
like
him
Written narrative
People
started
dressing
like
him

刺激诱发

口语和文字神经响应模式



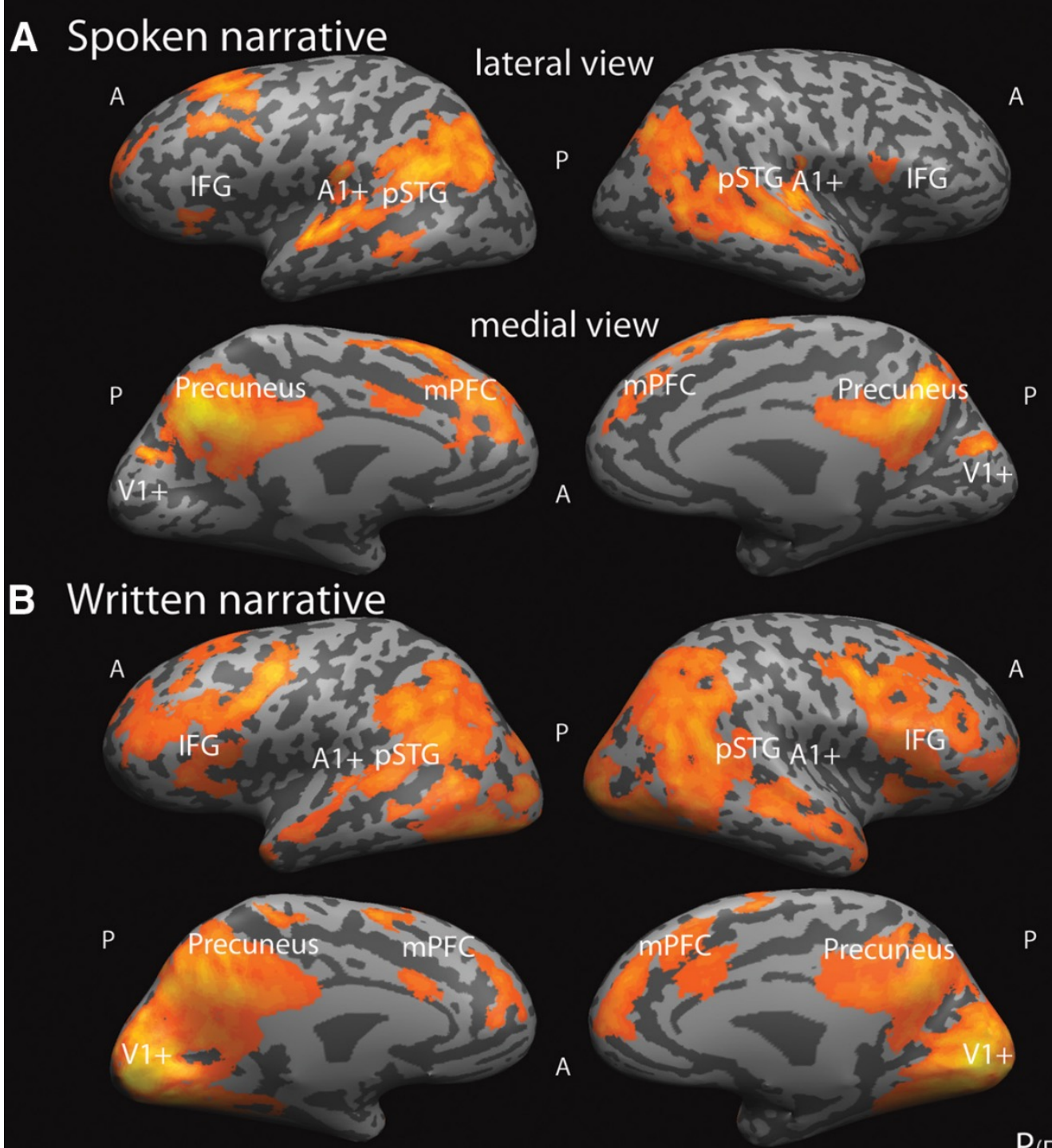
Subject X　　Subject Y

$x_A(t) = c(t) + id_A(t) + s_A(t)$　　$x_B(t) = c(t) + id_B(t) + s_B(t)$

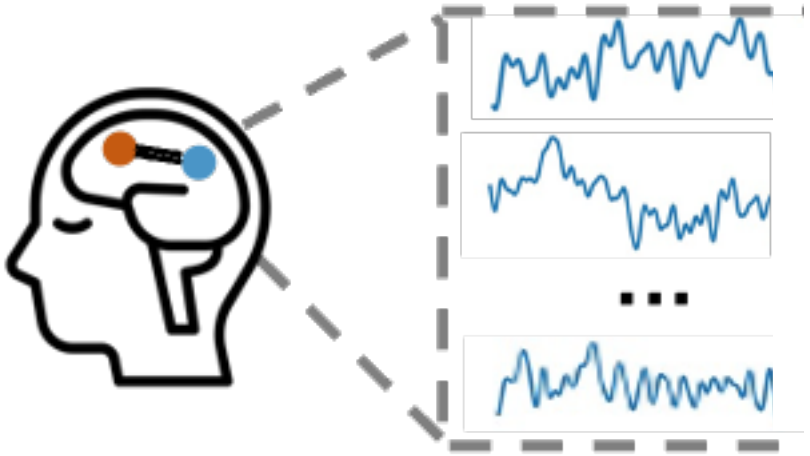
口语　　文字

$E_{spoken} \cong E[X_{S1}(t), X_{S2}(t)]$

$E_{written} \cong E[X_{W1}(t), X_{W2}(t)]$



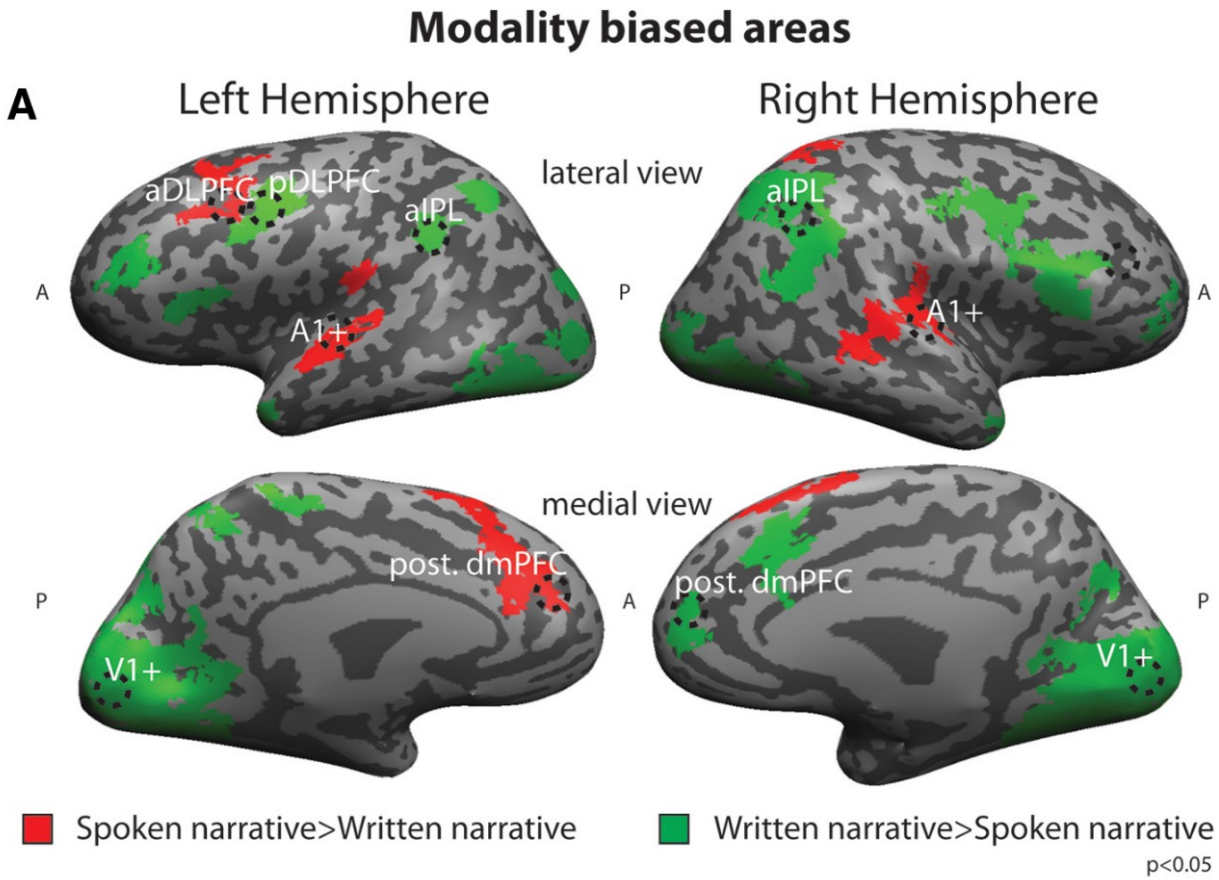
时光回溯

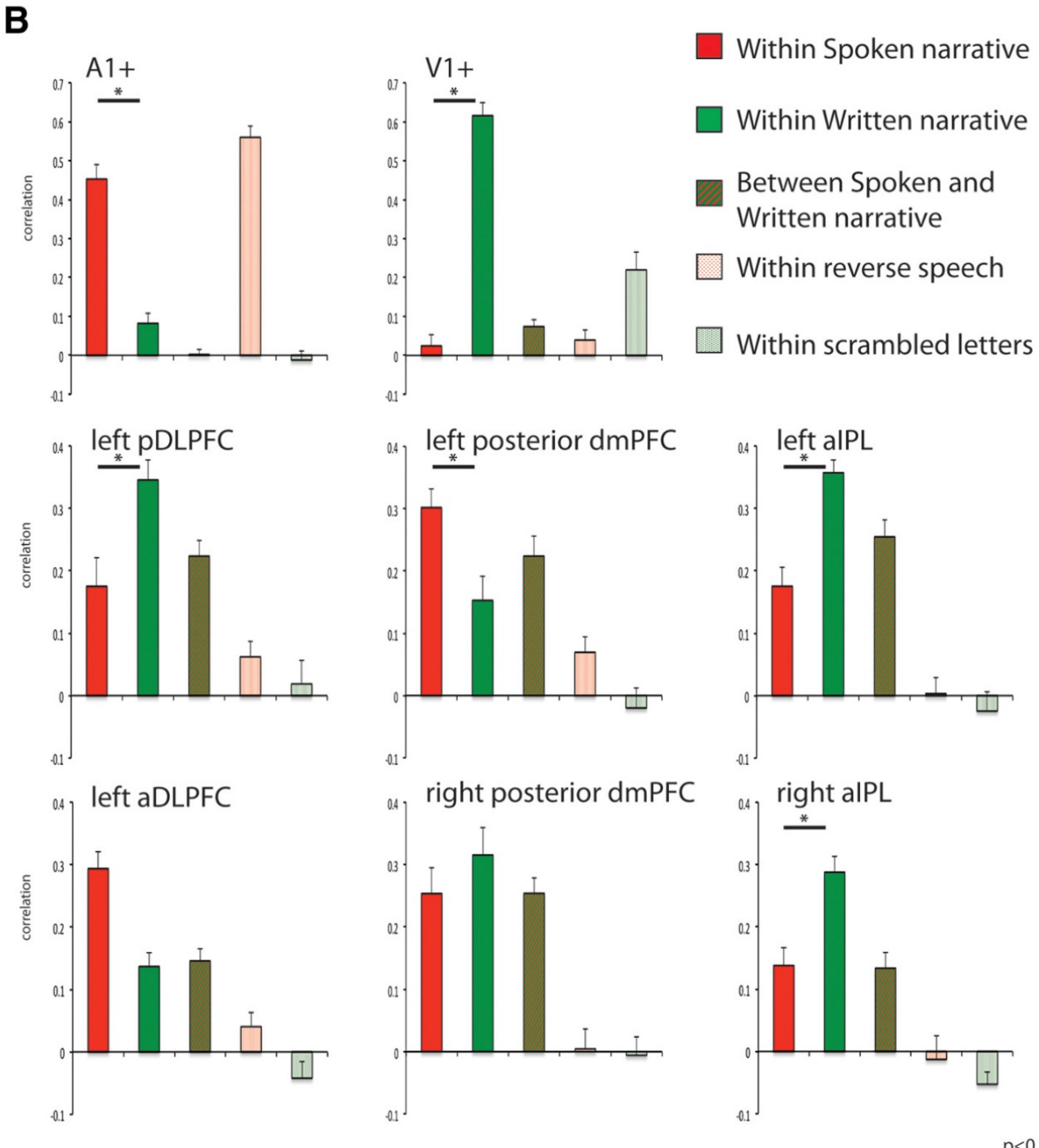


假设被试观看的是一部默片，我们能否通过比较激活强度发现V1的激活比A1更高？

刺激诱发

模态特异的语言加工神经响应模式





刺激诱发

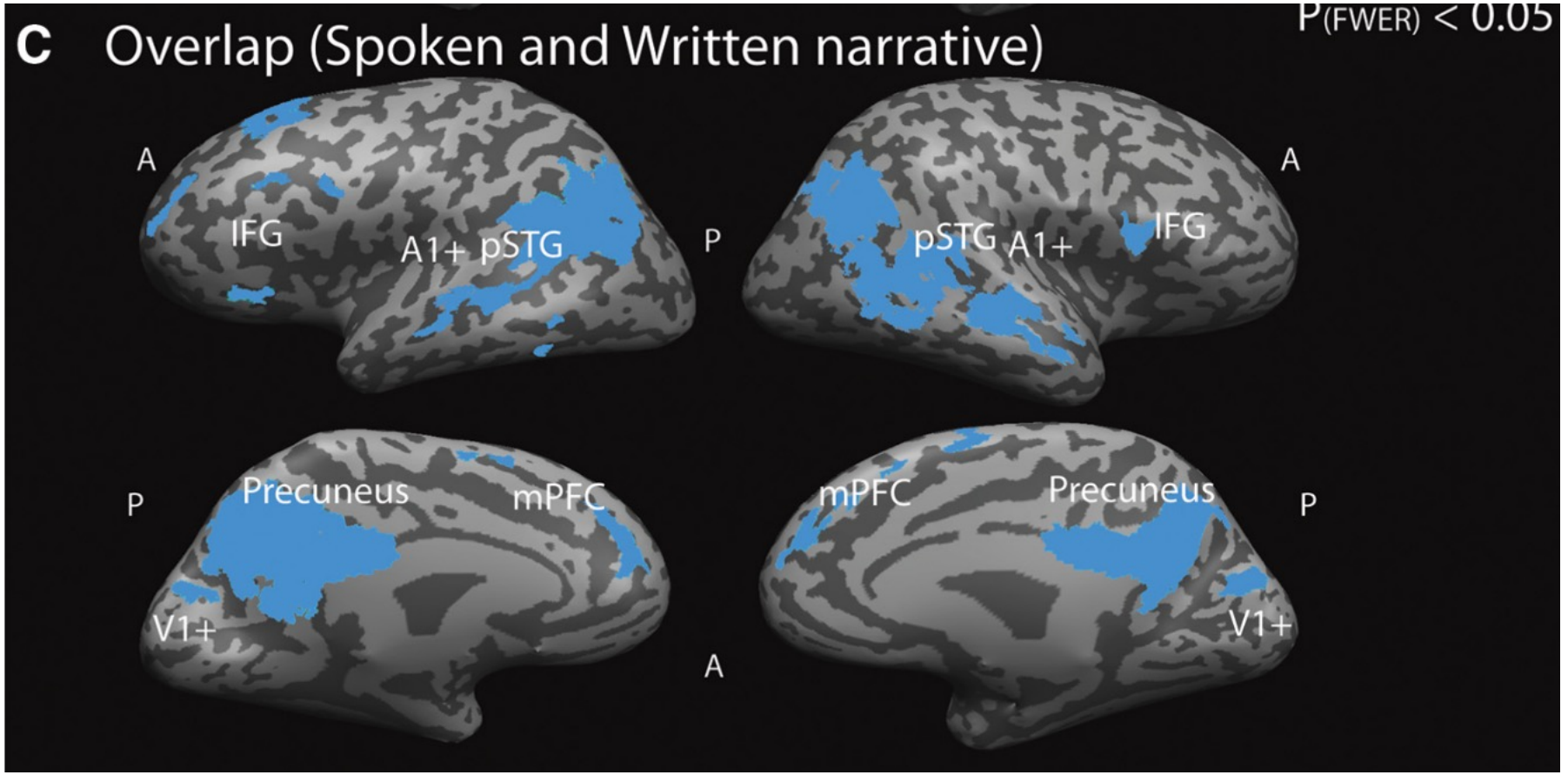
模态共享的语言加工神经响应模式

通过对口语和文字两个条件的ISC进行比较可以揭示模态特异的神经响应模式。但如何探究口语和文字共享的神经响应模式呢？

刺激诱发

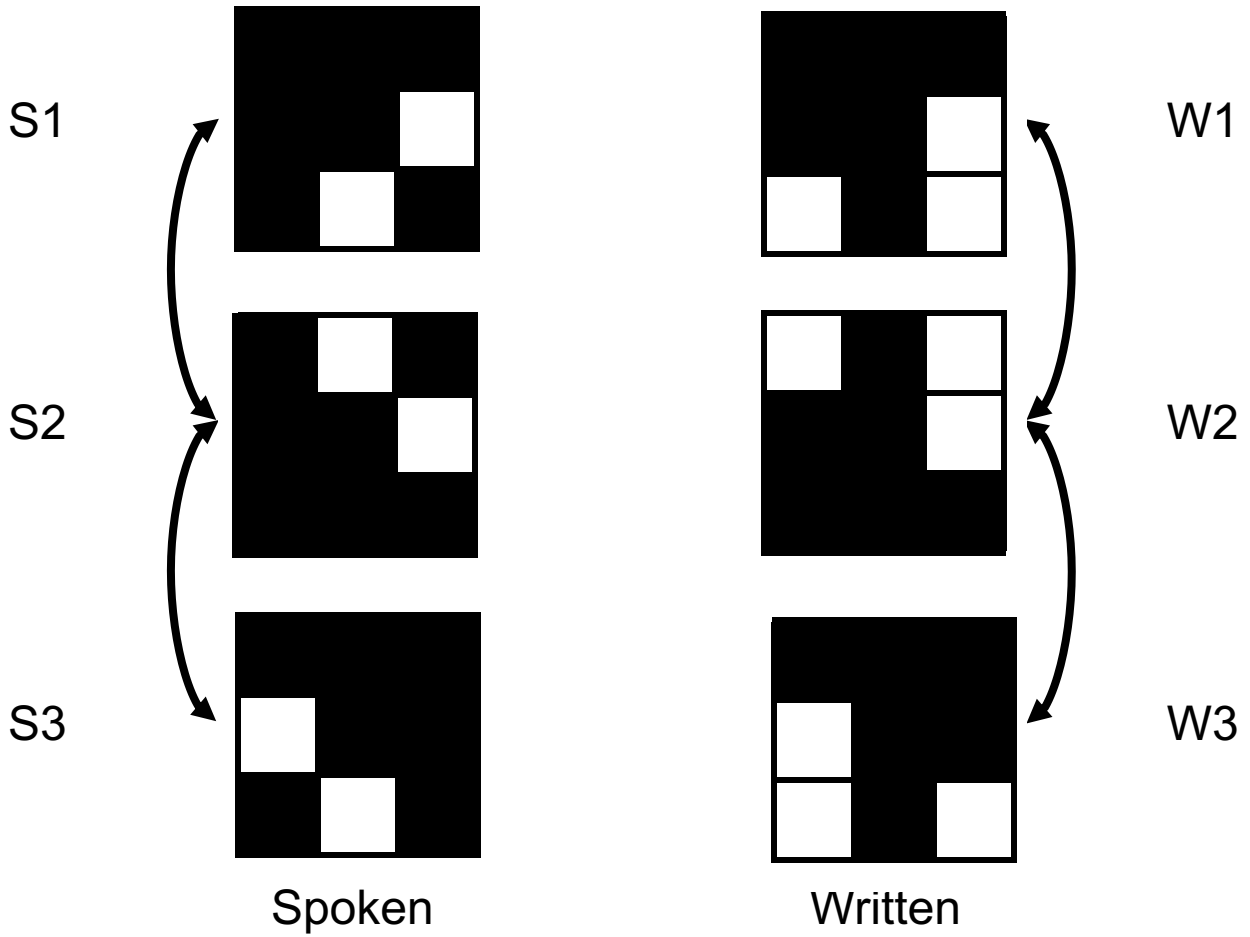
模态共享的语言加工神经响应模式

ISC差异不显著 ＝ 活动模式相同？



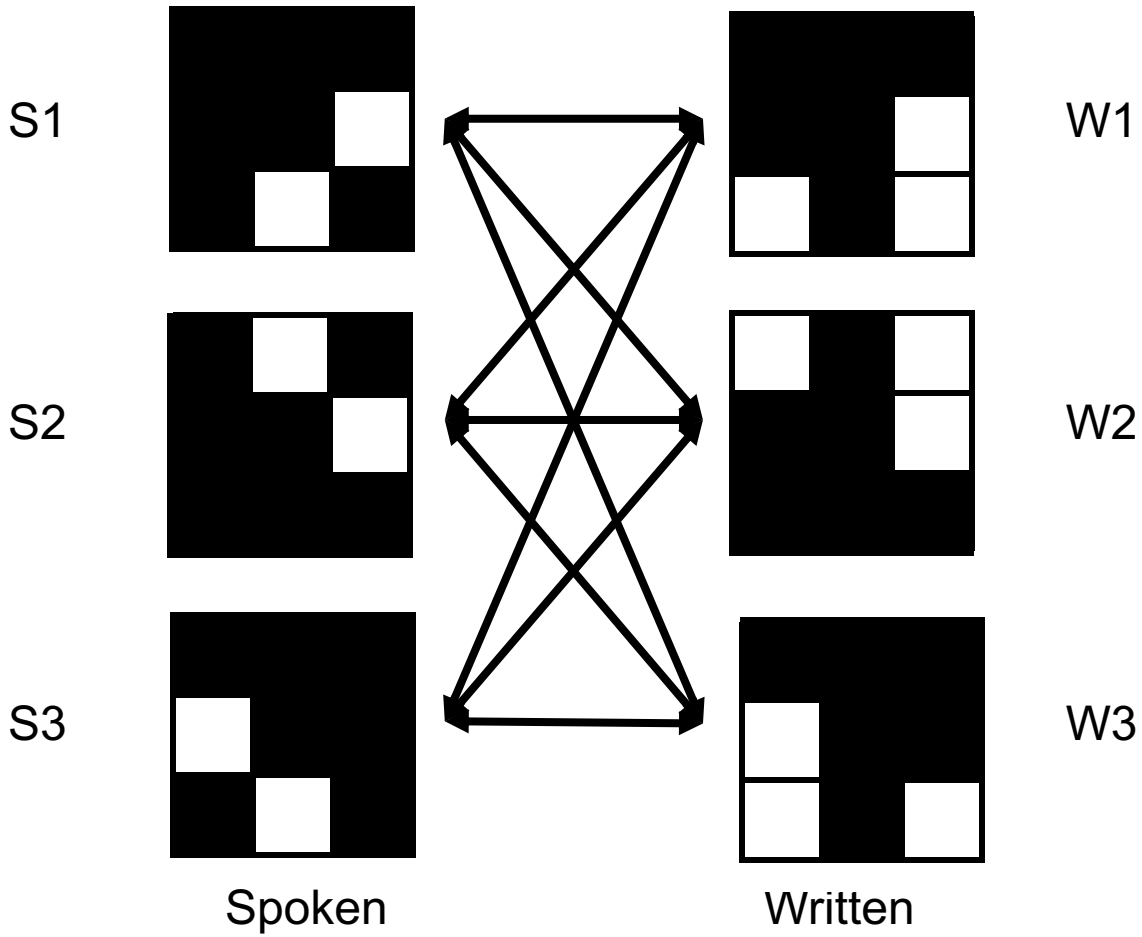
Inter Intersubject Correlation (Inter-ISC)

ISC差异不显著 ＝ 活动模式相同？



刺激诱发

Inter Intersubject Correlation (Inter-ISC)



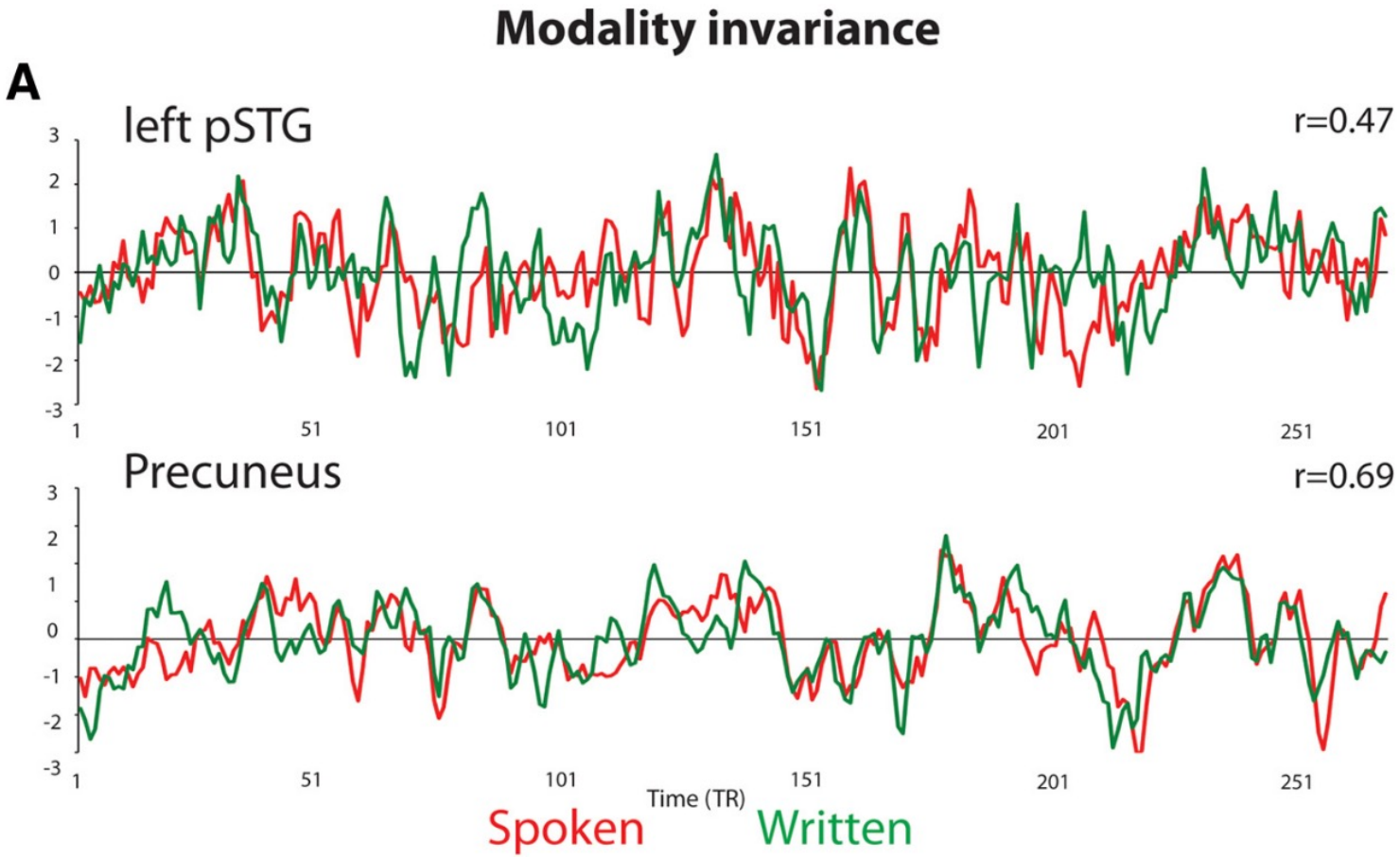
口语

文字

$E_{shared} \cong E[X_{S1}(t), X_{W1}(t)]$

共享

模态特异的语言加工神经响应模式



口语

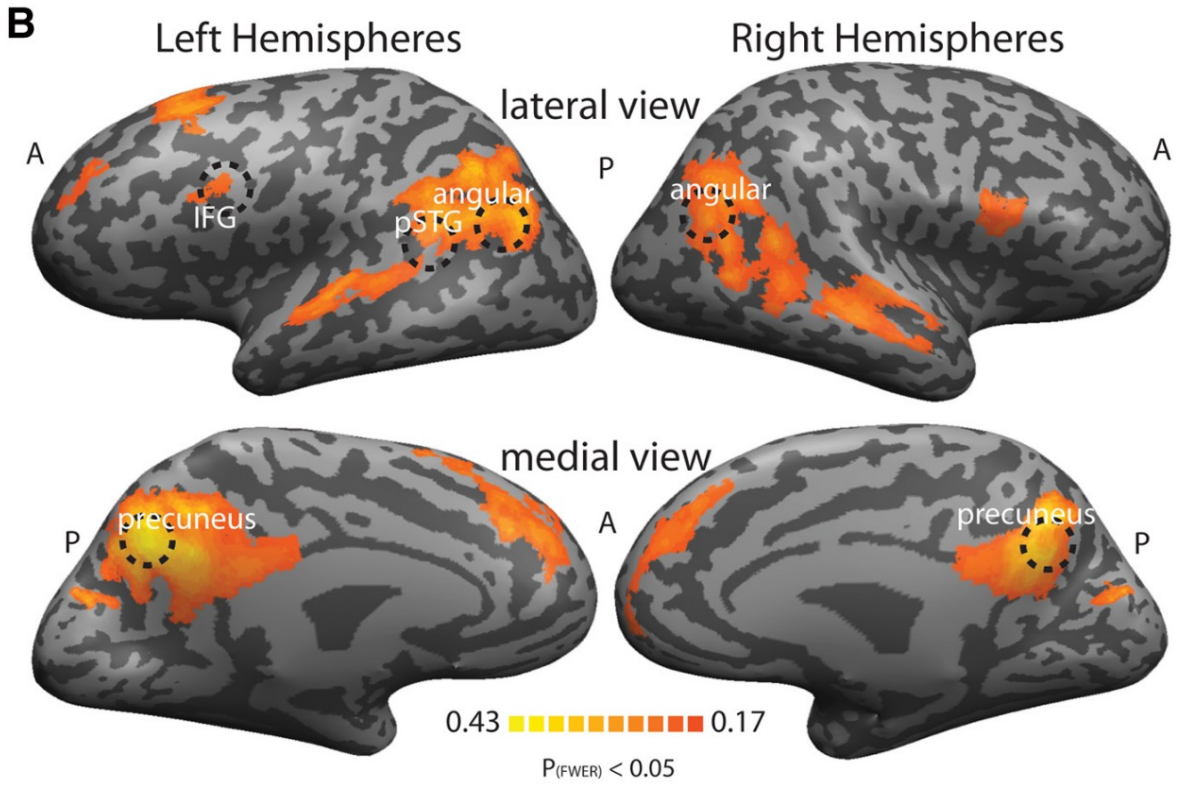
文字

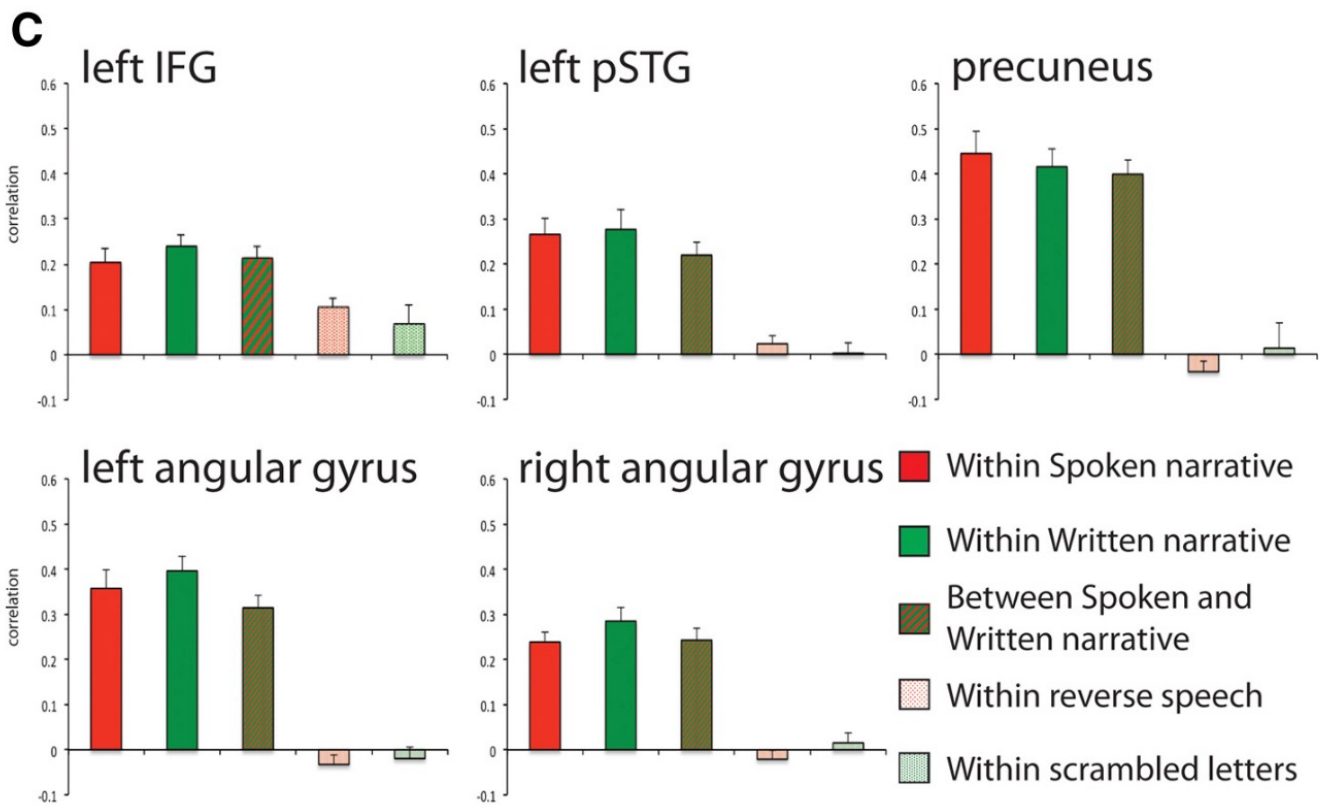
$E_{shared} \cong E[X_{S1}(t), X_{W1}(t)]$

共享

刺激诱发

模态特异的语言加工神经响应模式





结论

- 在自然语言加工过程中，口语和文字语言在初级和次级感觉皮层上存在模态特异的神经响应模式。
- 但在左侧IFG（布洛卡区），双侧AG（威尔尼克区），Precuneus等高级脑区则表现为共享的神经响应模式。，即使他们的stimulus form完全不同

使用自然刺激探讨个体编码不同属性、层次刺激的神经响应模式

编码了什么？

日常生活中，加工不同语言信息的神经活动模式是什么？

The Journal of Neuroscience, October 31, 2012 • 32(44):15277–15283 • 15277

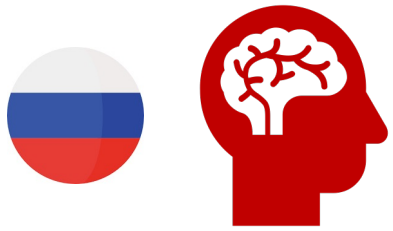
Behavioral/Systems/Cognitive

Not Lost in Translation: Neural Responses Shared Across Languages

Christopher J. Honey,[1,2]* Christopher R. Thompson,[1]* Yulia Lerner,[1,2] and Uri Hasson[1,2]

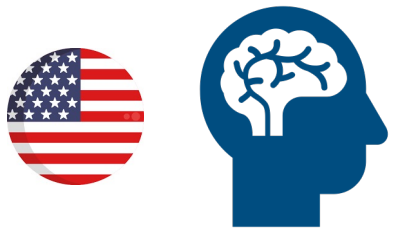
[1]Department of Psychology and [2]Princeton Neuroscience Institute, Princeton University, Princeton, New Jersey 08540

实验设计



Russian / English

俄语故事

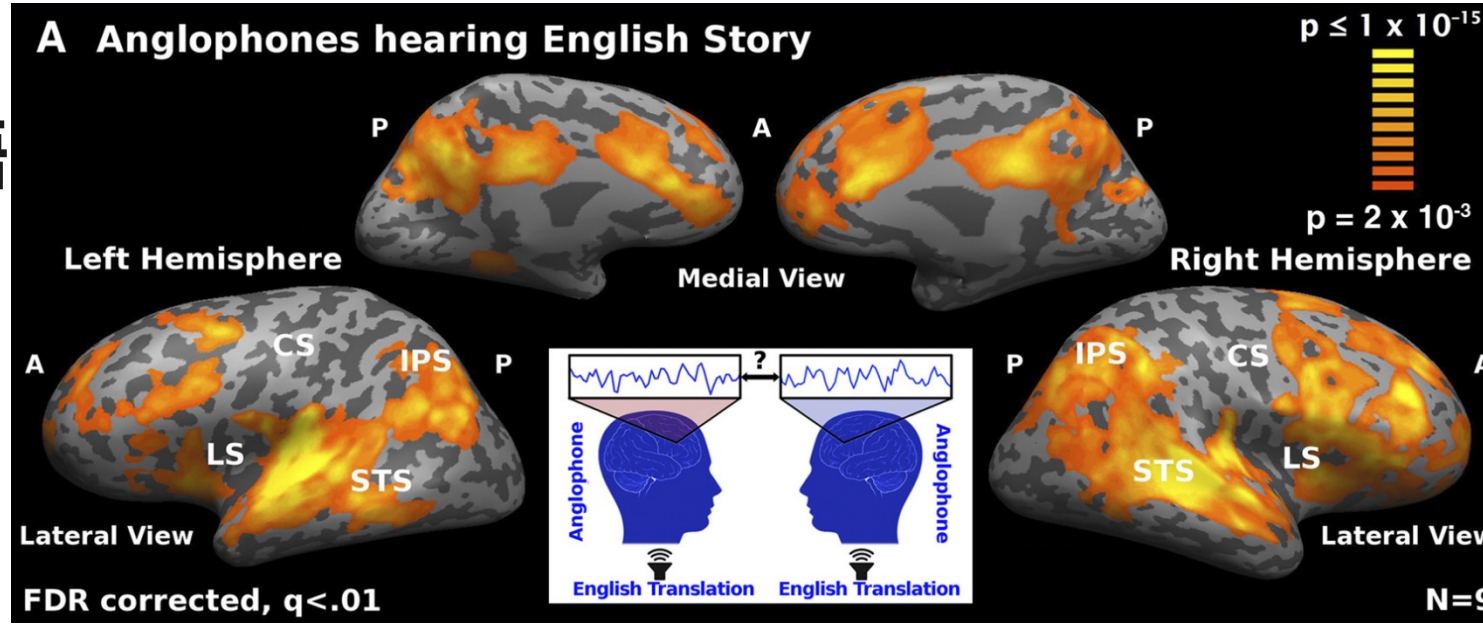


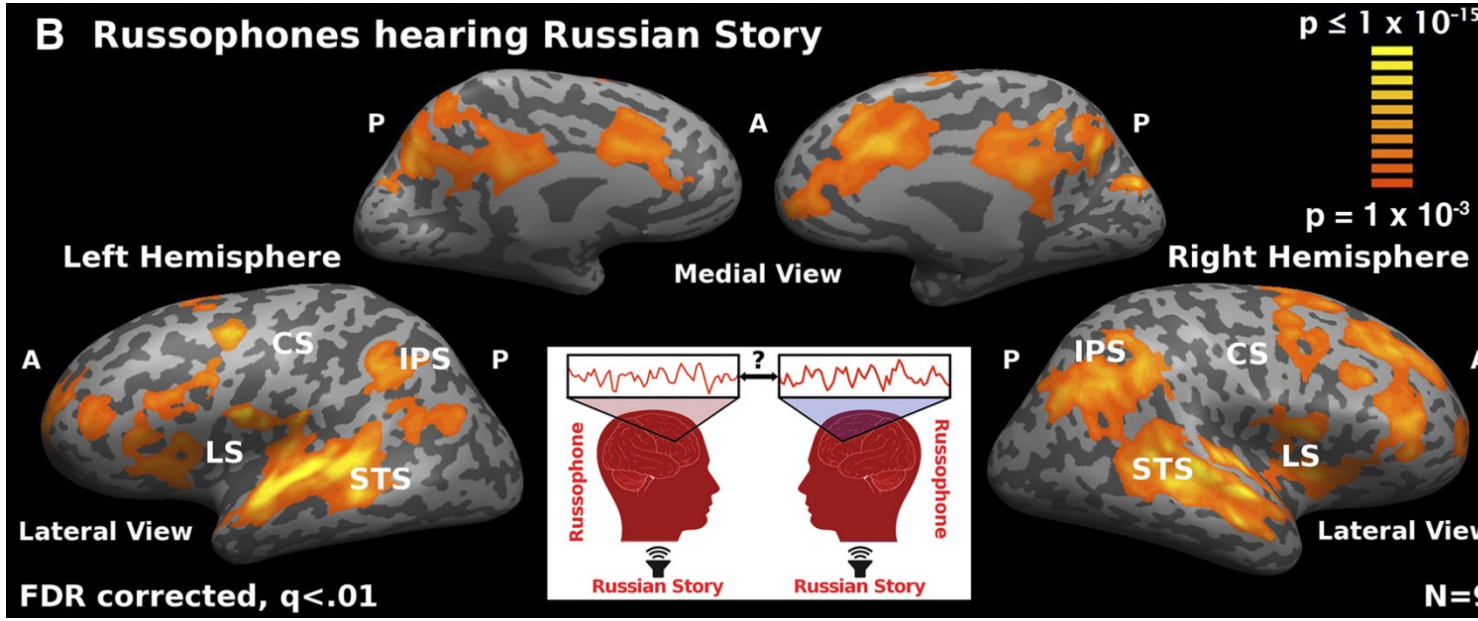
English

英语故事

表征编码

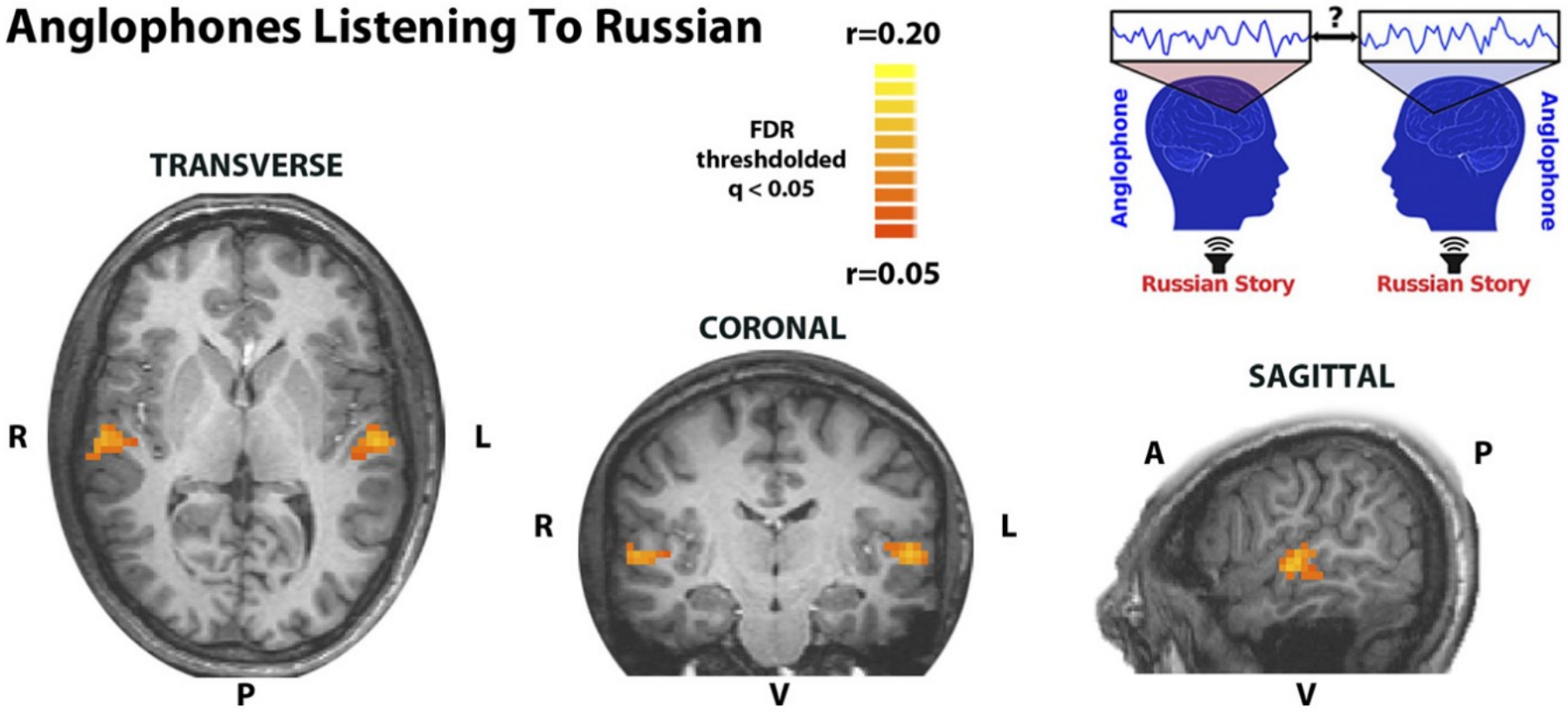
美国人听英语，俄国人听俄语





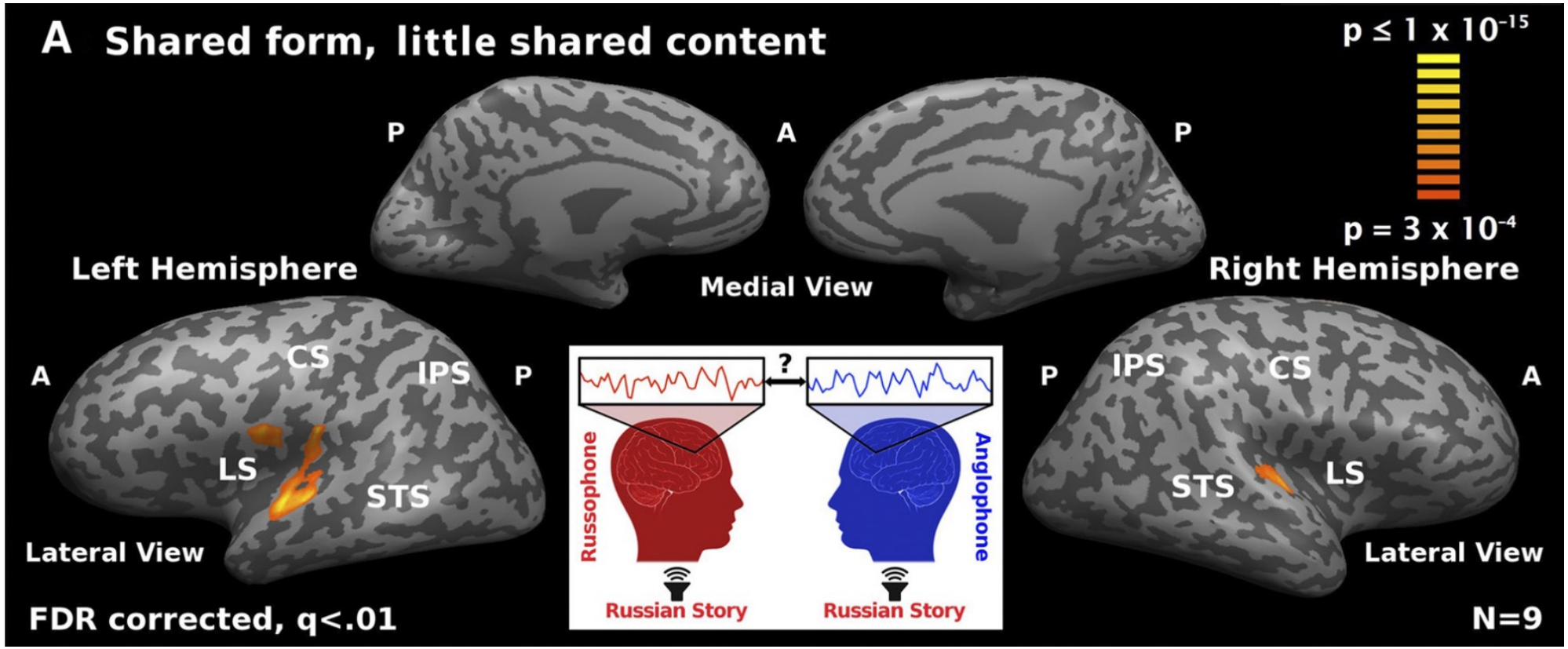
加工母语时在听觉区、语言区和DMN都诱发了广泛的ISC

美国人听俄语



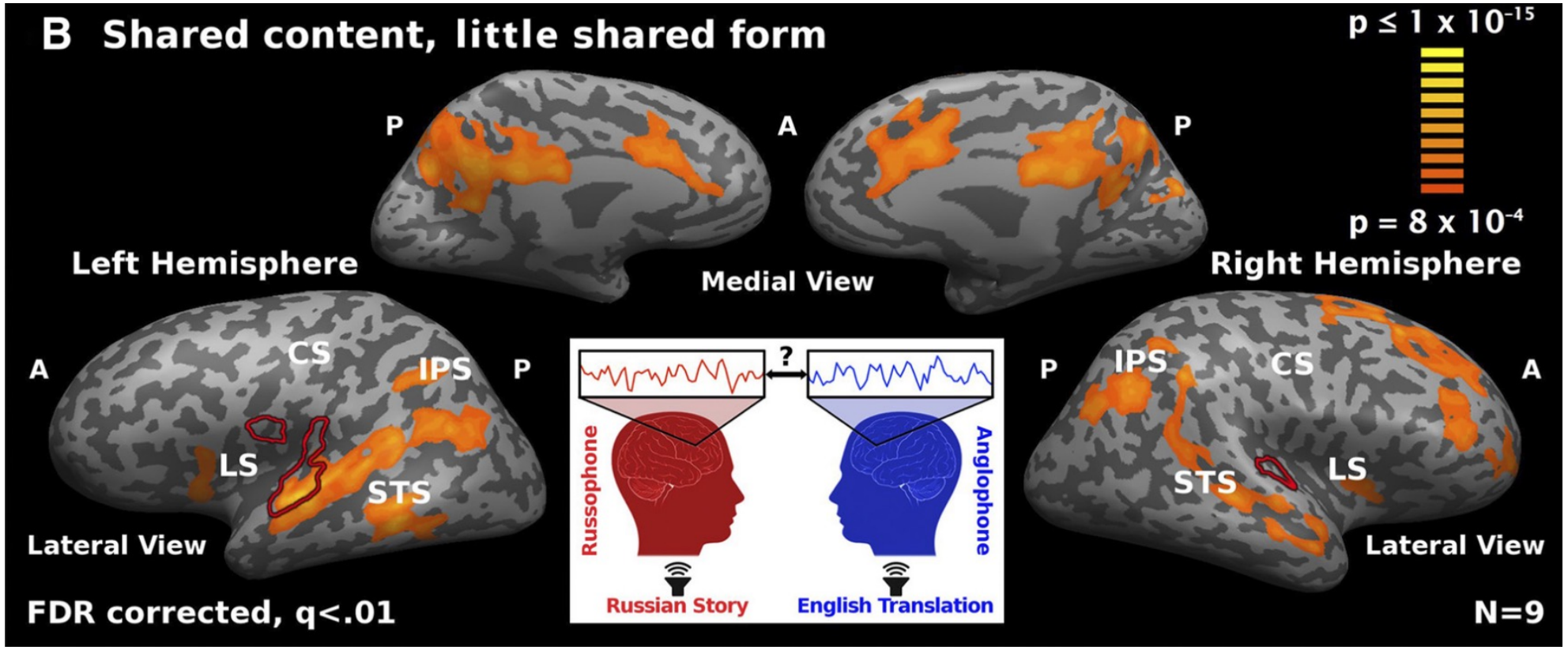
由于听不懂俄语，美国人在加工俄语故事时仅在A1有显著ISC

俄国人加工俄语 ∩ 美国人加工俄语



计算俄国人加工俄语和美国人加工俄语时的inter-ISC也发现，仅在A1即附近脑区存在共享的神经响应模式。说明这些脑区编码了语言的形式信息

俄国人加工俄语 ∩ 美国人加工英语



由于语言形式完全不同，所以在A1等脑区的inter-ISC不再显著；但是在语言区、默认网络等高级脑区诱发了广泛的inter-ISC，说明这些脑区表征了语言的内容信息

结论

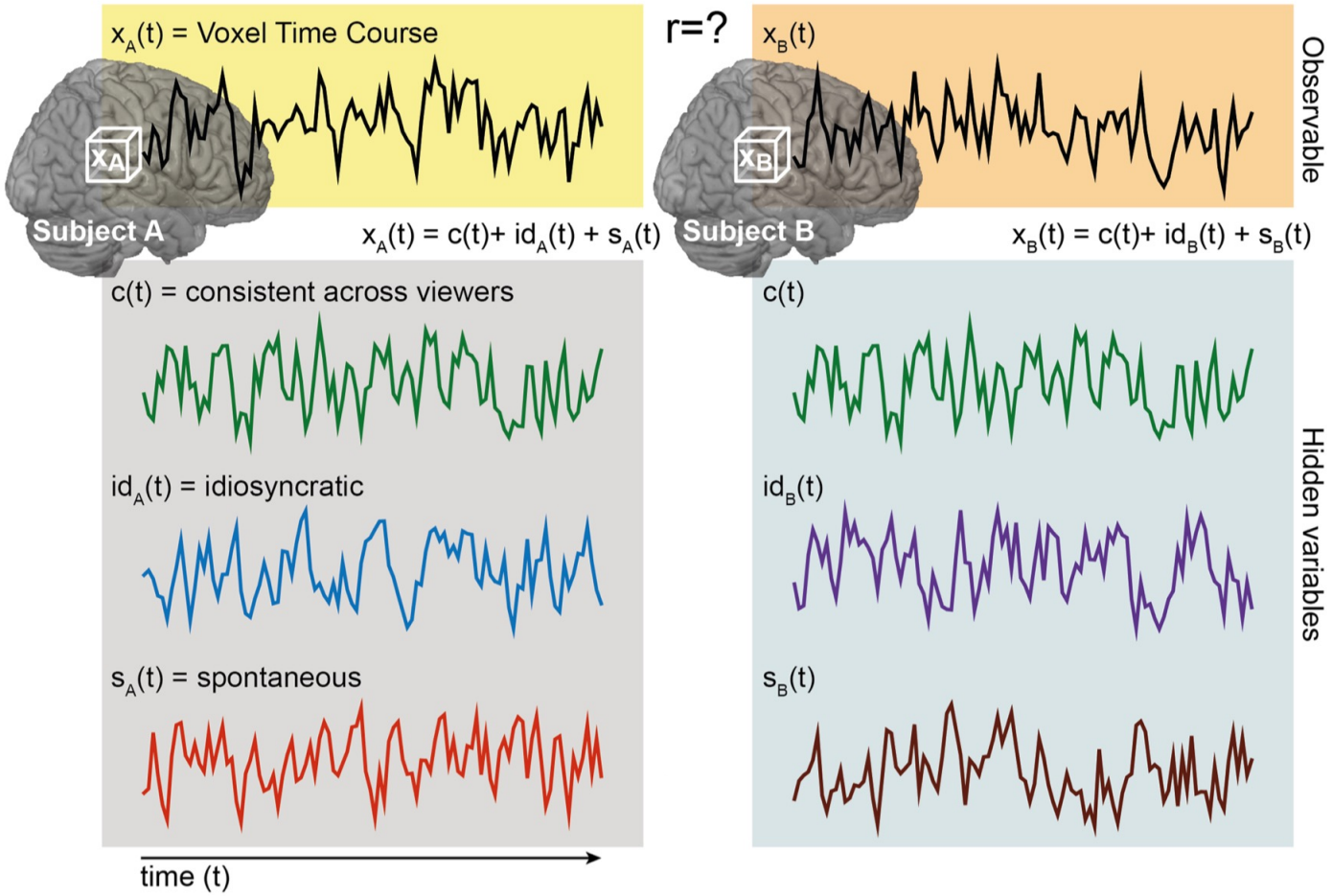
- 听觉皮层是大脑中的语言屏障，编码了语言的形式信息
- 虽然世界上语言形式千变万化，但只要能跨越听觉皮层，不同语言使用者就会在语言区和DMN等脑区以相同的方式编码语言的内容信息

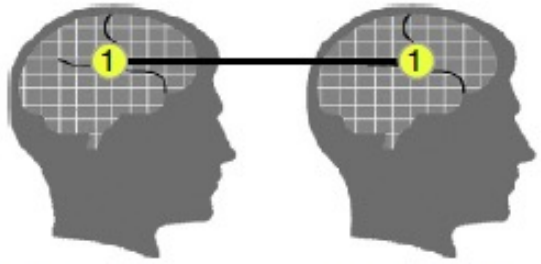
个体之间理解更相似，神经活动越相似？

探讨个体理解与加工方式对自然刺激神经响应的调制机制

理解越相似，神经响应越相似？

回到ISC的基本原理部分





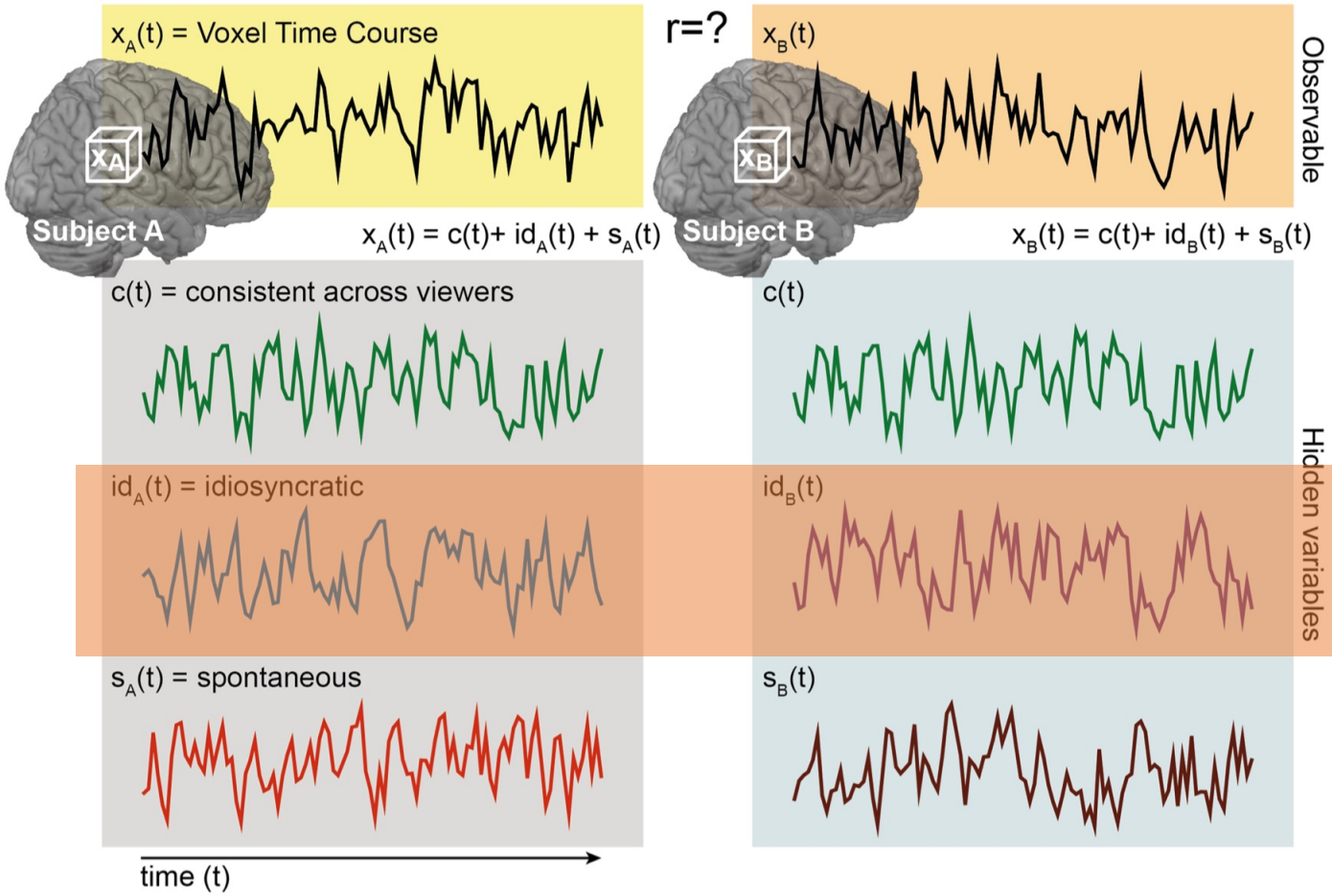
$x_A(t) = c(t) + id_A(t) + s_A(t)$ $x_B(t) = c(t) + id_B(t) + s_B(t)$

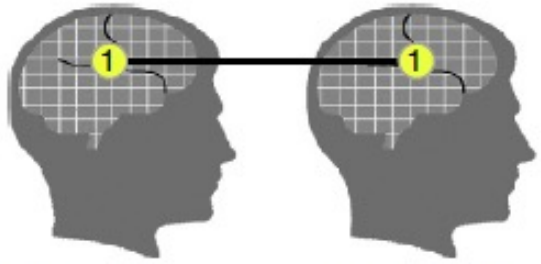
$$E[C_A(t), C_B(t)] \; 1 \; + \; E[id_A(t), id_B(t)] \; 0 \; + \; E[S_A(t), S_B(t)] \; 0 \; = E[X_A(t), X_B(t)]$$

理论相关值

$$E[C_A(t), C_B(t)] \cong E[X_A(t), X_B(t)]$$

个体特异成分的理论ISC值真的是0吗？





$x_A(t) = c(t) + id_A(t) + s_A(t)$ $x_B(t) = c(t) + id_B(t) + s_B(t)$

$$E[C_A(t), C_B(t)] \quad 1$$
$$+$$
$$E[id_A(t), id_B(t)] \quad 0 \quad = E[X_A(t), X_B(t)]$$
$$+$$
$$E[S_A(t), S_B(t)] \quad 0$$

理论相关值

$$E[C_A(t), C_B(t)] \cong E[X_A(t), X_B(t)]$$

探讨个体理解与加工方式对自然刺激神经响应的调制机制

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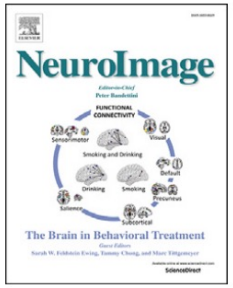


Shared understanding of narratives is correlated with shared neural responses

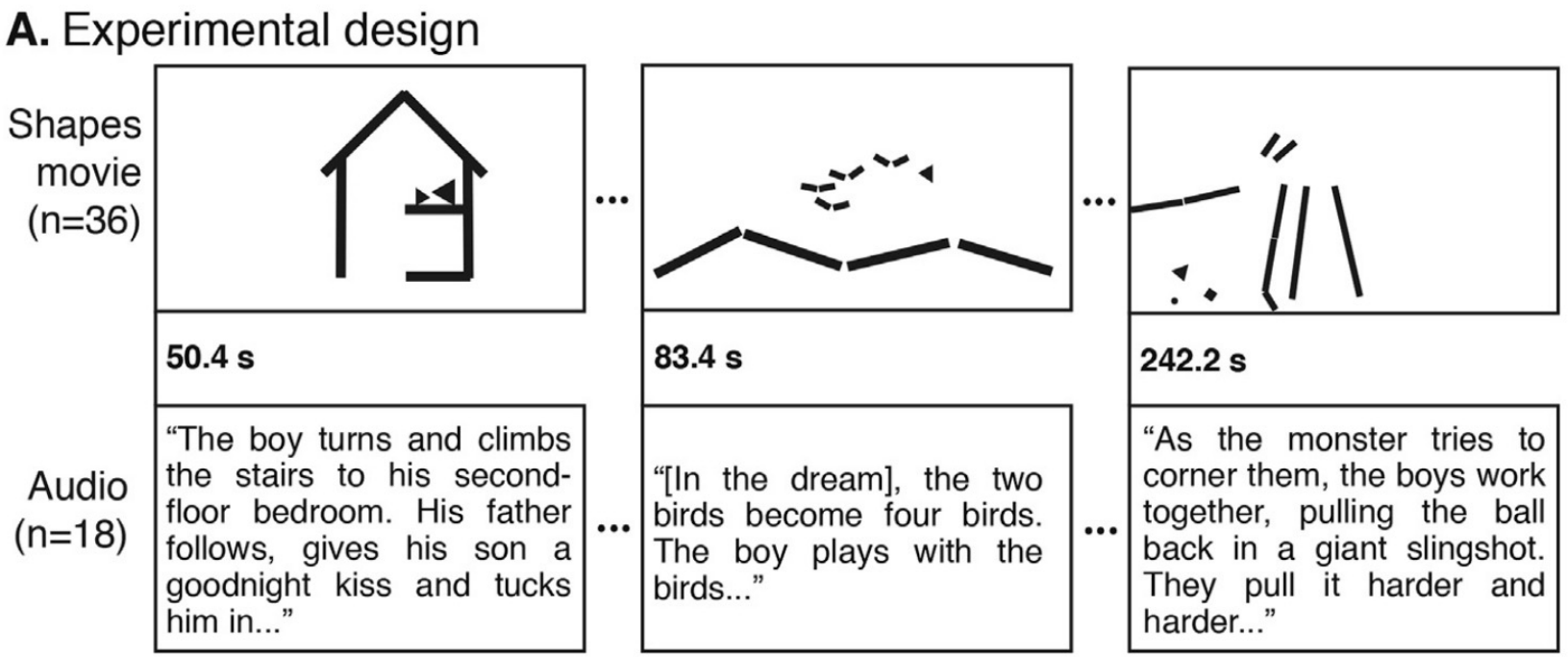
Mai Nguyen [a,*], Tamara Vanderwal [b], Uri Hasson [a,c]

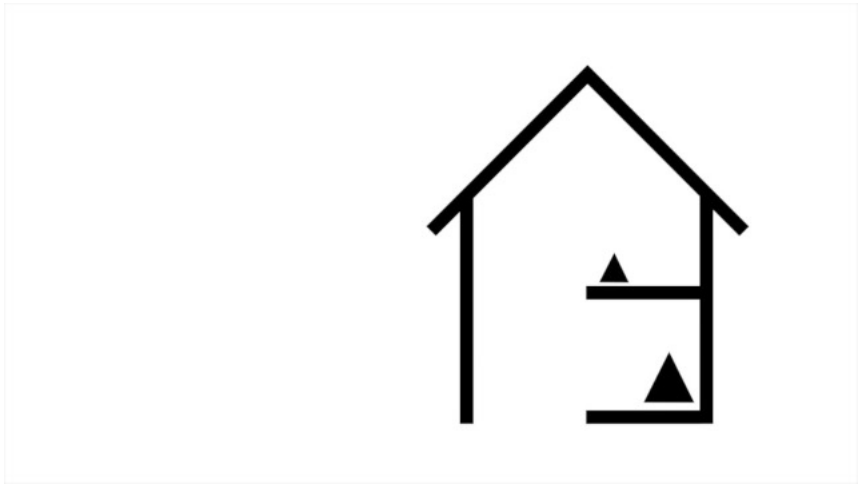
[a] Department of Psychology, Princeton University, Princeton, NJ, 08540, USA
[b] Yale Child Study Center, Yale University, 230 S Frontage Rd, New Haven, CT, 06520, USA
[c] Princeton Neuroscience Institute, Princeton University, Princeton, NJ, 08540, USA

Check for updates

个体对内容理解越相似，神经活动越相似？

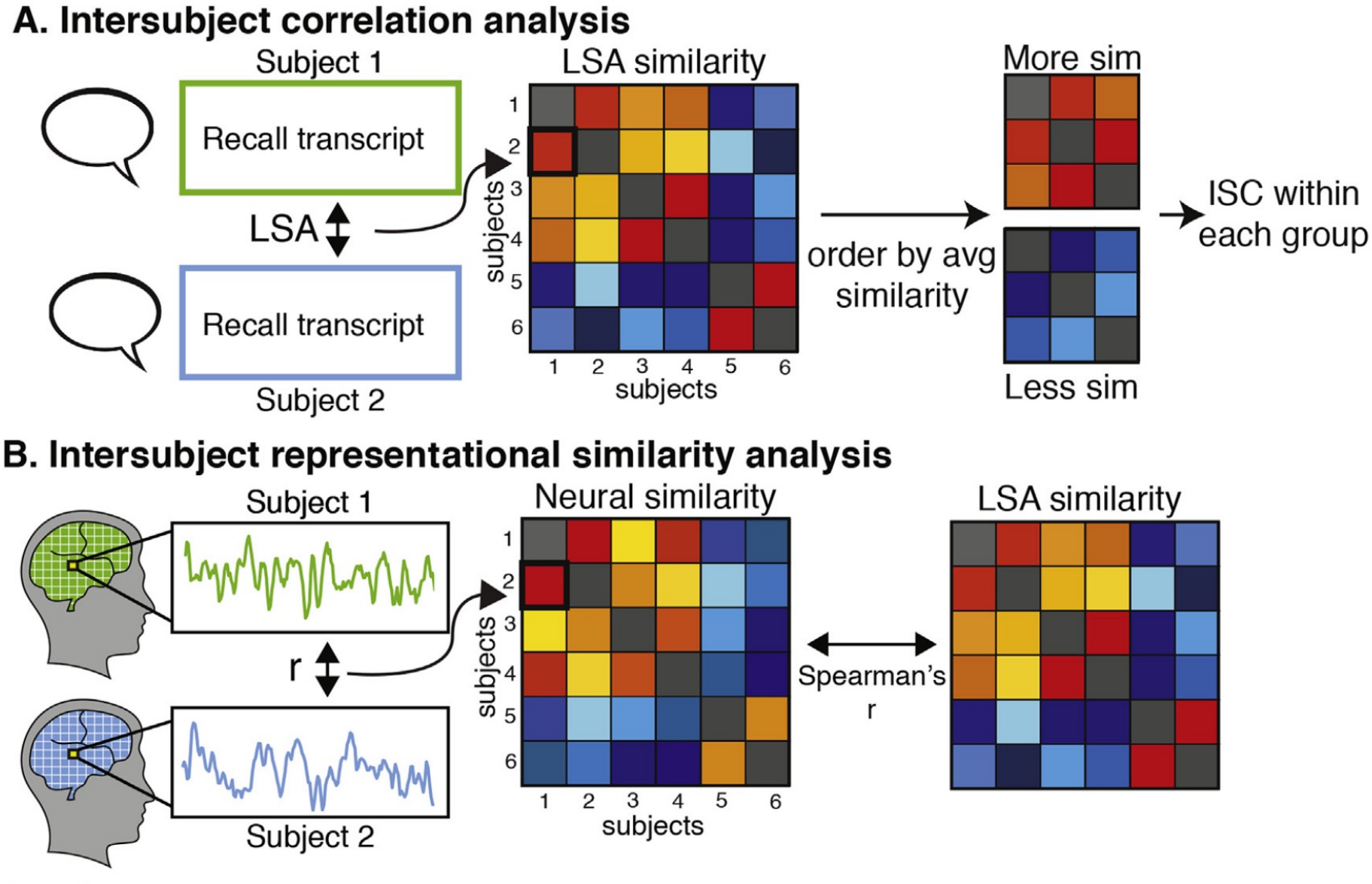
实验设计



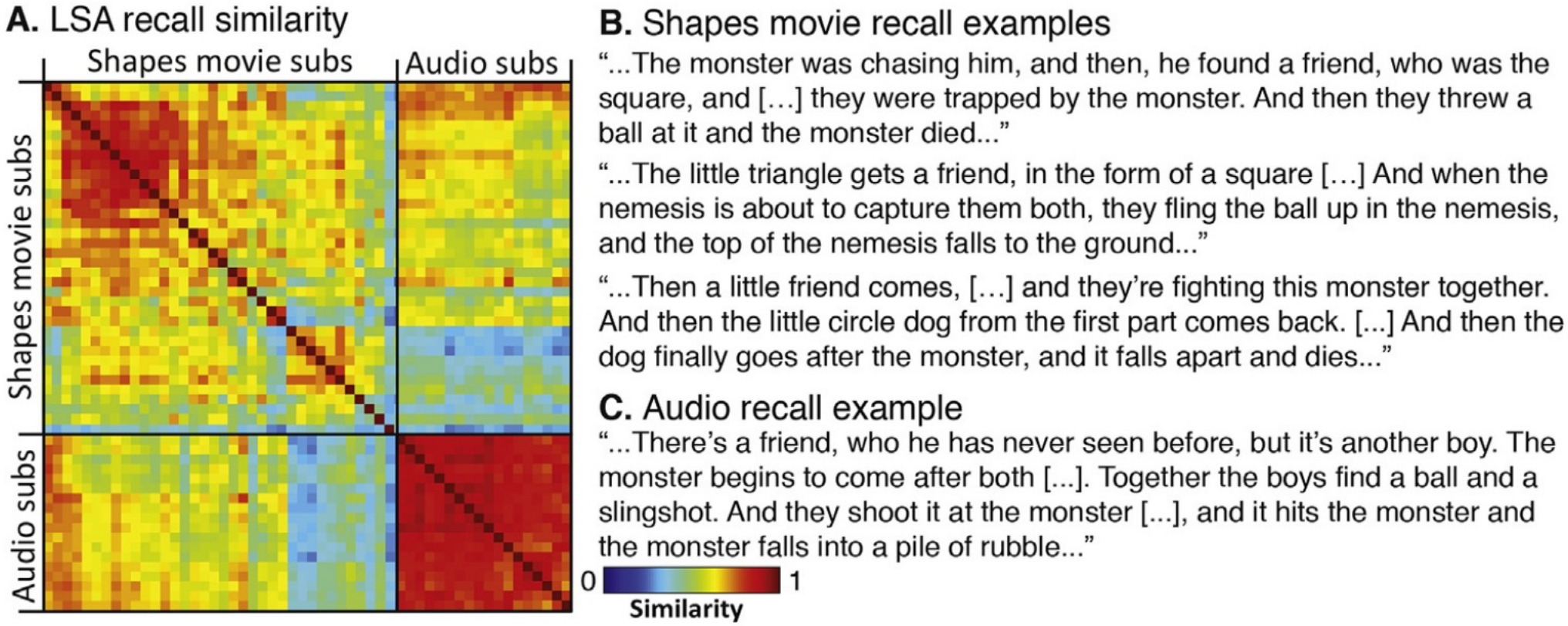


模棱两可的自然刺激

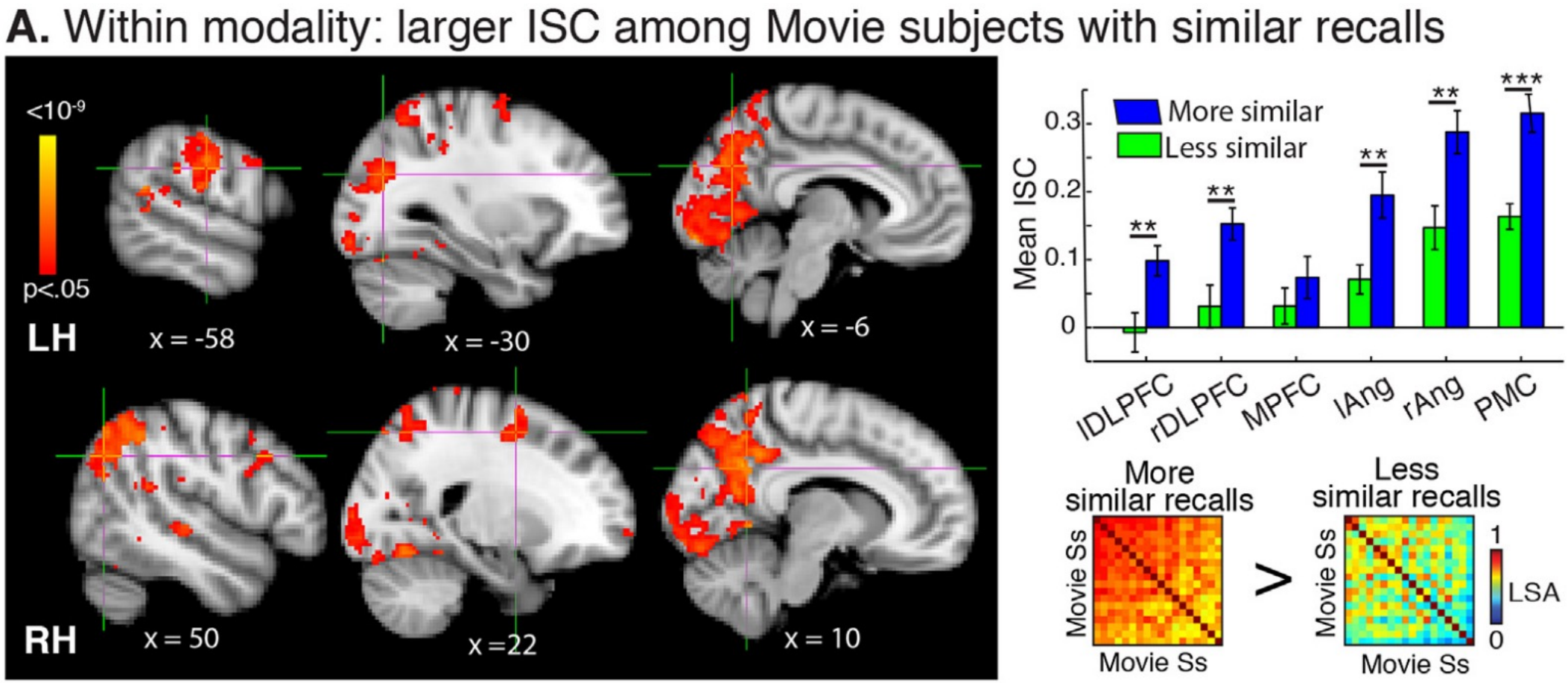
实验设计


A. Intersubject correlation analysis
Subject 1
Recall transcript
LSA
Recall transcript
Subject 2
LSA similarity
subjects
1 2 3 4 5 6
subjects
order by avg similarity
More sim
Less sim
ISC within each group
B. Intersubject representational similarity analysis
Subject 1
r
Subject 2
Neural similarity
subjects
1 2 3 4 5 6
subjects
Spearman's r
LSA similarity

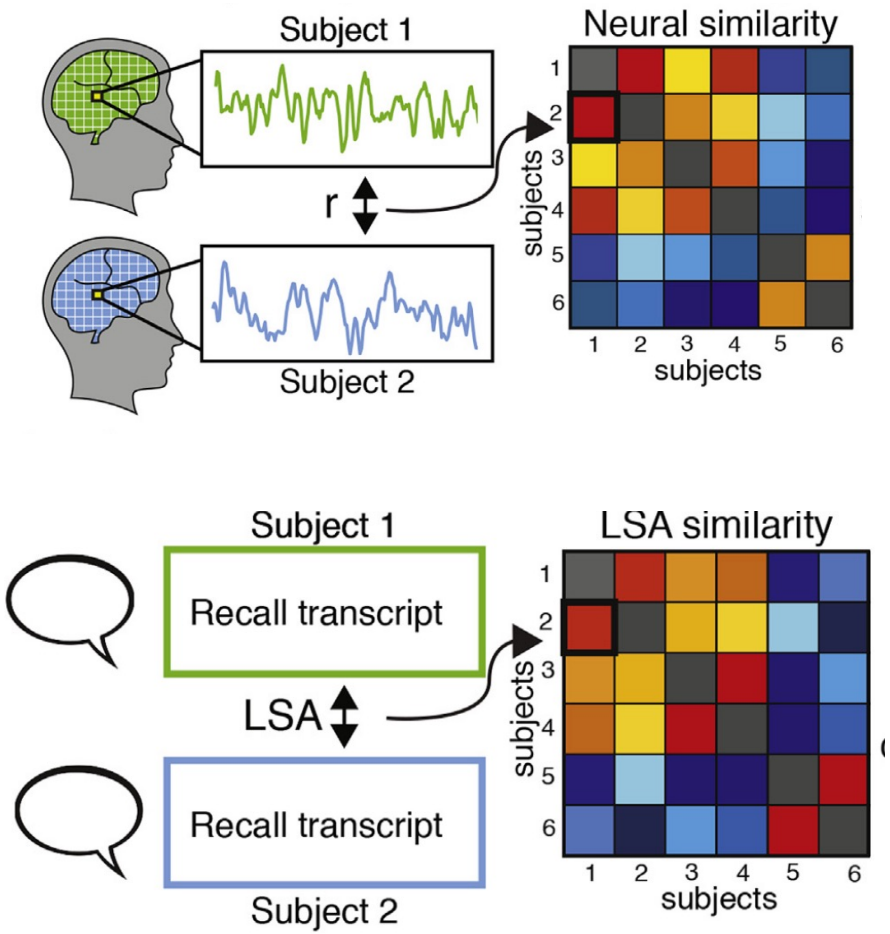
有些被试的视频理解文本更相似

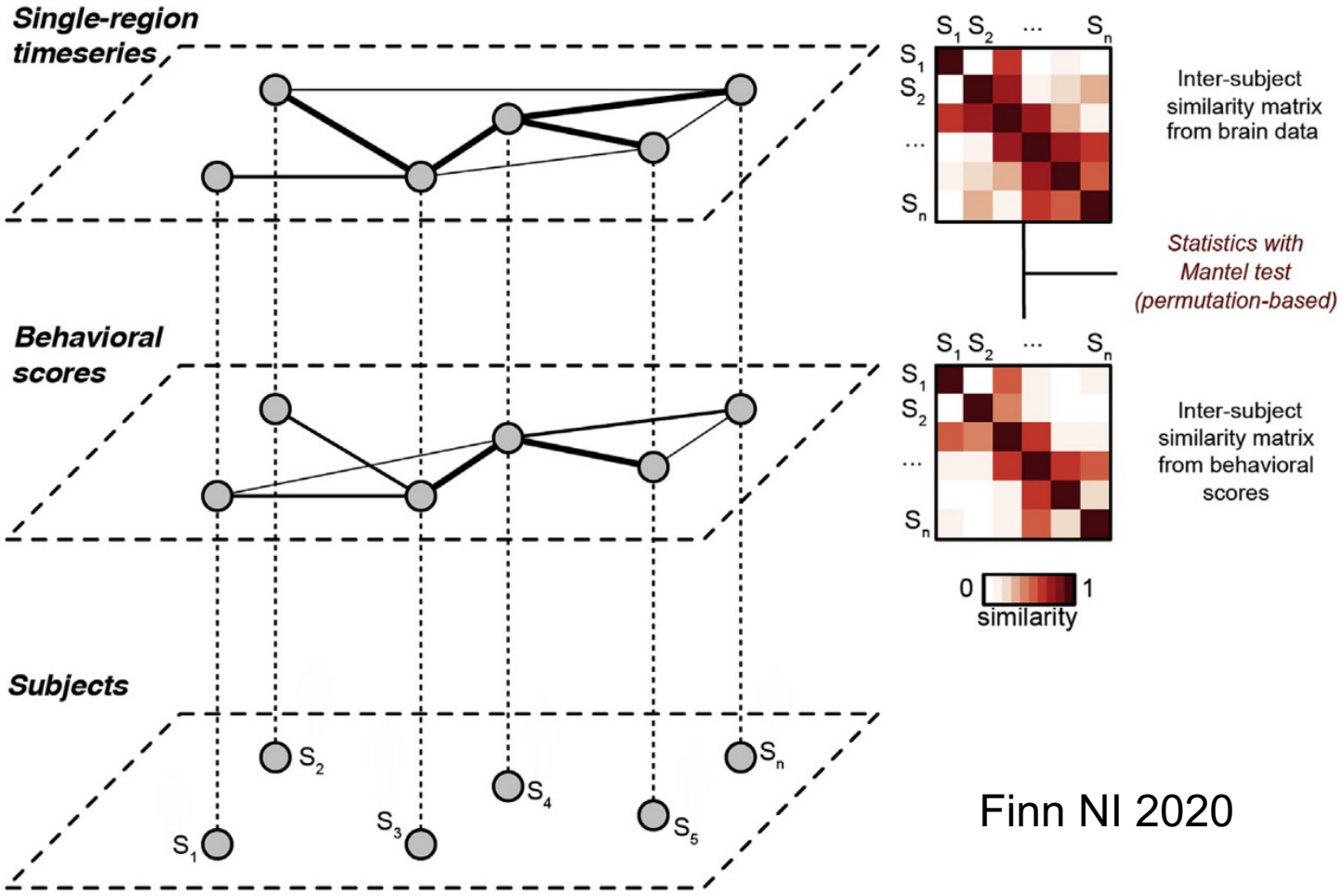


理解相似组在DMN等高级脑区的ISC比不相似组更高



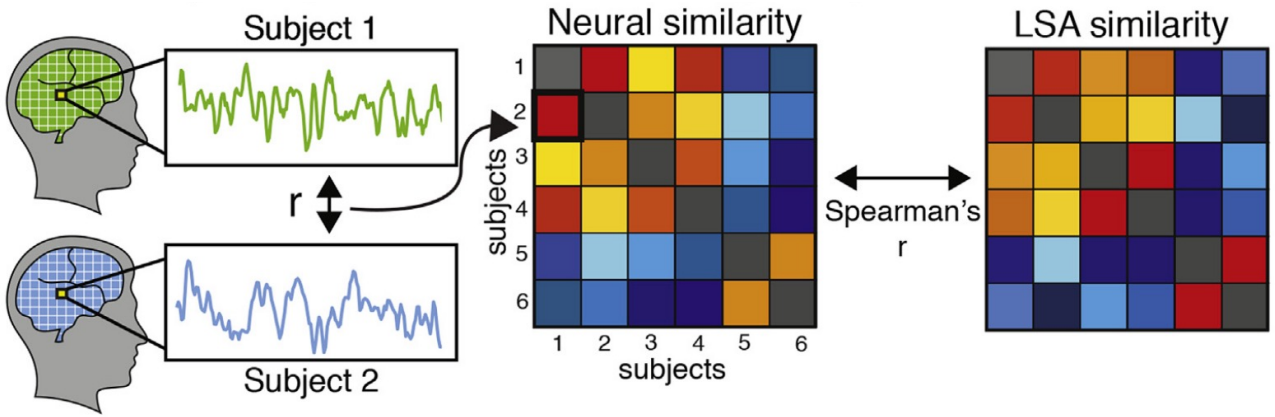
Intersubject Representational Similarity Analysis(IS-RSA)

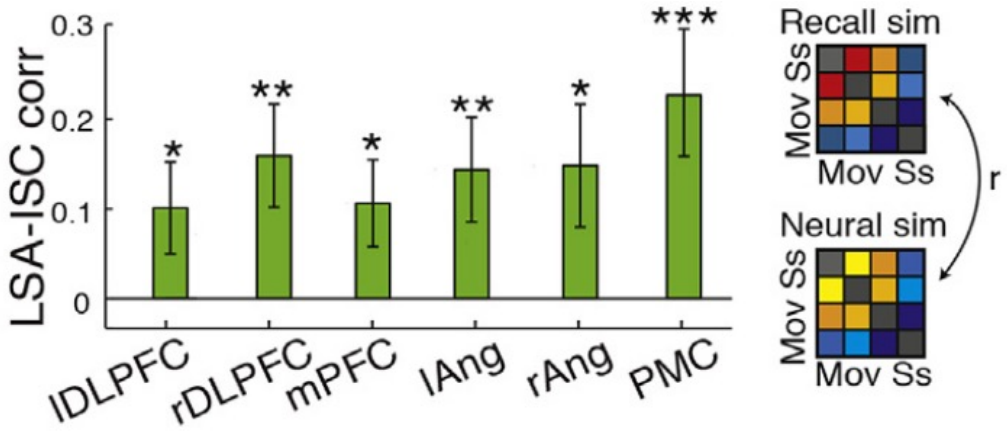


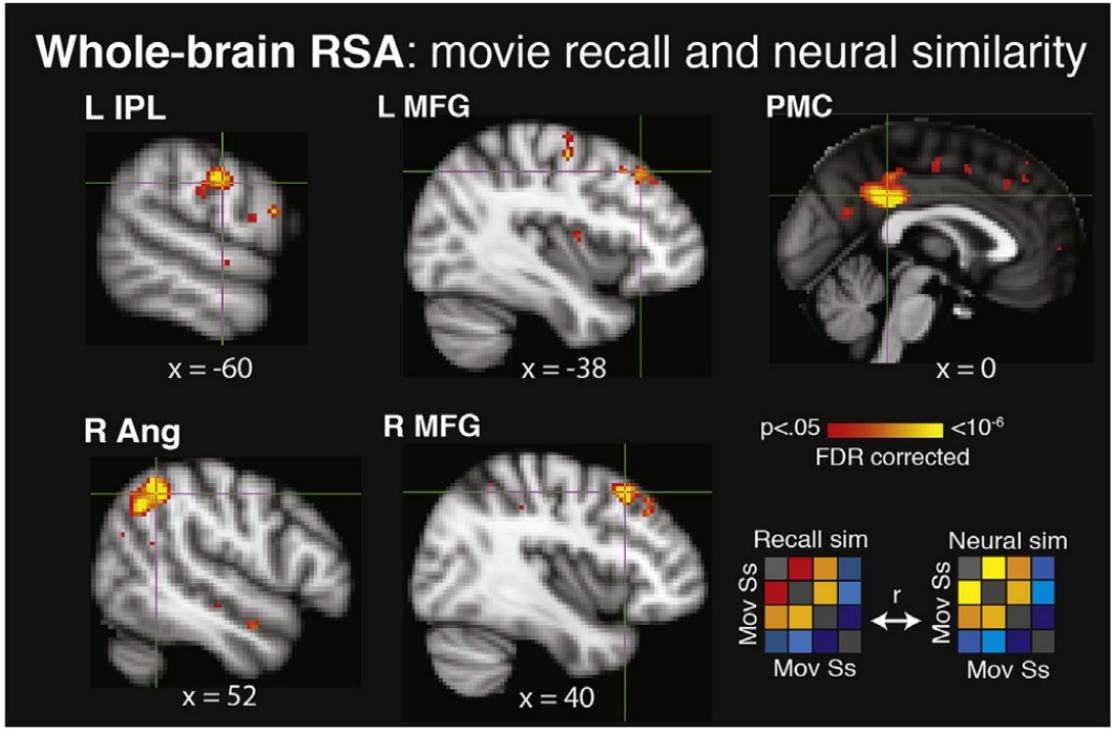


Finn NI 2020

精细粒度的IS-RSA也表明，理解越相似，神经响应越相似



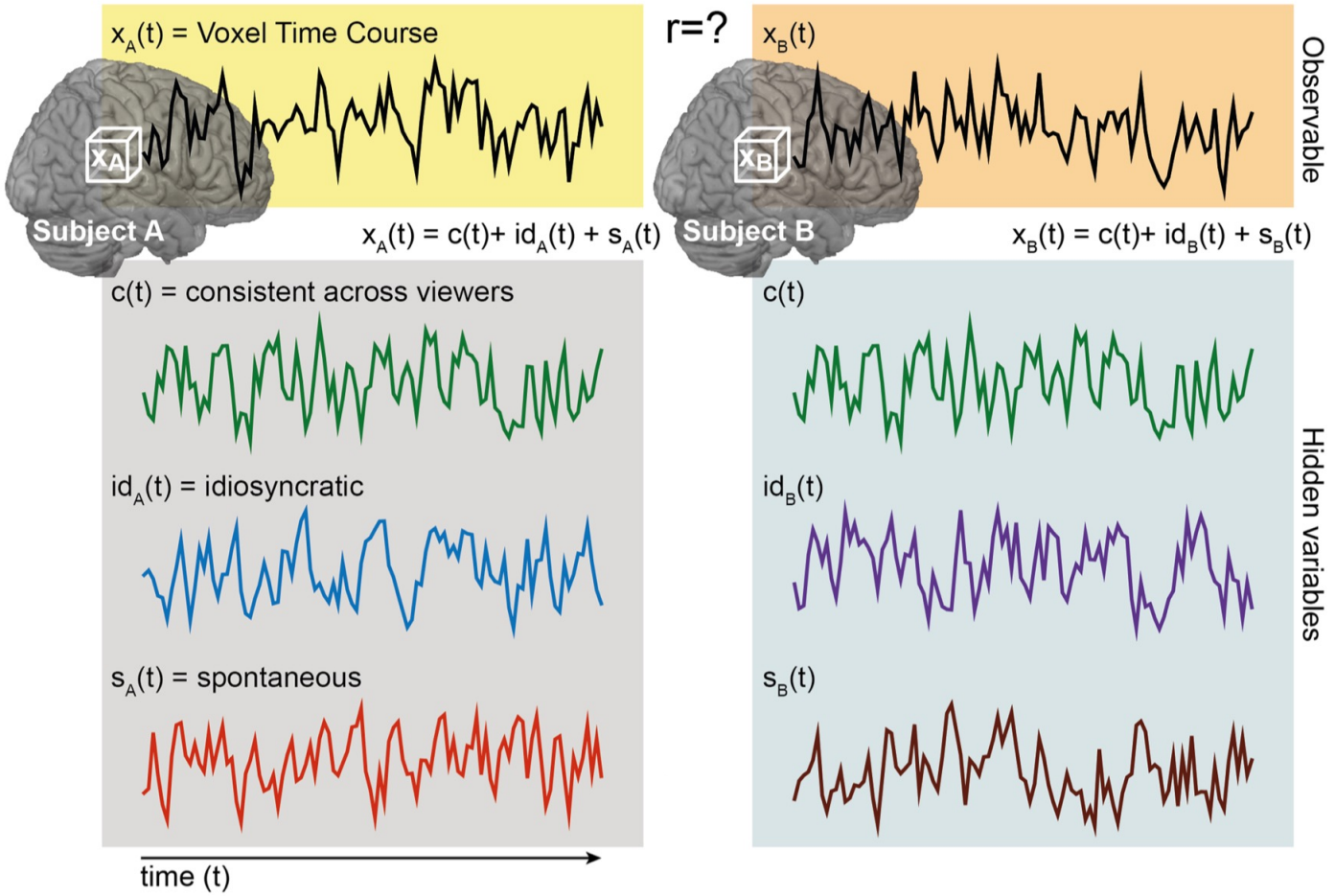




结论

- 在DMN等涉及理解加工的高级脑区，如果被试间的理解方式越相似，则神经响应模式也越相似。这也是人类能互相交流、互相理解的基础

个体特异成分的理论ISC值受到被试群体认知模式相似性的调节



$$E[C_A(t), C_B(t)] + E[id_A(t), id_B(t)] + E[S_A(t), S_B(t)] = E[X_A(t), X_B(t)]$$

$E[C_A(t), C_B(t)]$ → 1

$E[id_A(t), id_B(t)]$ → [0, 1]

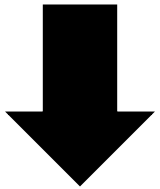
$E[S_A(t), S_B(t)]$ → 0

理论相关值

$$E[C_A(t), C_B(t)] + E[id_A(t), id_B(t)] \cong E[X_A(t), X_B(t)]$$

结论

- 在DMN等涉及理解加工的高级脑区，如果被试间的理解方式越形似，则神经响应模式也越相似。这也是人类能互相交流、互相理解的基础



个体之间理解方式的差异是个体特质差异的投影，

个体特质越相似，神经响应模式越相似？

探讨个体理解与加工方式对自然刺激神经响应的调制机制

因为特质越相似，所以理解越相似？

特质越相似，理解越相似，神经响应越相似？

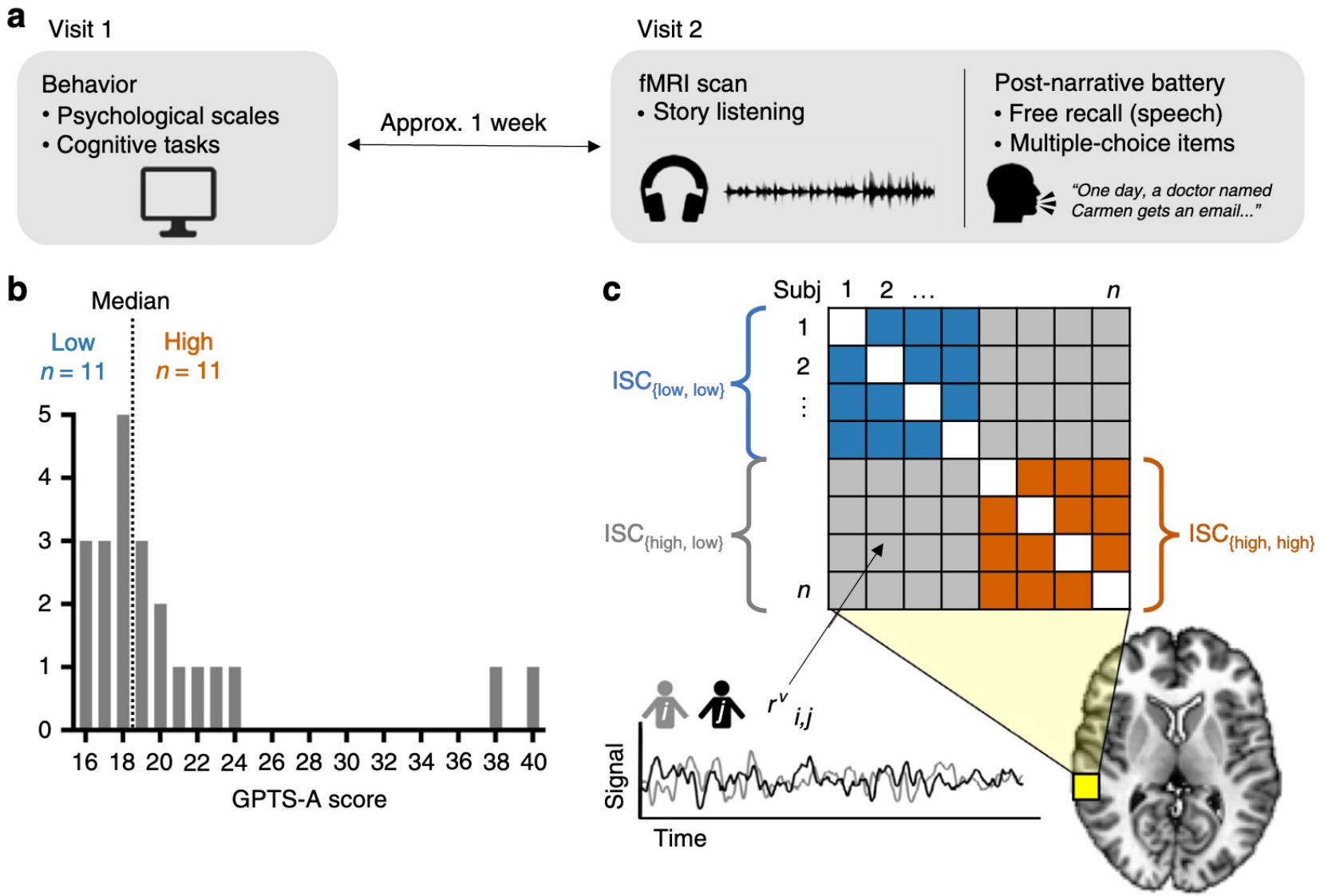
ARTICLE

DOI: 10.1038/s41467-018-04387-2 OPEN

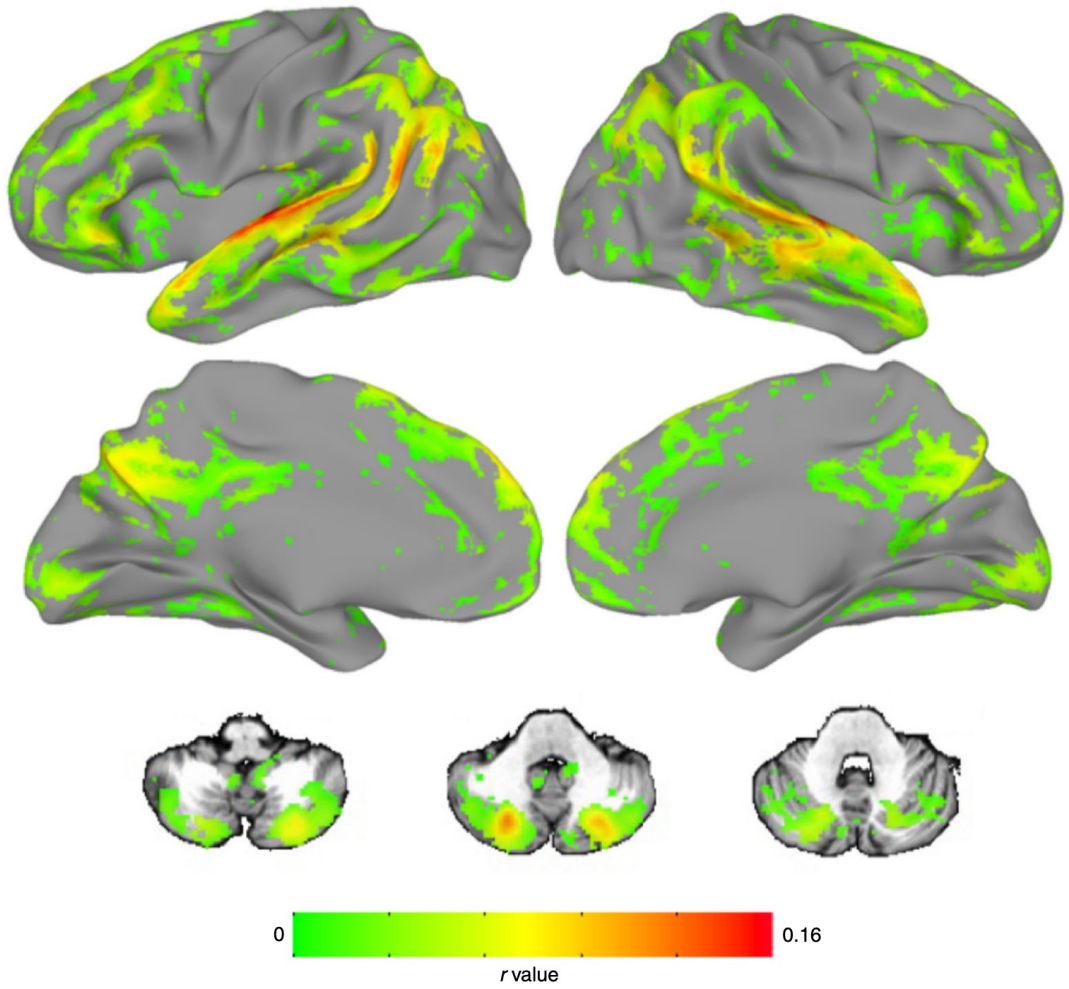
Trait paranoia shapes inter-subject synchrony in brain activity during an ambiguous social narrative

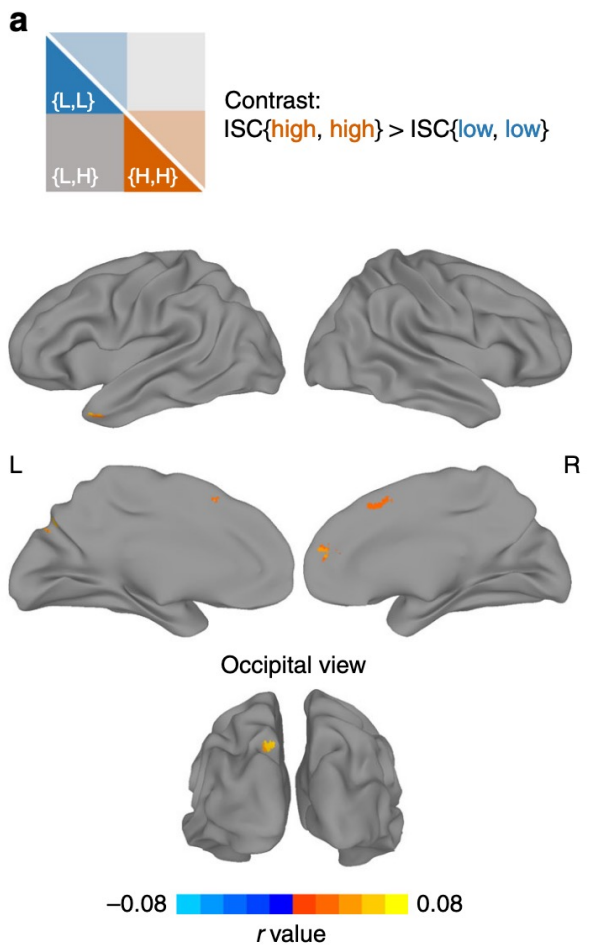
Emily S. Finn [1], Philip R. Corlett[2], Gang Chen[3], Peter A. Bandettini[1] & R. Todd Constable [4]

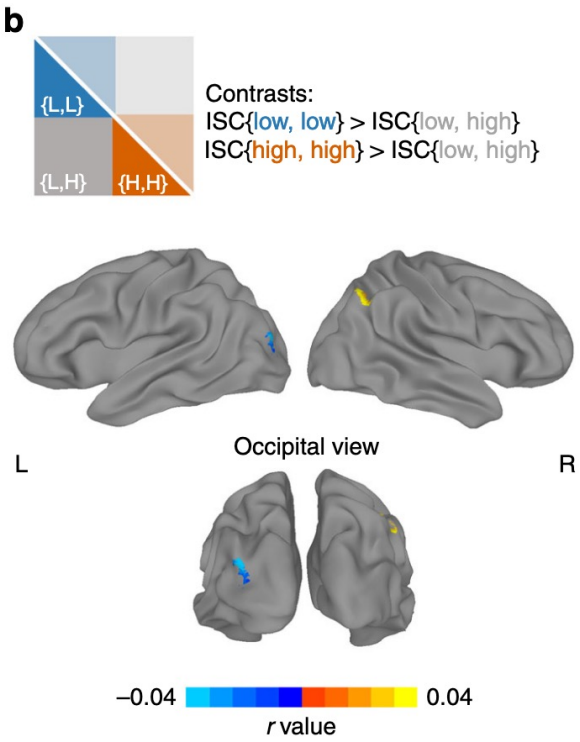
实验设计


a
Visit 1
Behavior
• Psychological scales
• Cognitive tasks
Approx. 1 week
Visit 2
fMRI scan
• Story listening
Post-narrative battery
• Free recall (speech)
• Multiple-choice items
"One day, a doctor named Carmen gets an email..."
b
Median
Low
n = 11
High
n = 11
5
4
3
2
1
0
16 18 20 22 24 26 28 30 32 34 36 38 40
GPTS-A score
c
Subj 1 2 … n
1
2
n
ISC{low, low}
ISC{high, low}
ISC{high, high}
r v i,j
Signal
Time

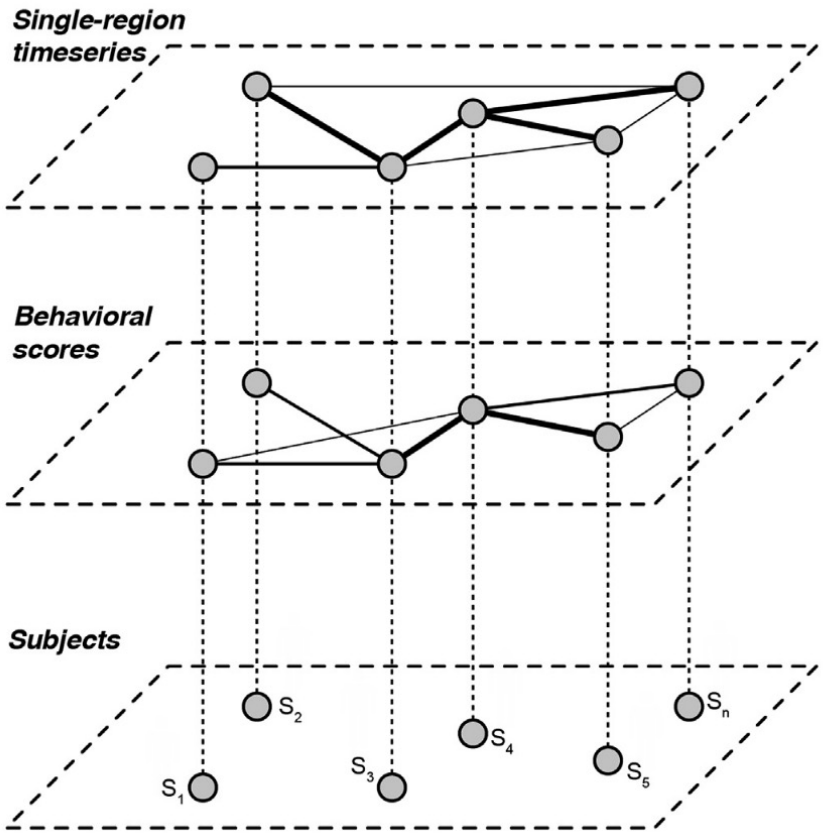
妄想障碍在心智化网络的ISC值更高

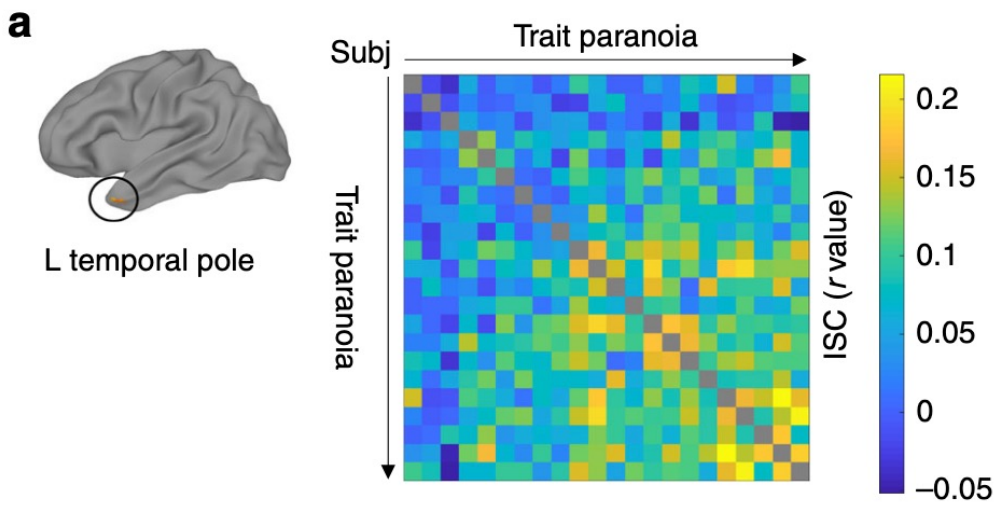


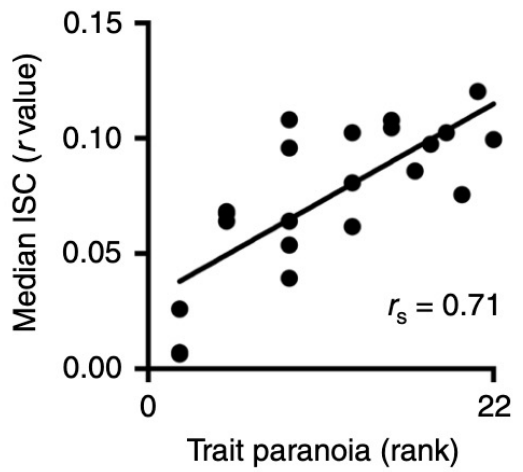


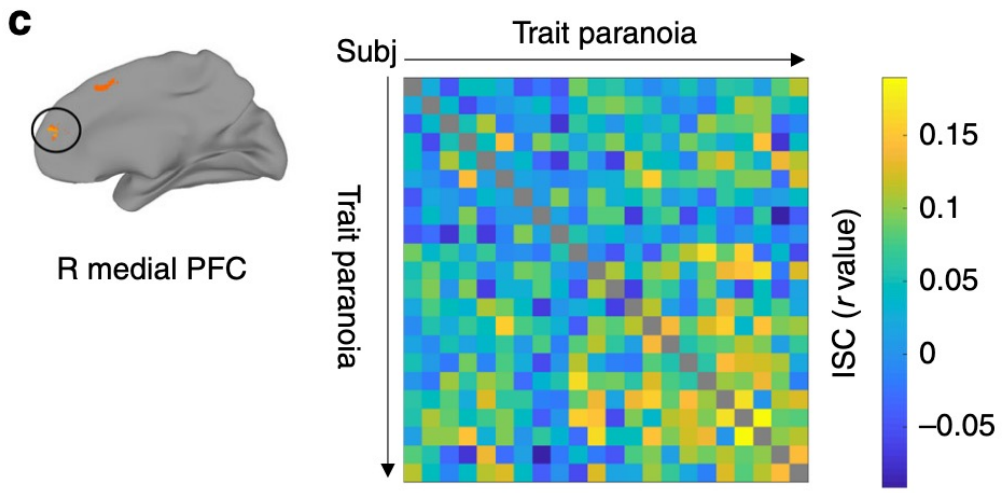


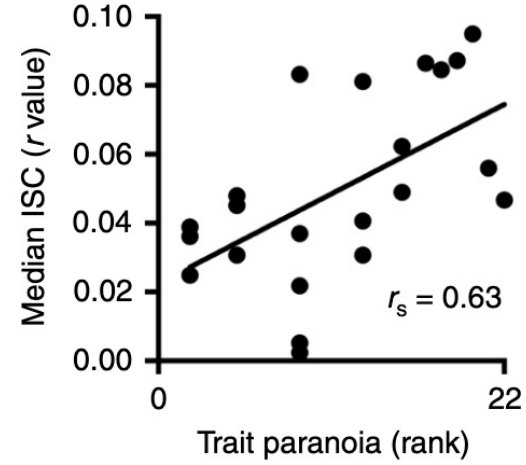
妄想障碍程度越接近，心智化网络的神经响应越相近



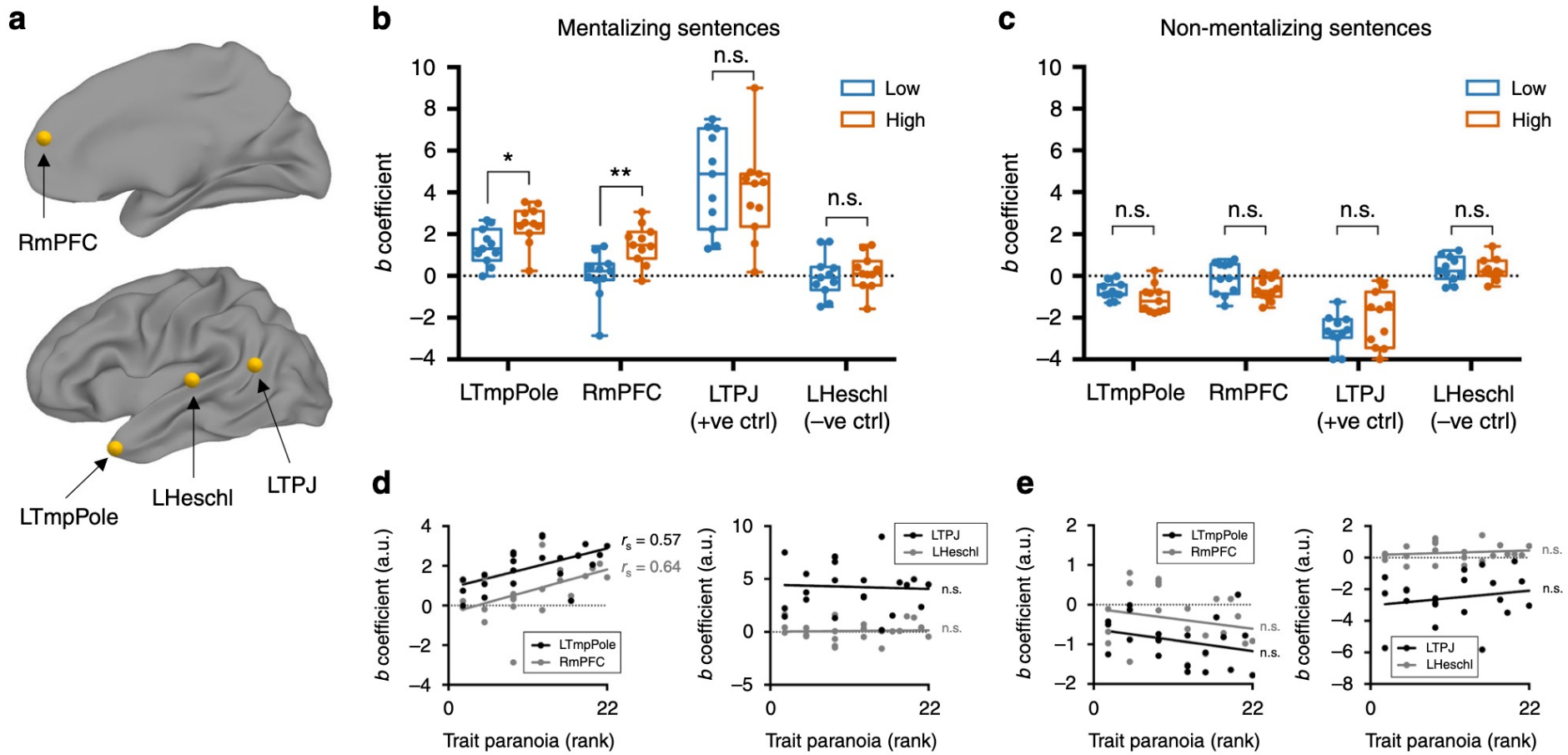








事件分析表明，妄想障碍的心智化网络活动更强



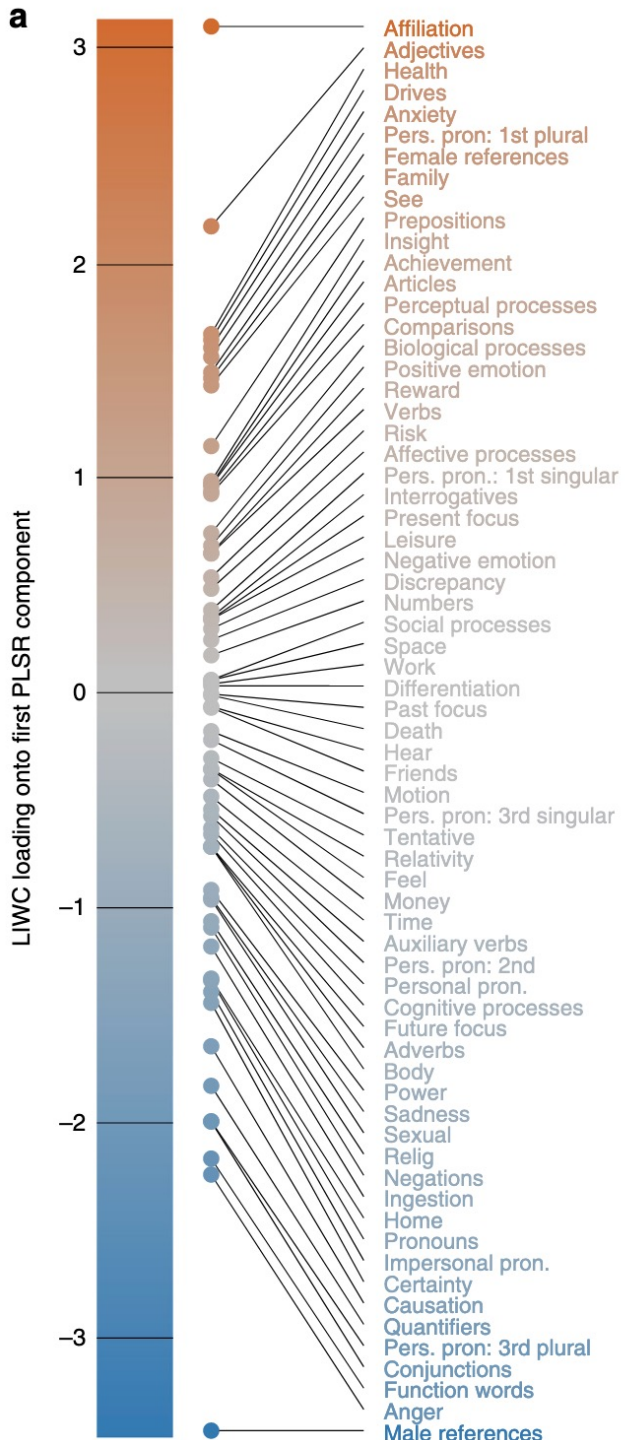
个体差异

理解文本分析

通过使用LIWC，计算妄想障碍者理解音频内容文本的词频类别

发现妄想障碍程度越高，越容易使用夸张的、过度揣测的表述

LIWC



b

Affiliation

"…but they become **friends** once she gets to know her better."

Health

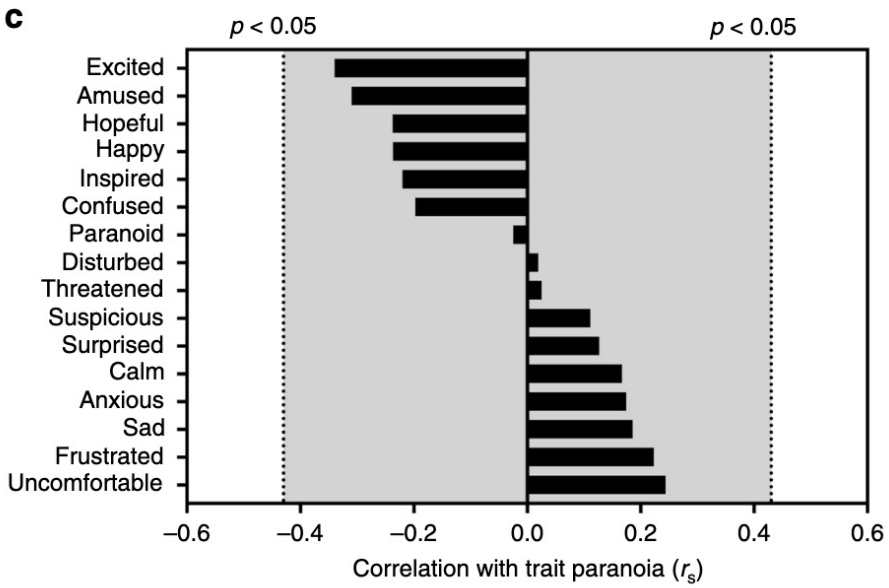
"…there were a series of **patients** that had a **fever** accompanied by a **rash**…"

Anxiety

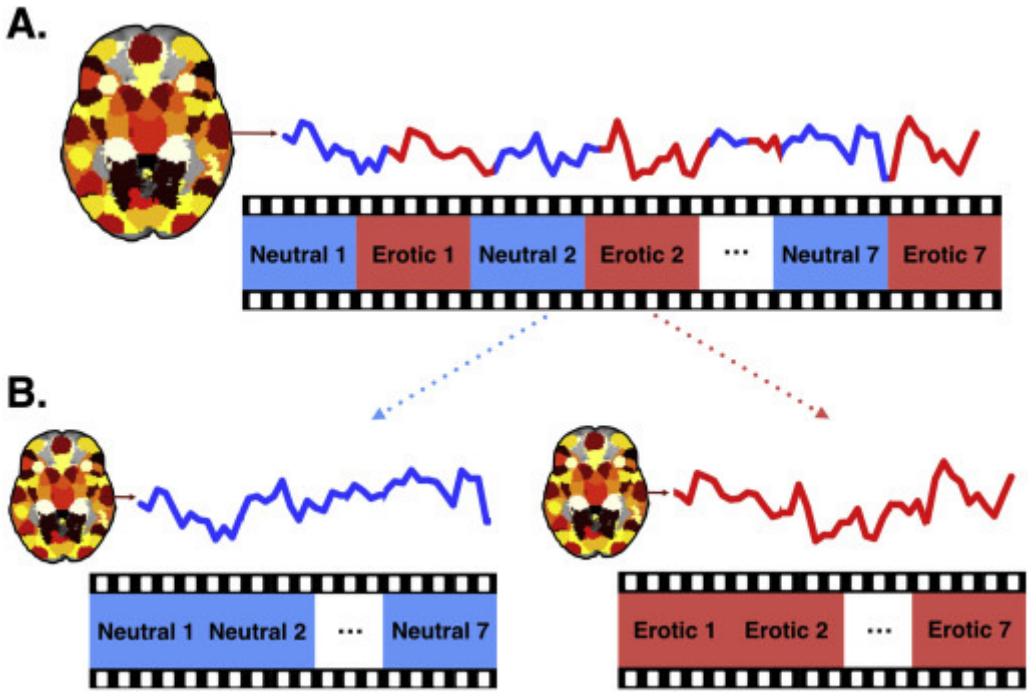
"…she almost **panicked**…"

Anger

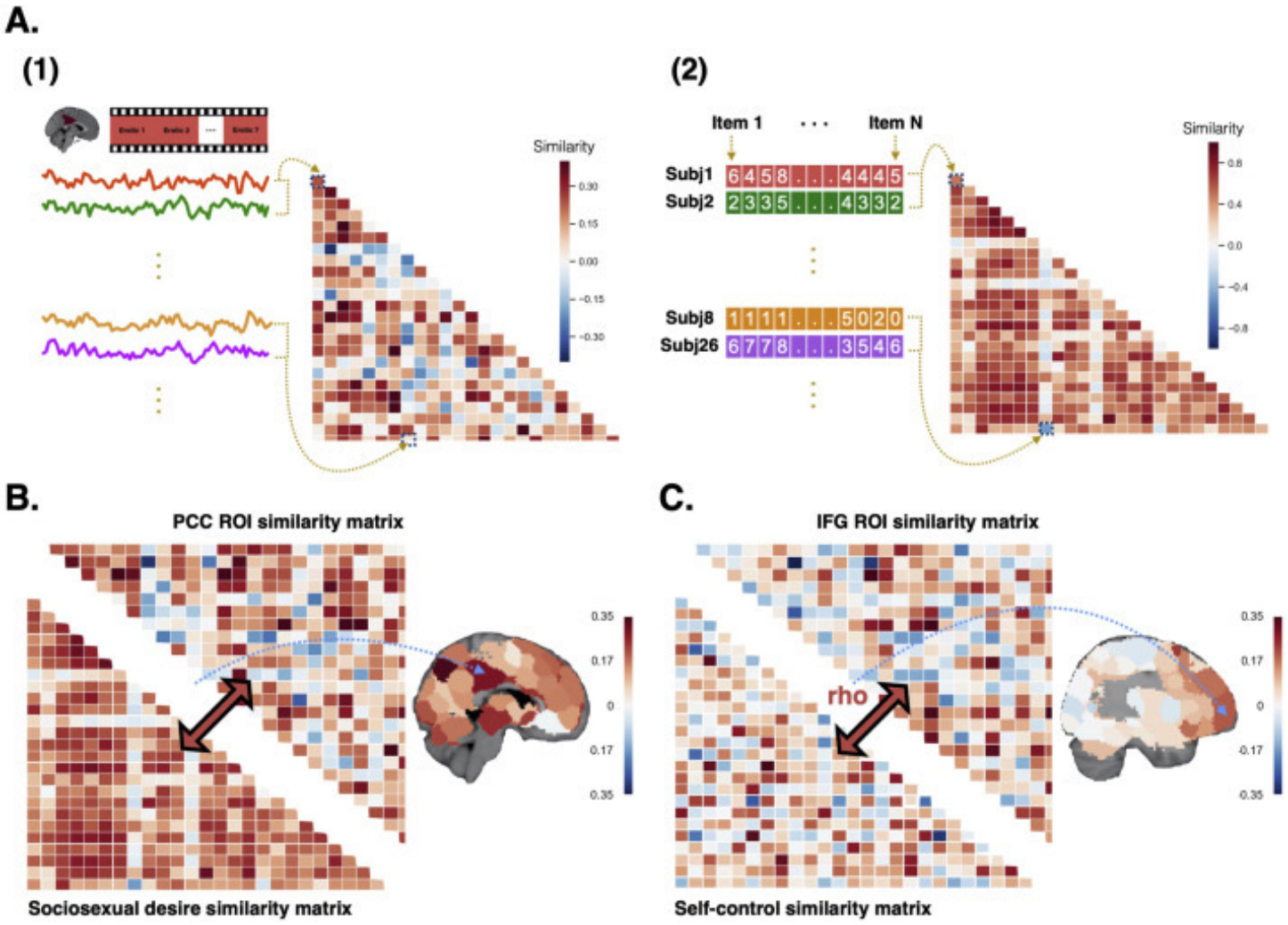
"…and she **yells** at him…"



个体偏好越相似，情绪体验越相似



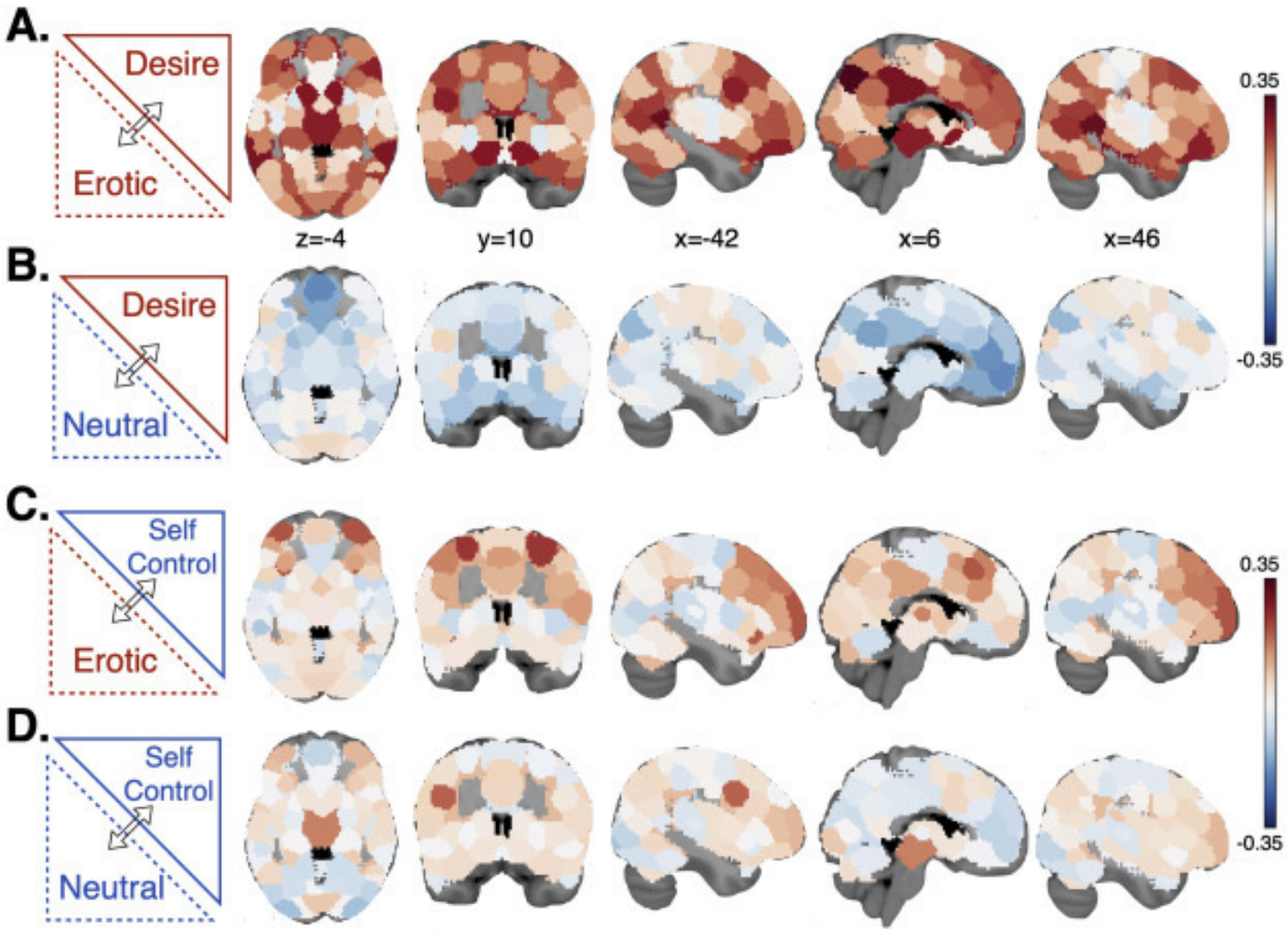
- Sexual Desire
- Self-Control

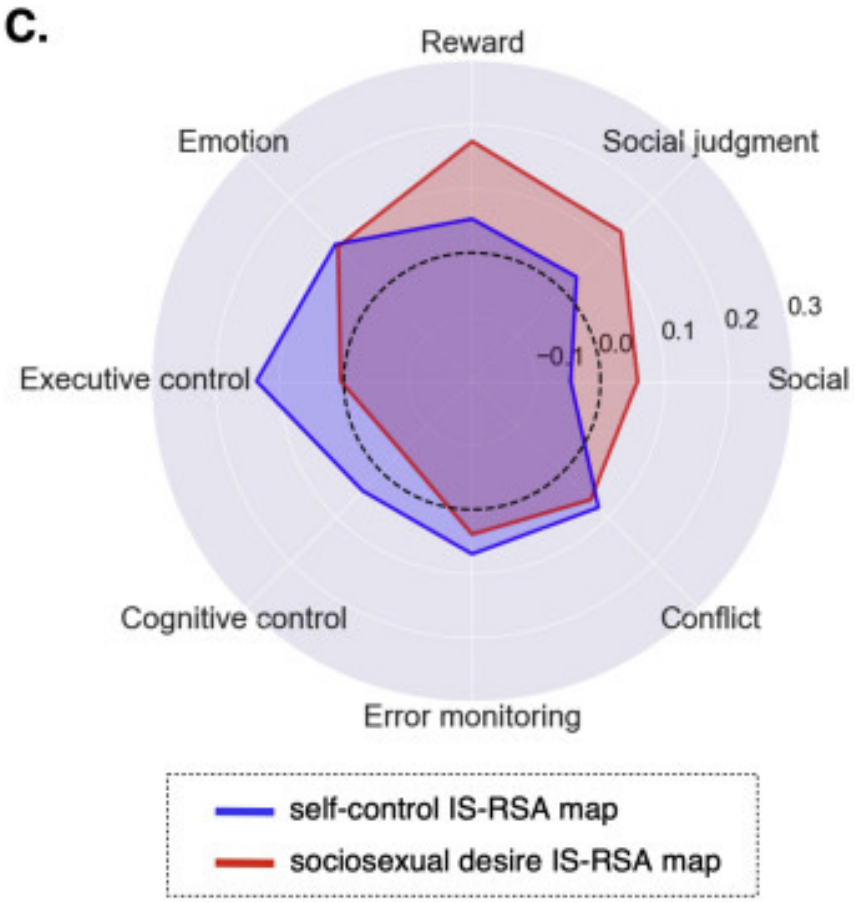


PHA Chen NI 2020

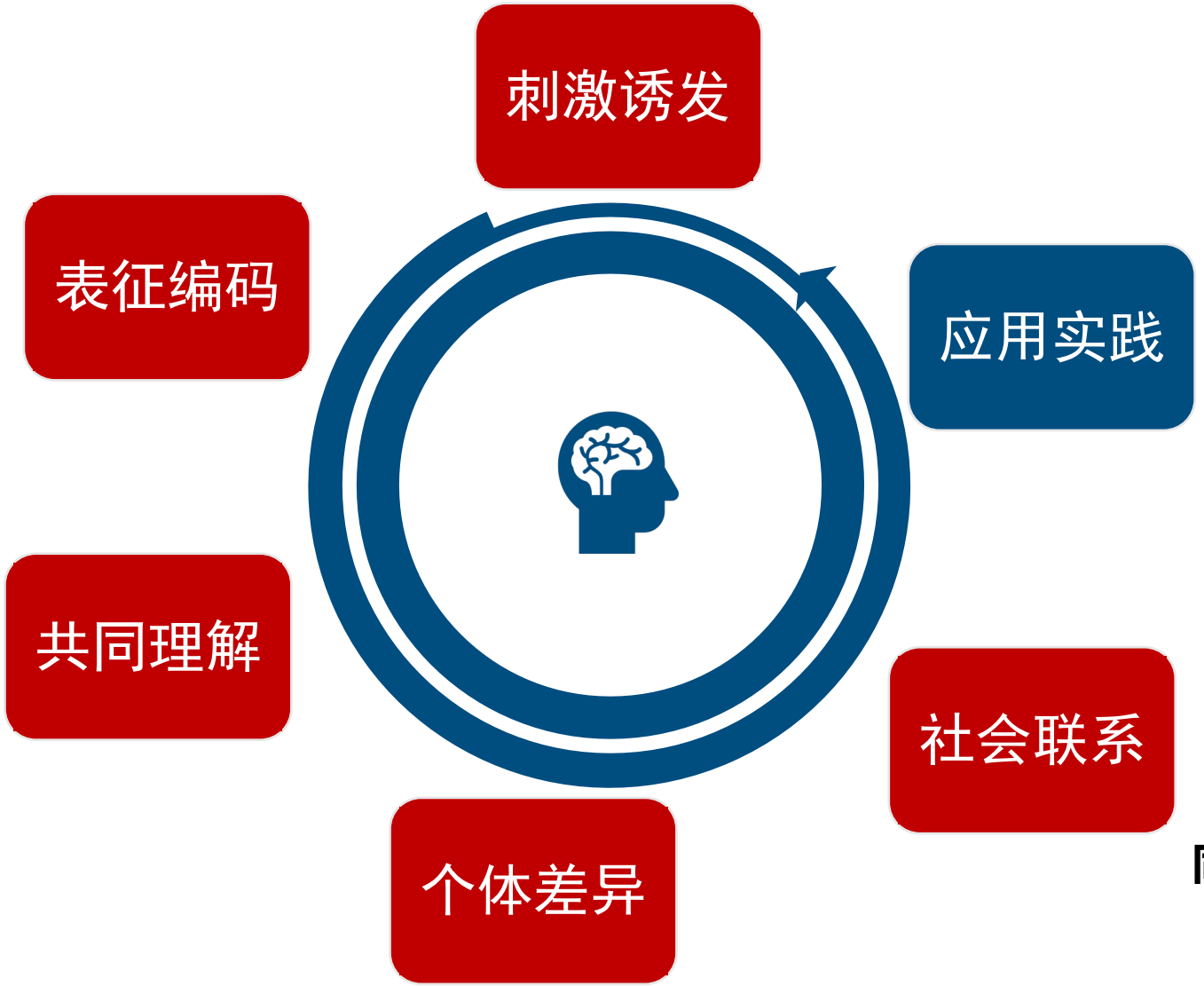
个体差异

个体偏好越相似，情绪体验越相似





通过自然刺激探讨个体间社会关系与个体共同认知模式的联系



同性相吸？

神经响应越相似，社会关系越亲近？

nature COMMUNICATIONS

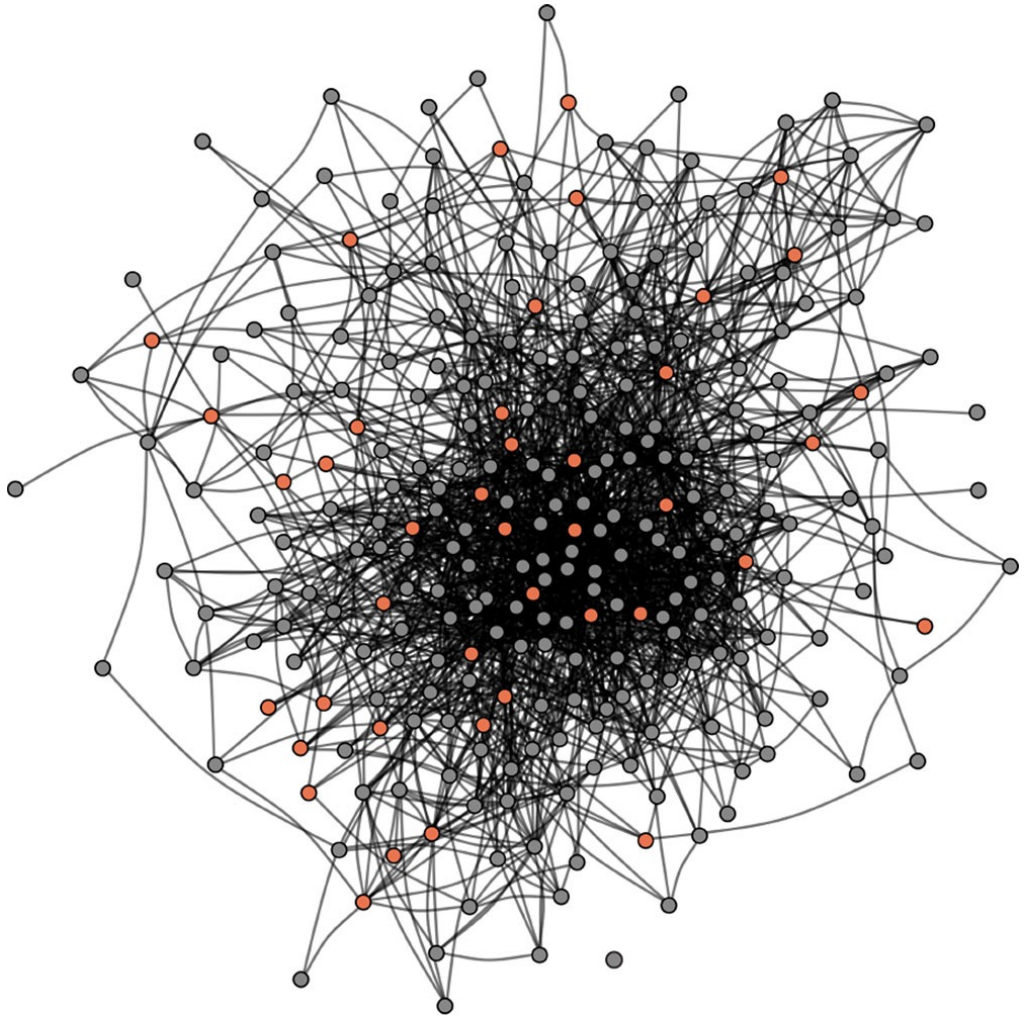
ARTICLE

DOI: 10.1038/s41467-017-02722-7 OPEN

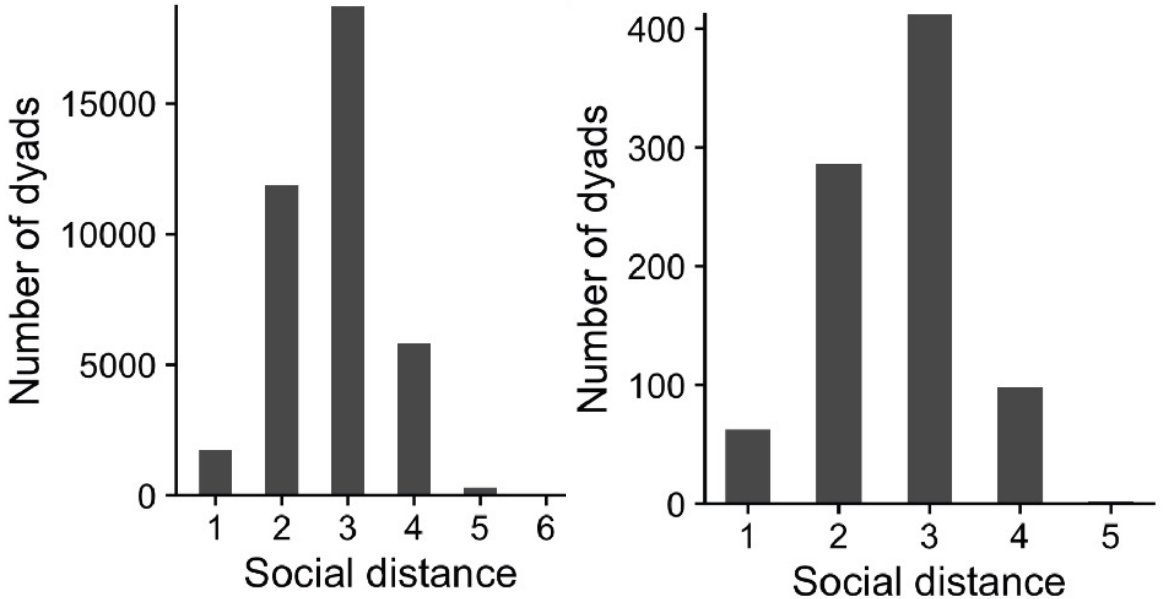
Similar neural responses predict friendship

Carolyn Parkinson [1], Adam M. Kleinbaum [2] & Thalia Wheatley[3]

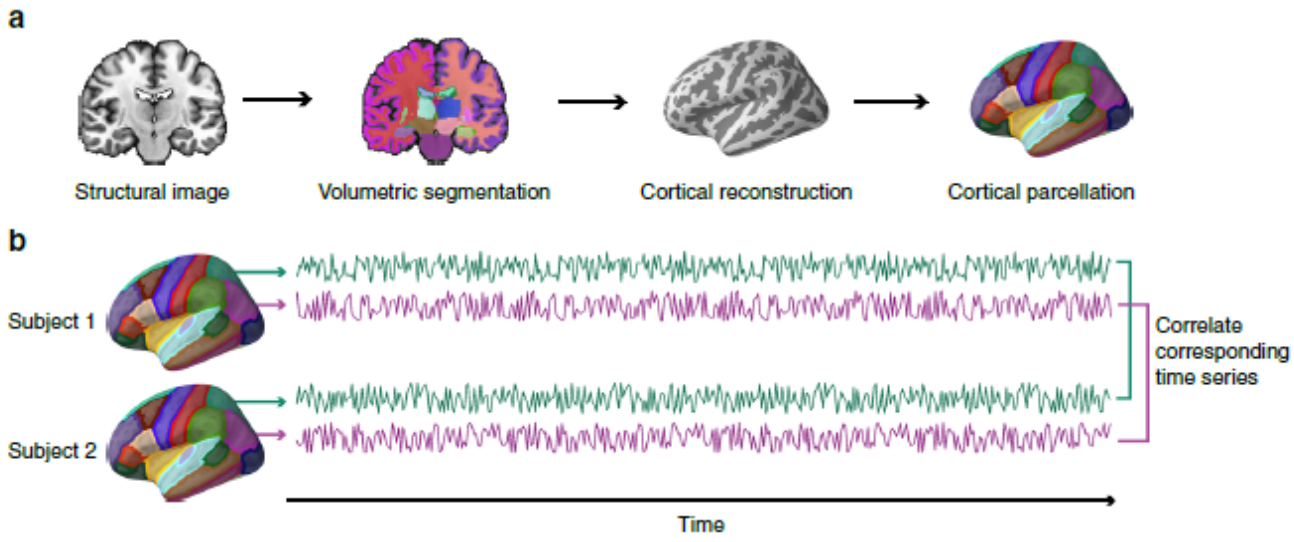
实验设计



Known each for 3 ~4 month

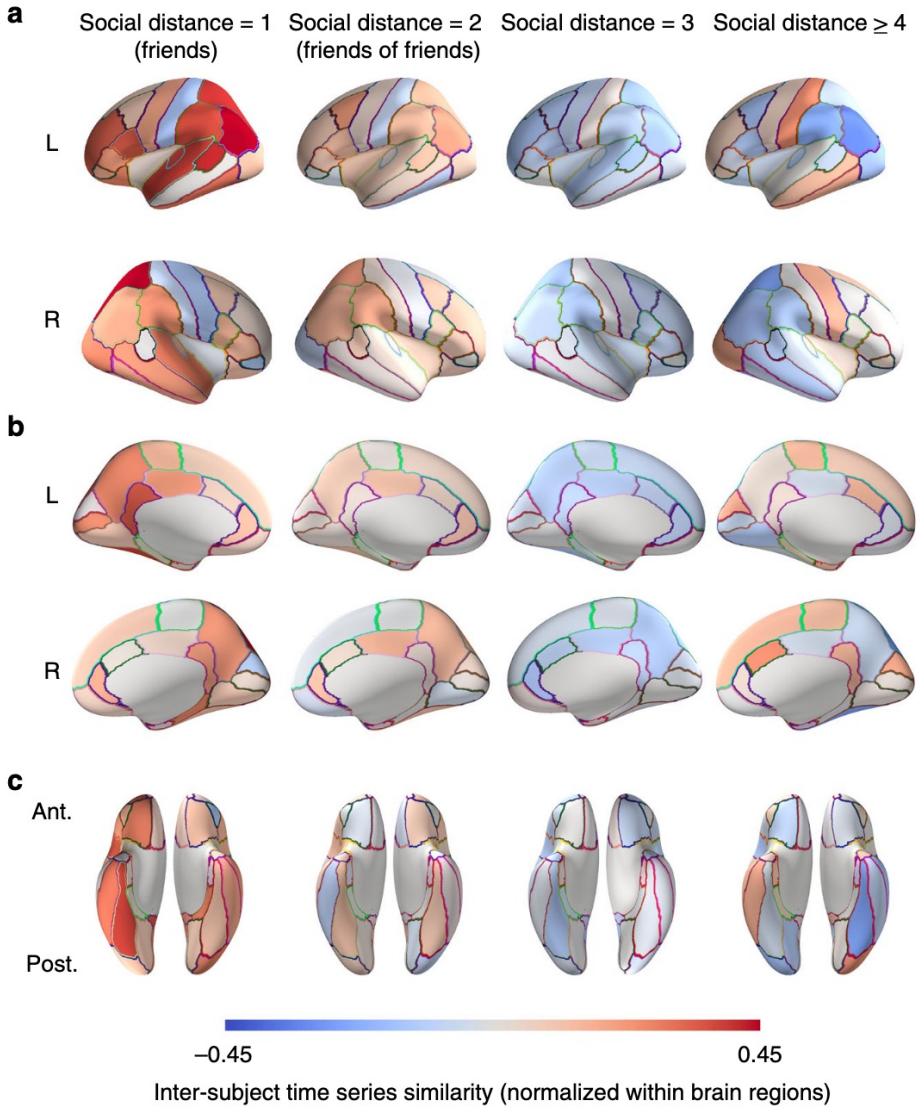


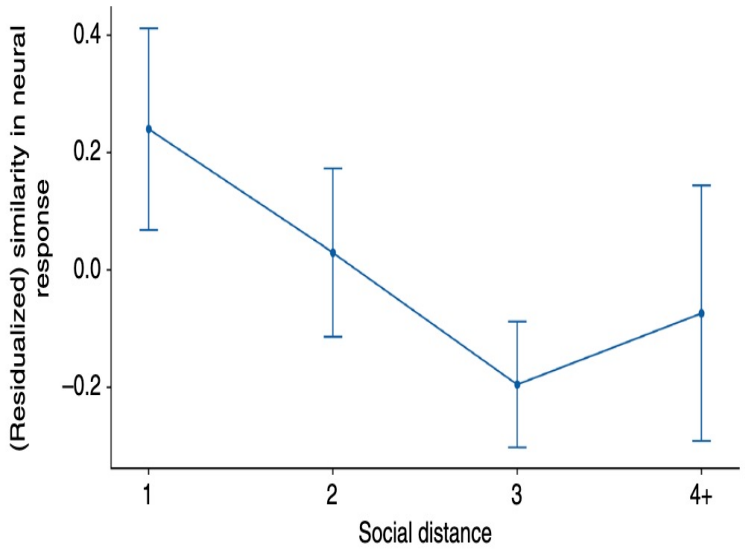
$C_{279}^2 = 38781$ $C_{42}^2 = 861$

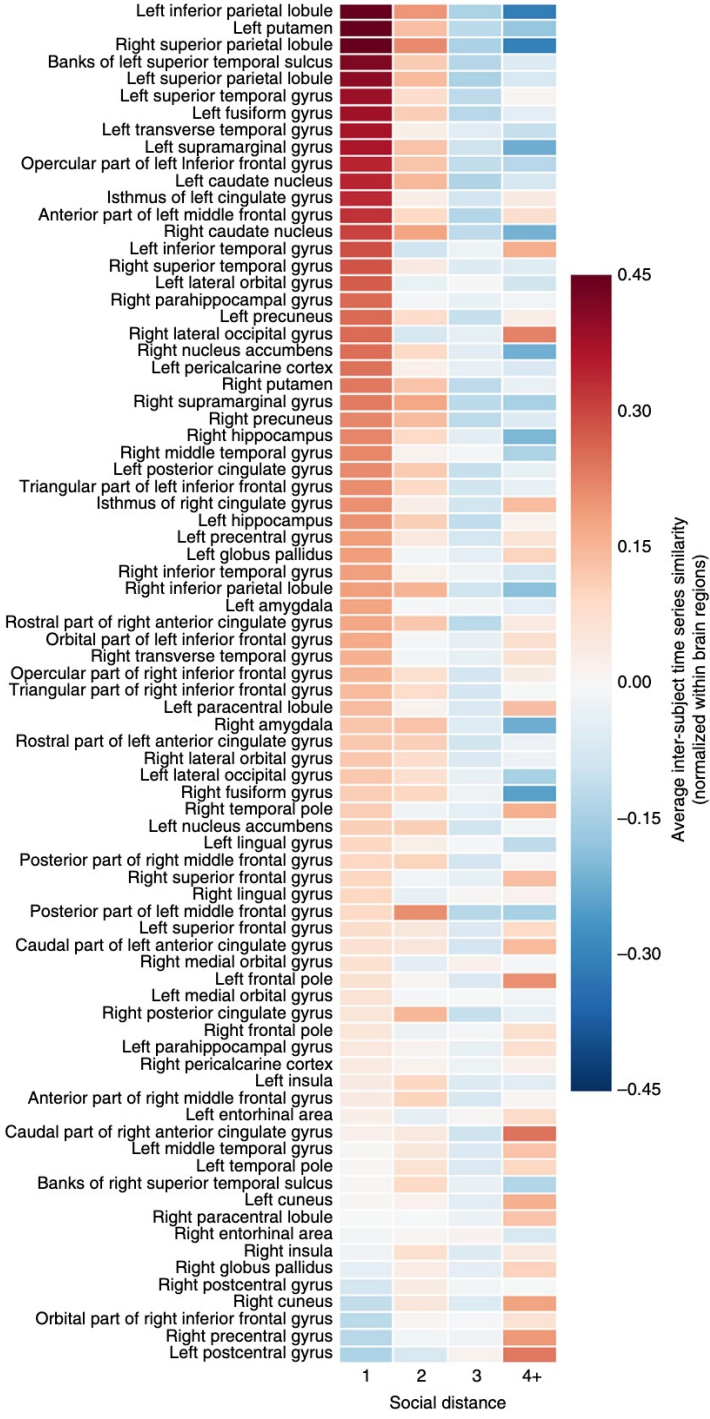


社会联系

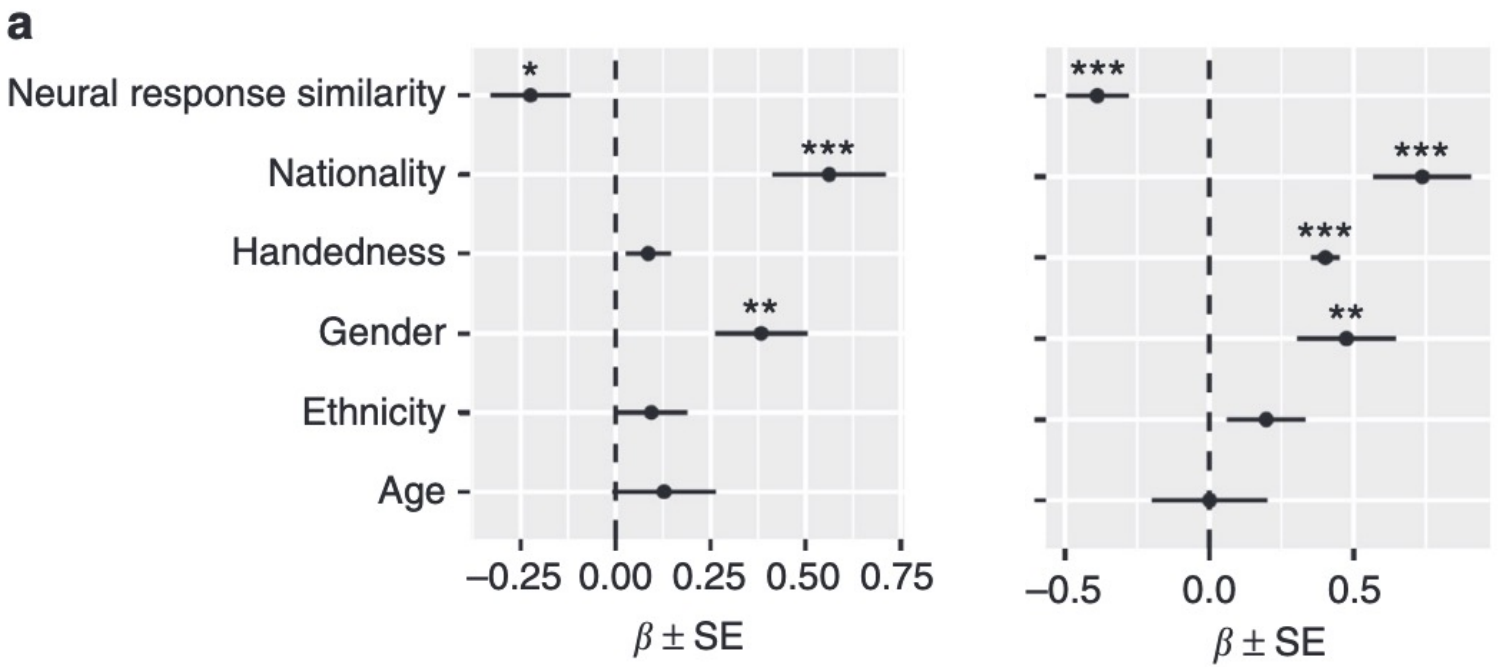
关系越近 ，神经响应越相似





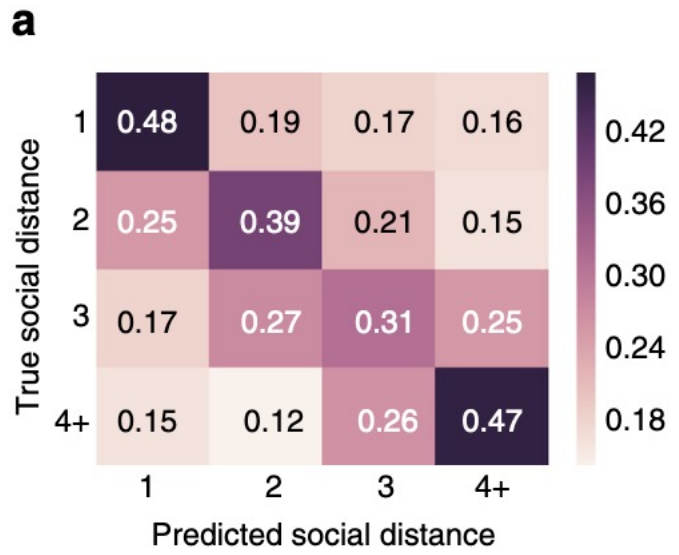


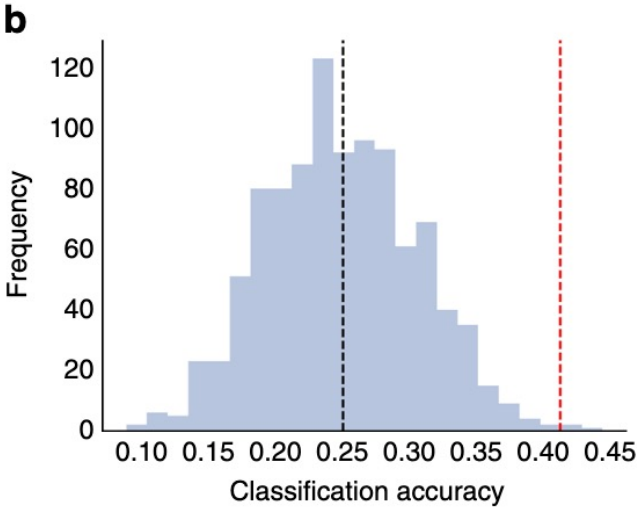
自然刺激神经响应相似性可以预测彼此关系的亲疏远近



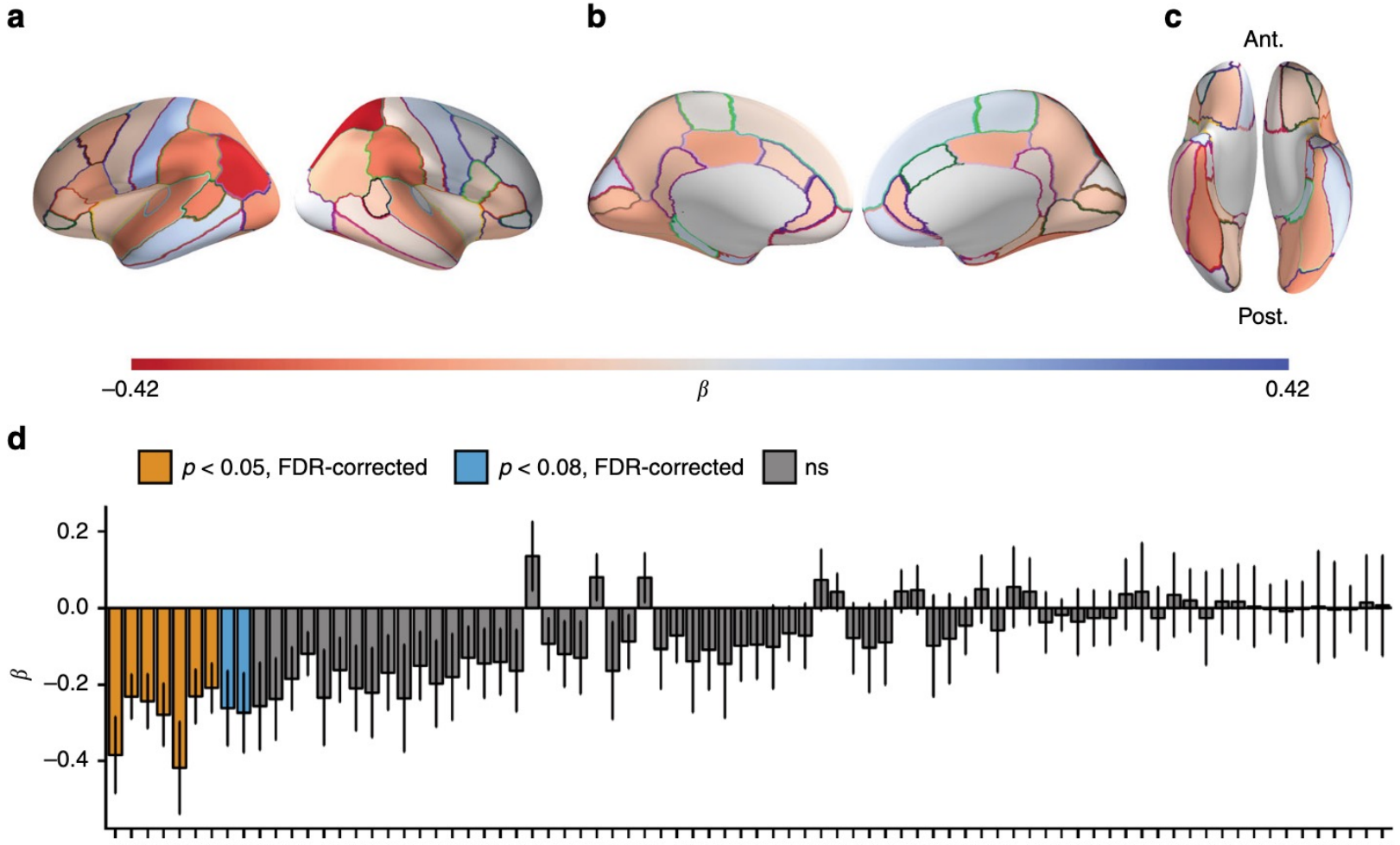
预测社会距离

预测是否是朋友





预测权重高的脑区主要为加工情感、奖赏、注意、动机的底层脑区



Region	β
Nucleus accumbens	−0.23
Inferior parietal cortex	−0.38
Superior parietal cortex	−0.42
Caudate nucleus	−0.28
Putamen	−0.24
Caudate nucleus	−0.23
Amygdala	−0.21
Supramarginal gyrus	*−0.26*
Supramarginal gyrus	*−0.27*

通过自然刺激构建有有效的神经标记

学习测量？

应用实践

如何通过真实教学情景的神经响应预测学习效果

nature COMMUNICATIONS

ARTICLE

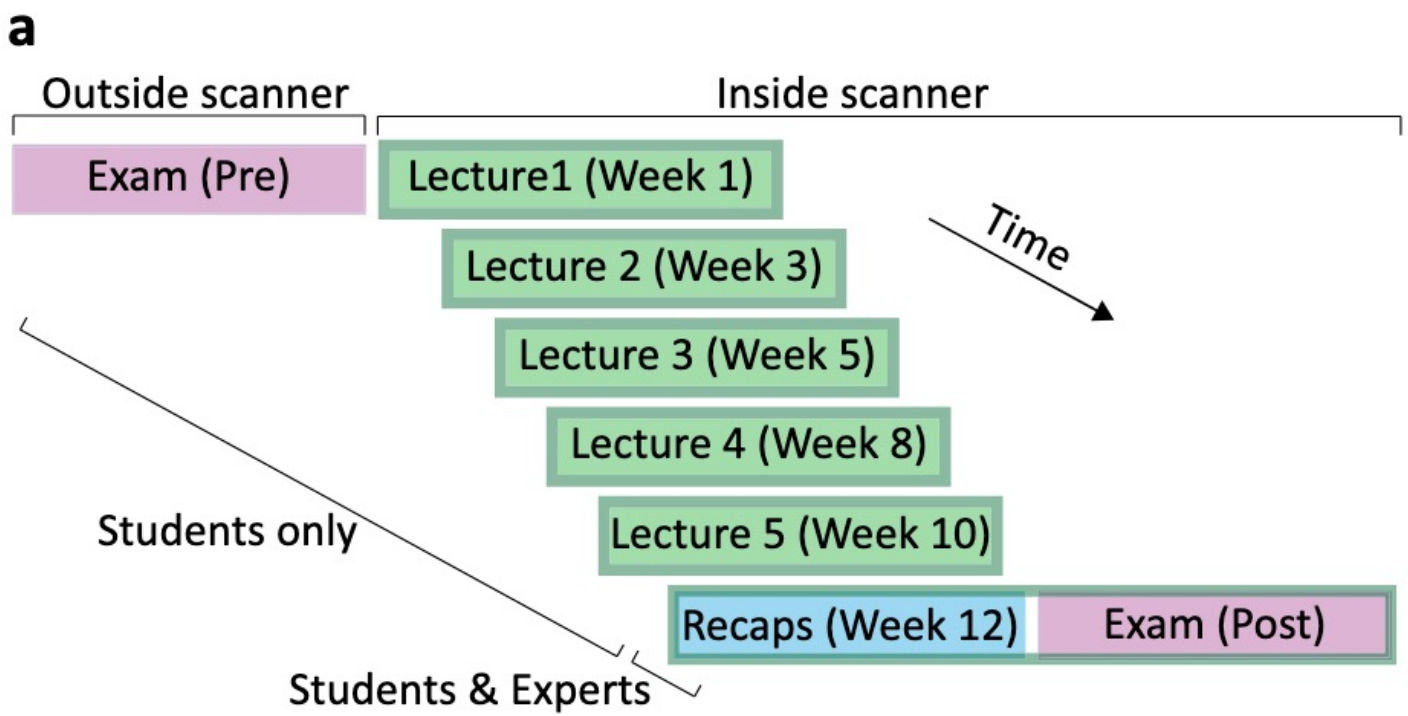
Check for updates

https://doi.org/10.1038/s41467-021-22202-3 OPEN

Neural alignment predicts learning outcomes in students taking an introduction to computer science course

Meir Meshulam[1,2✉], Liat Hasenfratz[1,2], Hanna Hillman[1,2], Yun-Fei Liu[1,2], Mai Nguyen[1,2], Kenneth A. Norman[1,2] & Uri Hasson[1,2]

实验设计



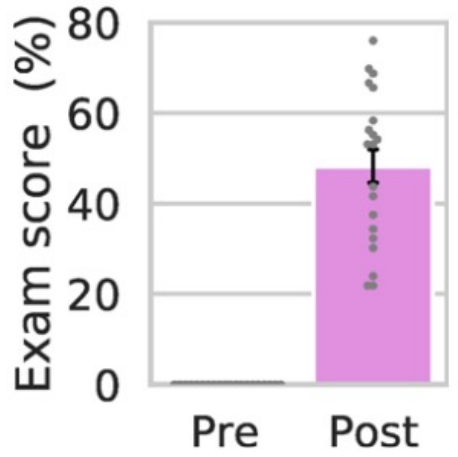
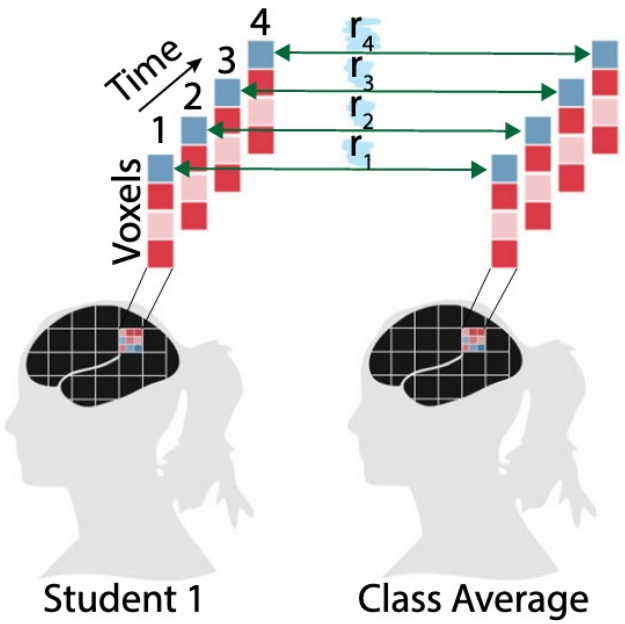


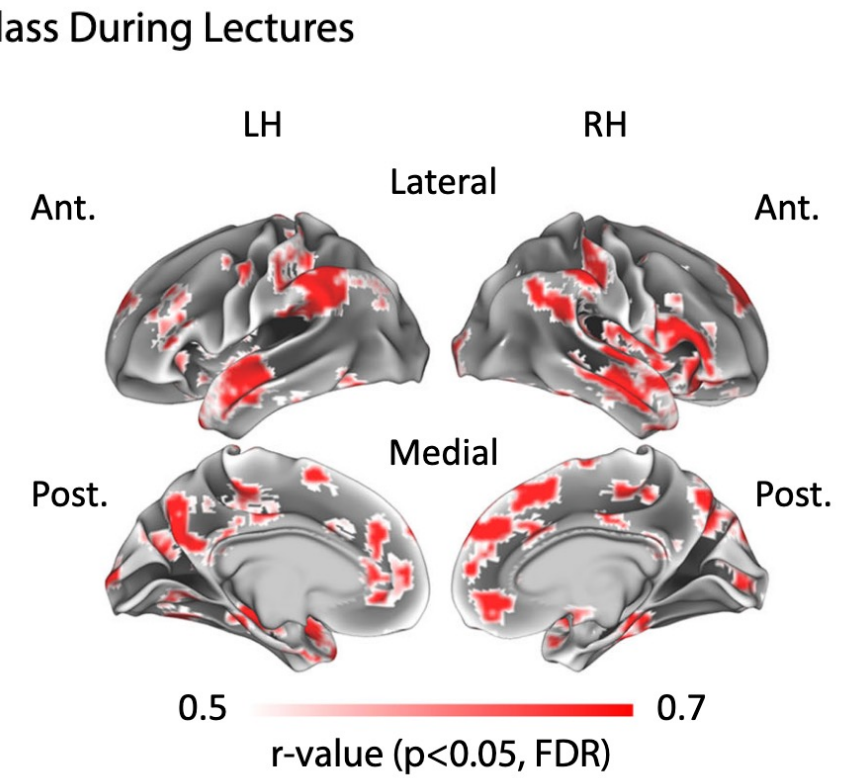
Table 1 Stimuli and tasks.

Stimulus	Participants	Task	Length of time bin for neural pattern	Total stimulus length
Lecture videos	Students	Passive viewing	30 s of video (fixed)	197 min
Recap videos	Students+Experts	Passive viewing	30 s of video (fixed)	16 min
Exam (in scanner)	Students+Experts	Verbal response	Entire question (variable)	10–22 min

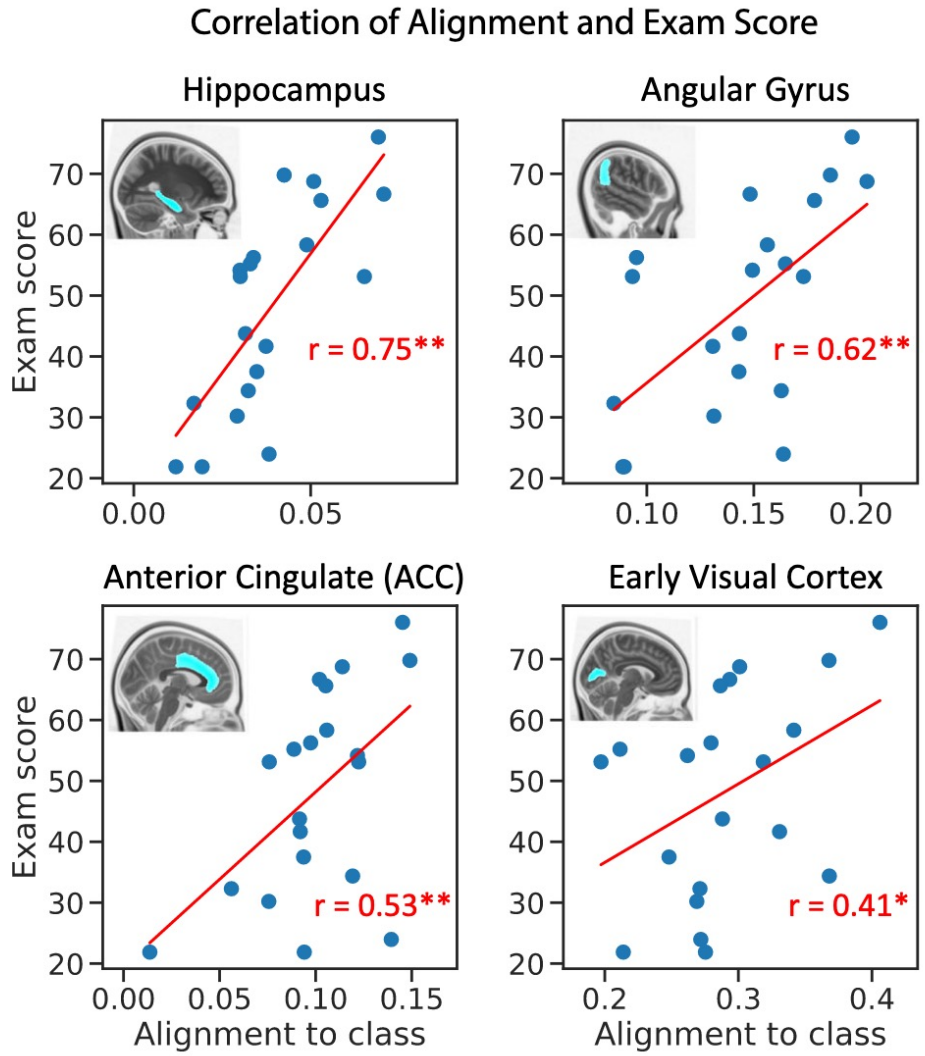
学生与全班的ISC可以预测学习成绩

a

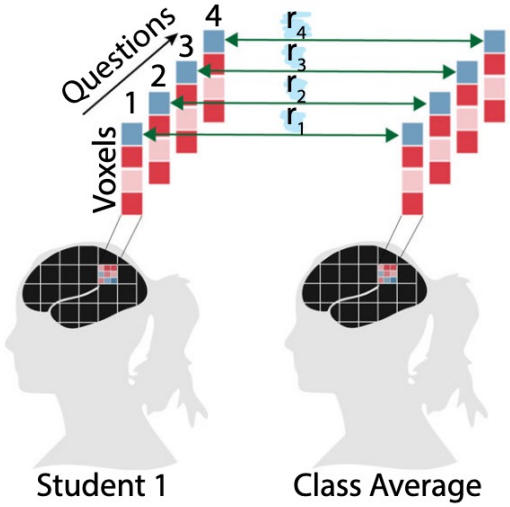


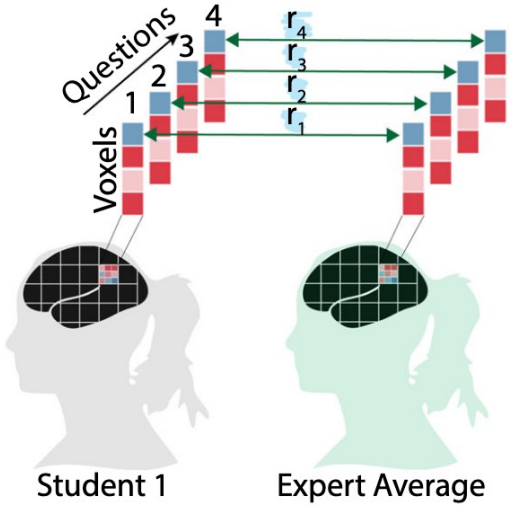


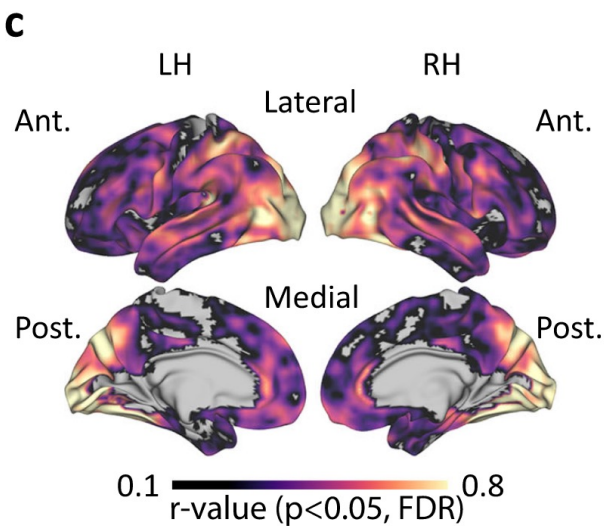
c

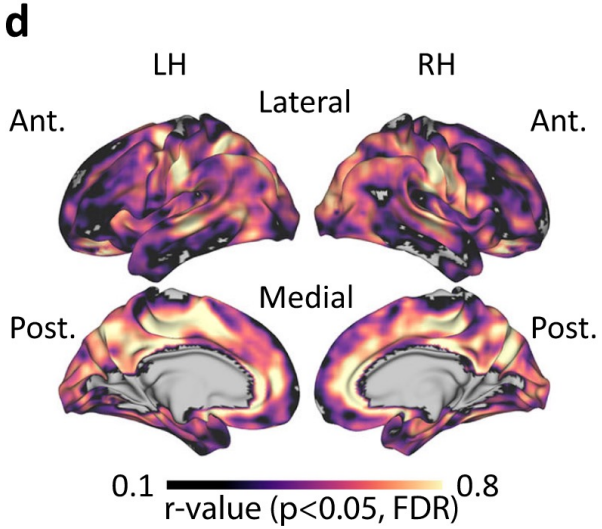


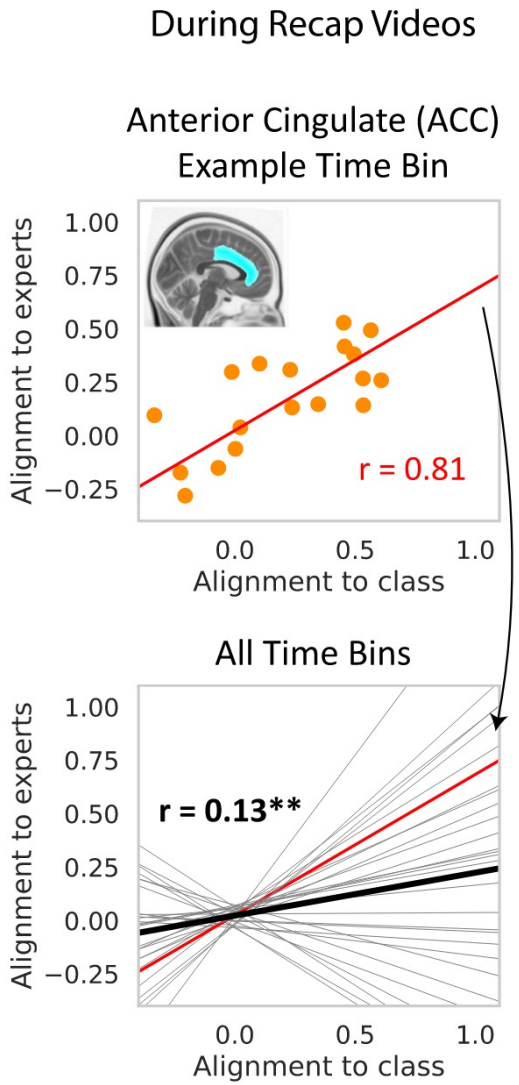
与全班ISC越高，与专家ISC越高

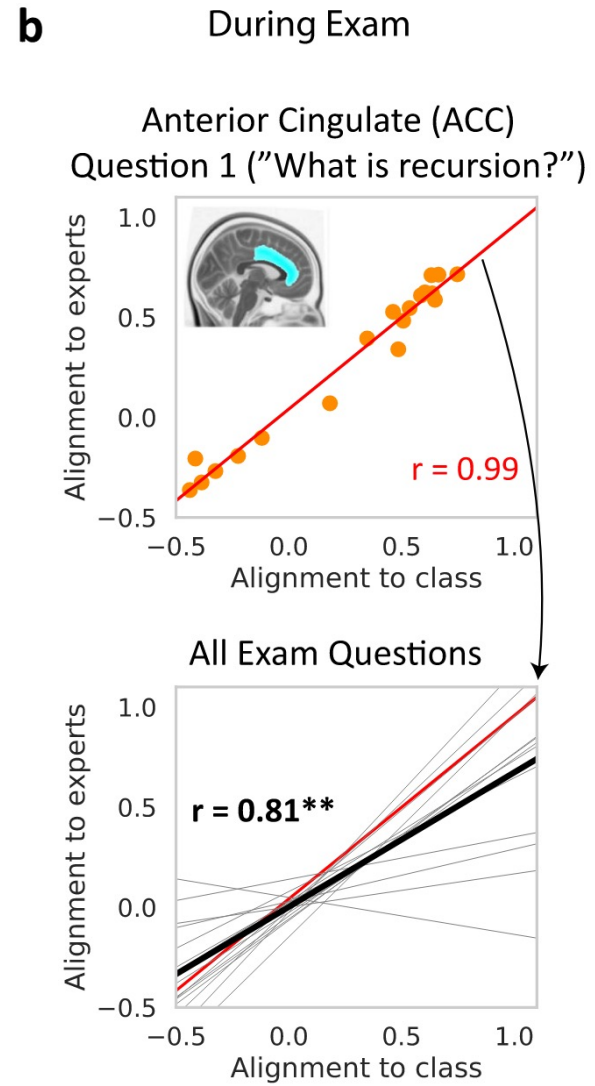




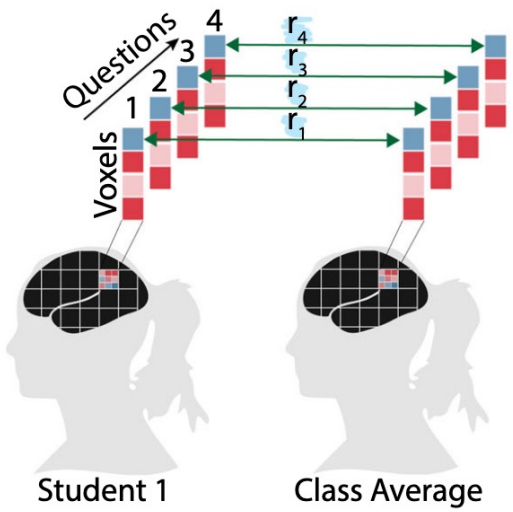


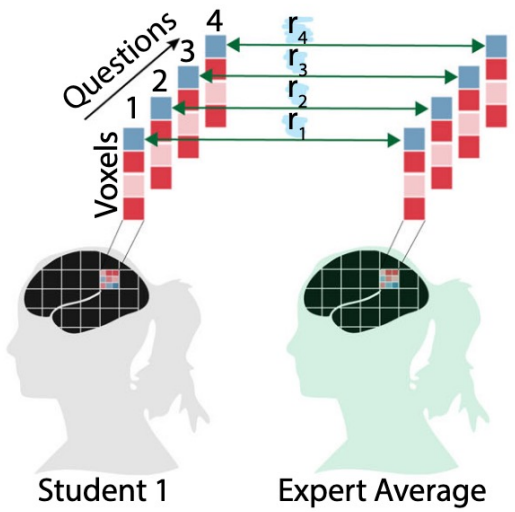


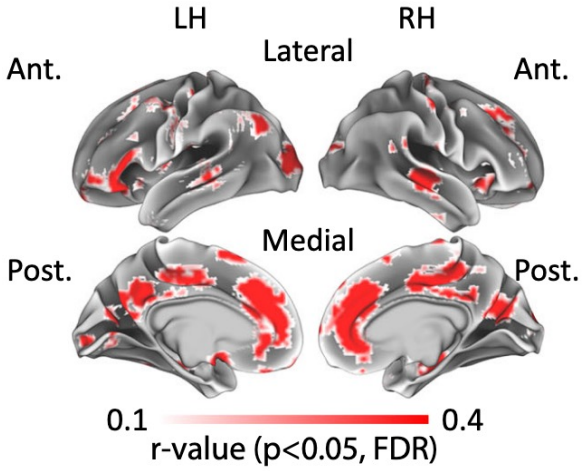


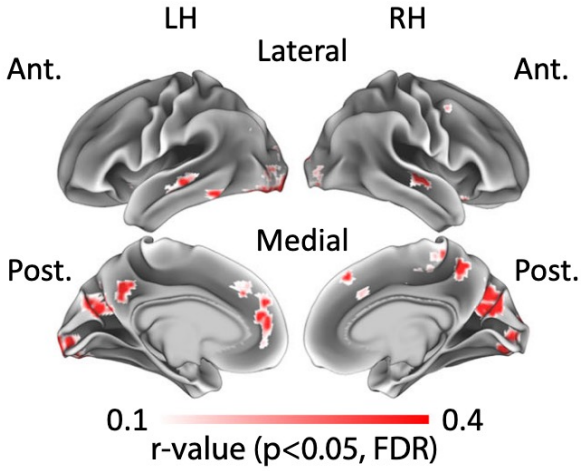


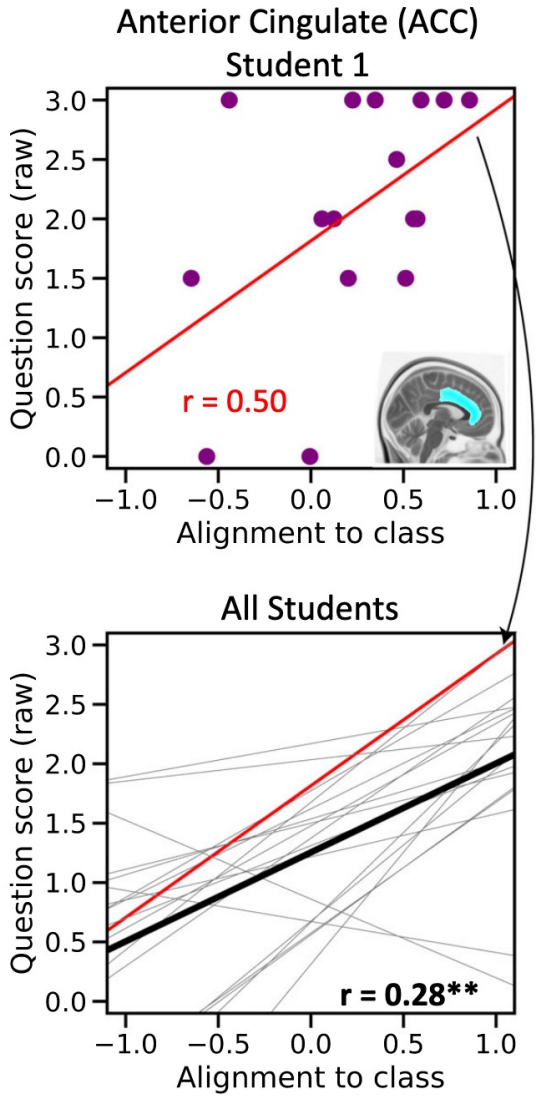
像专家一样思考

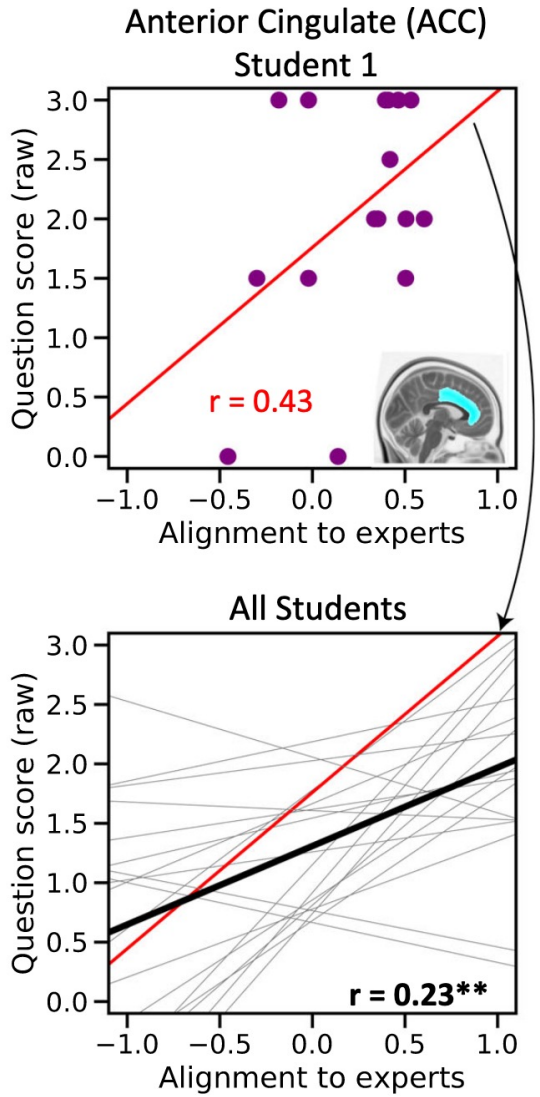

Questions
Voxels
Student 1
Class Average


Questions
Voxels
Student 1
Expert Average


LH
RH
Lateral
Ant.
Medial
Post.
0.1
0.4
r-value (p<0.05, FDR)

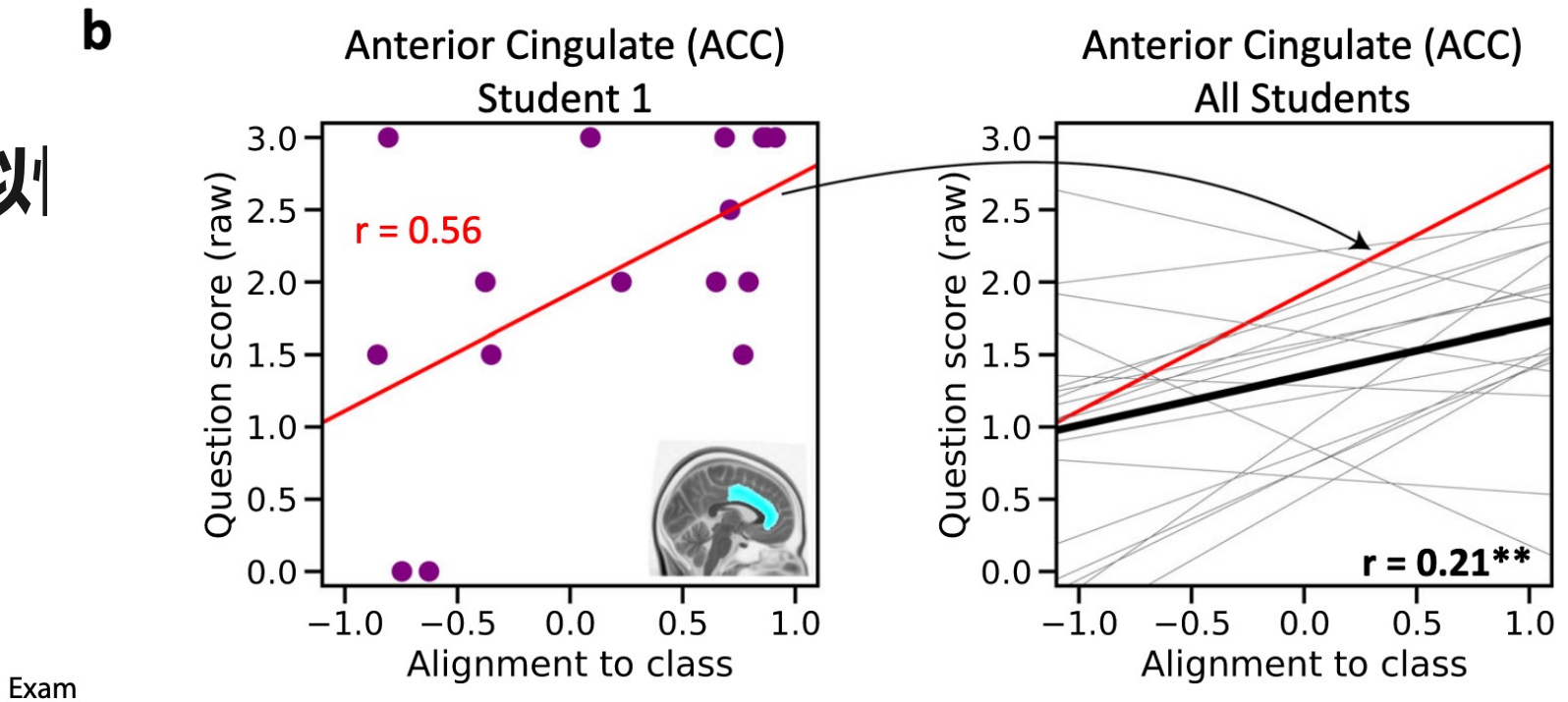

LH
RH
Lateral
Ant.
Medial
Post.
0.1
0.4
r-value (p<0.05, FDR)

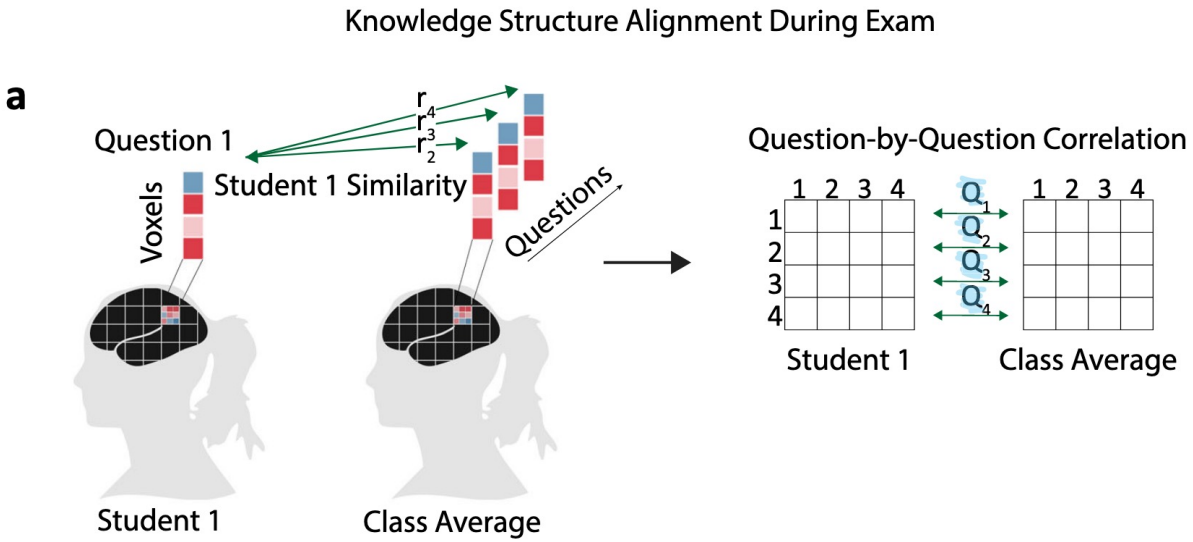

Anterior Cingulate (ACC)
Student 1
Question score (raw)
r = 0.50
Alignment to class
All Students
r = 0.28**
Alignment to class

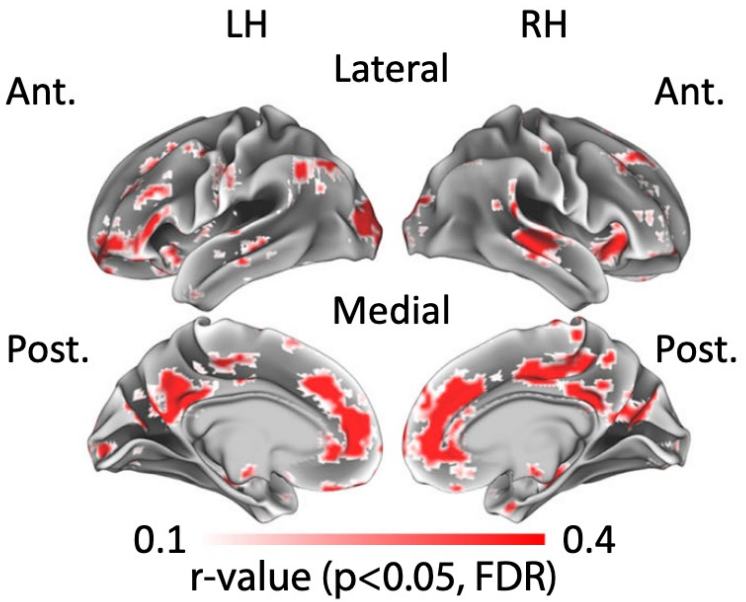

Anterior Cingulate (ACC)
Student 1
Question score (raw)
r = 0.43
Alignment to experts
All Students
r = 0.23**
Alignment to experts

应用实践

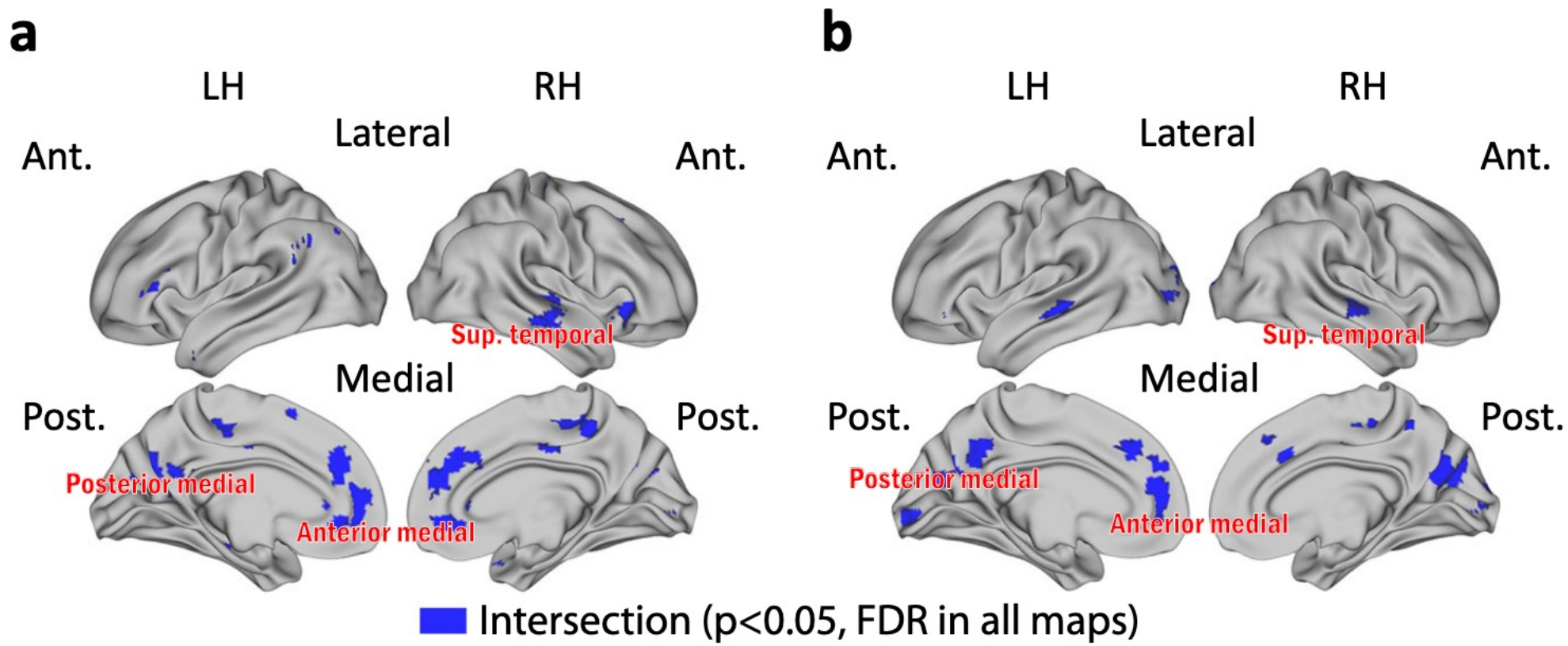
ISC反映了知识结构的相似







凝练提取教学神经标记

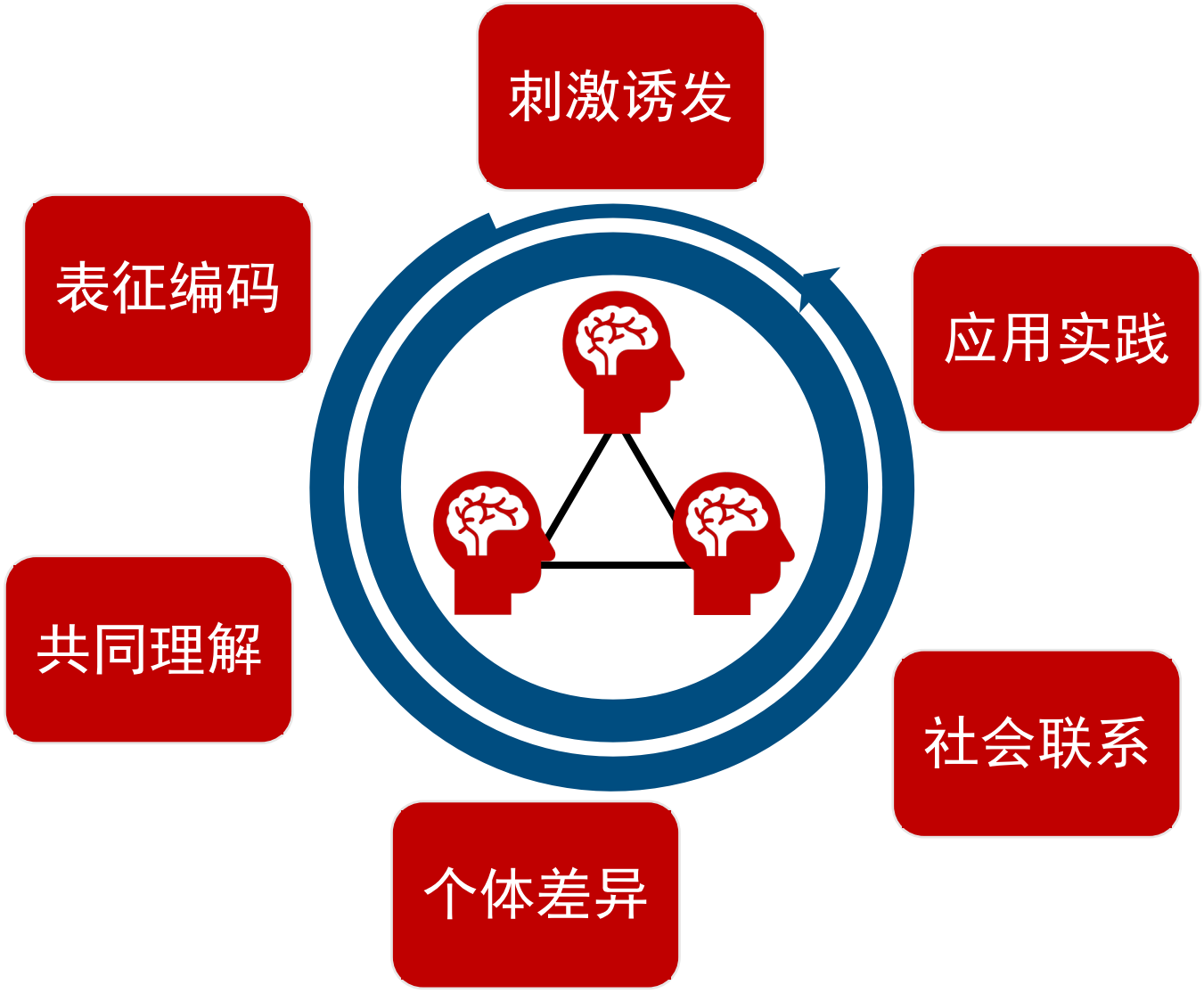

a
LH
RH
Lateral
Ant.
Ant.
Sup. temporal
Medial
Post.
Post.
Posterior medial
Anterior medial
b
LH
RH
Lateral
Ant.
Ant.
Sup. temporal
Medial
Post.
Post.
Posterior medial
Anterior medial
Intersection (p<0.05, FDR in all maps)

以自然主义范式为纽带，结合自己面向的研究问题，从合适的角度切入

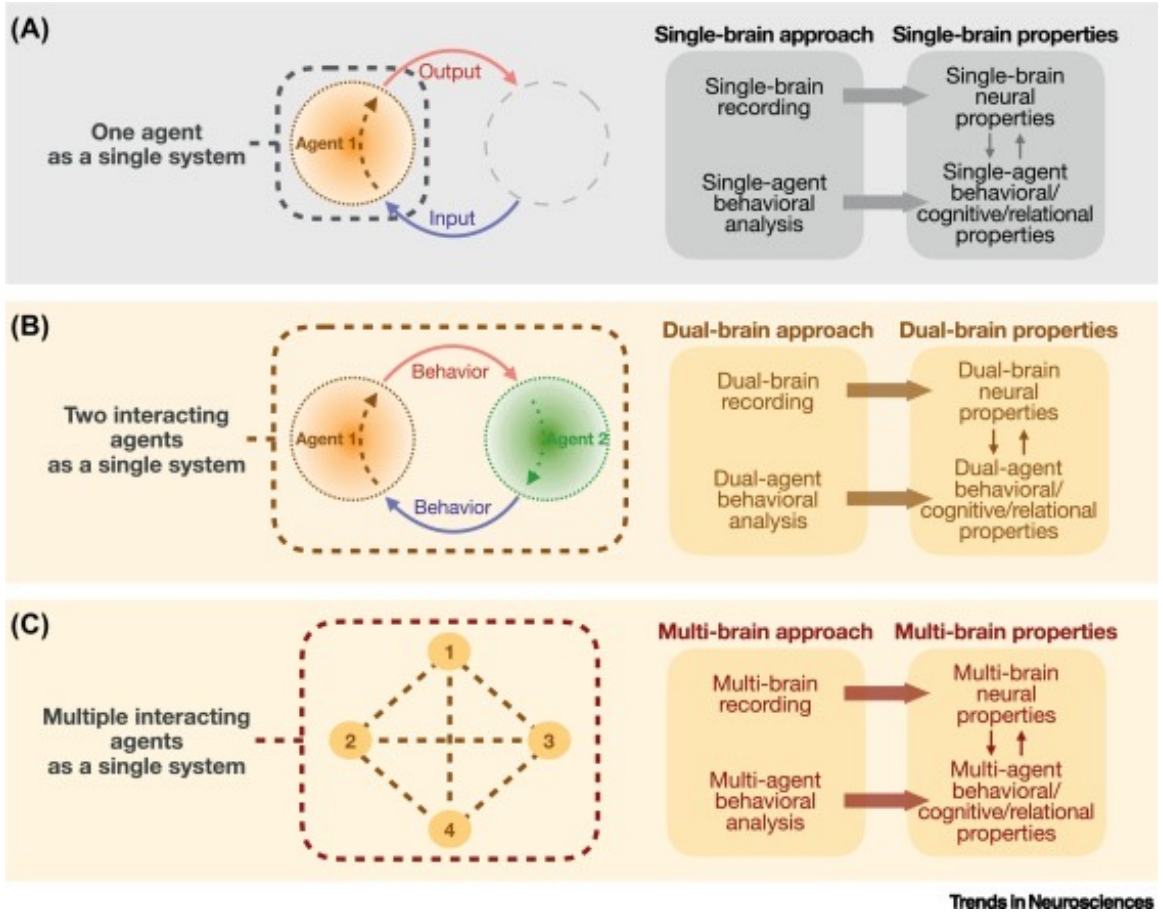
Part 4

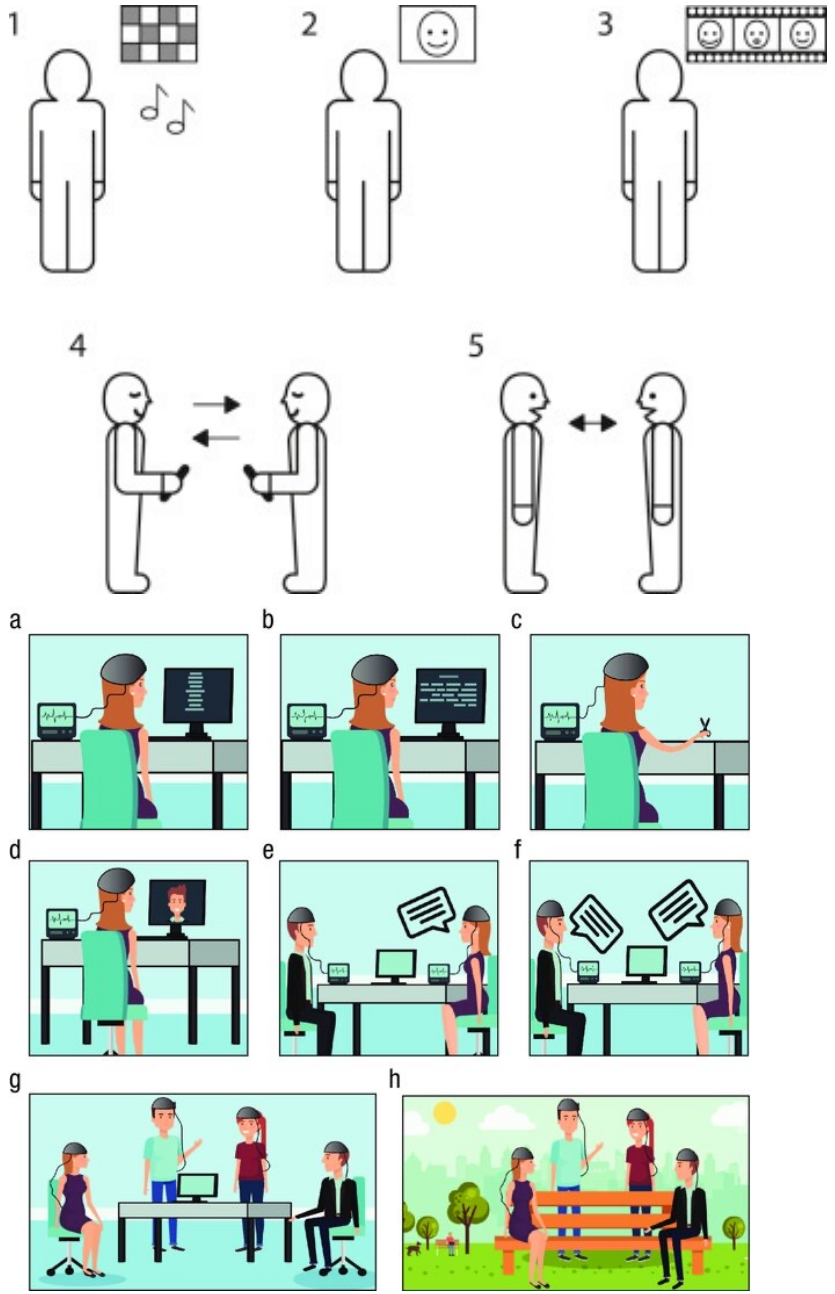
自然互动的研究进展

从单脑到群脑



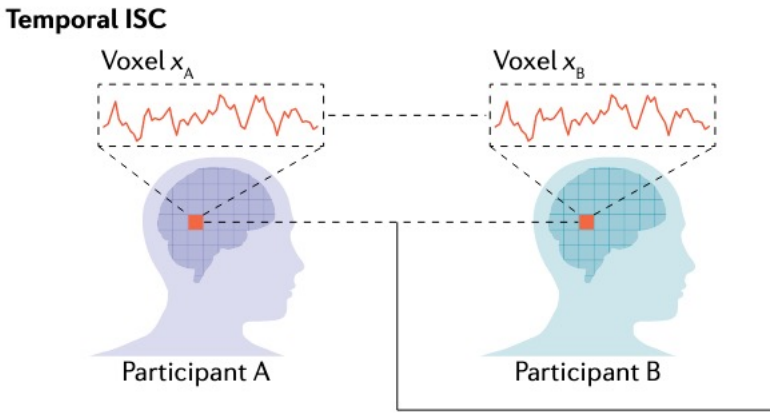
交流、教育与社会领域的思想和方法变革



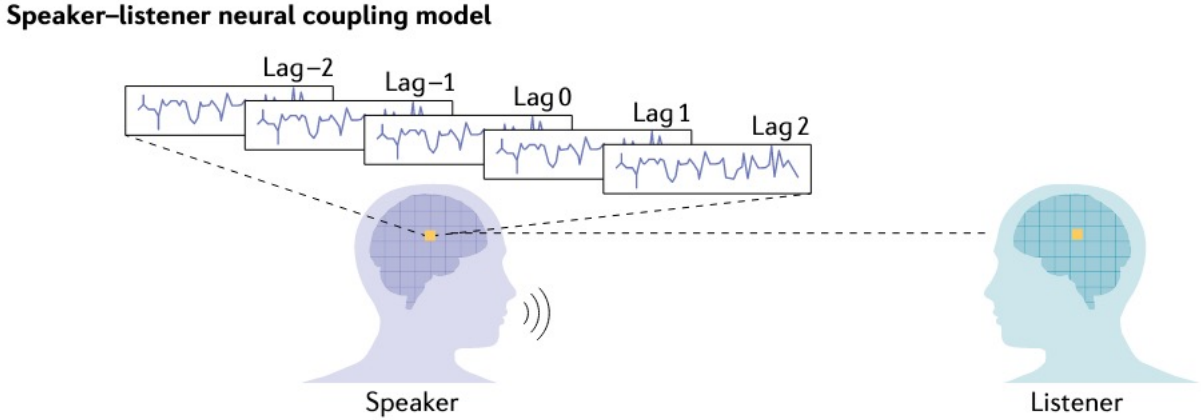


Hari et al., 2015 Neuron; Kingsbury et al., 2020 TICS; Shamay-Tsoory et al., 2019 Perspect Psychol Sci

群脑协同

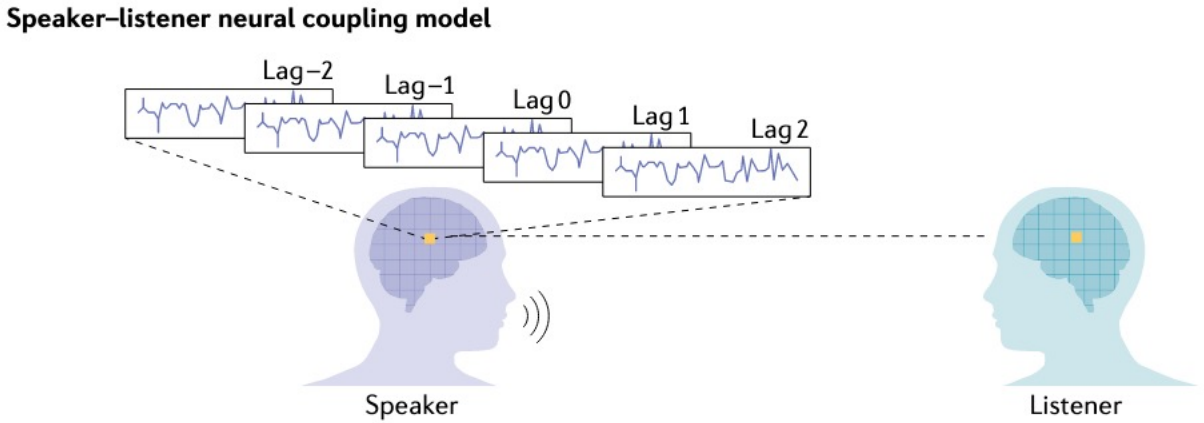


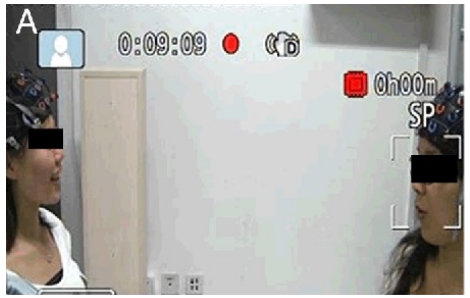
一组个体加工自然刺激时会诱发相似的神经响应



一组个体交互时也会诱发相似的神经响应，即群脑协同

超扫描

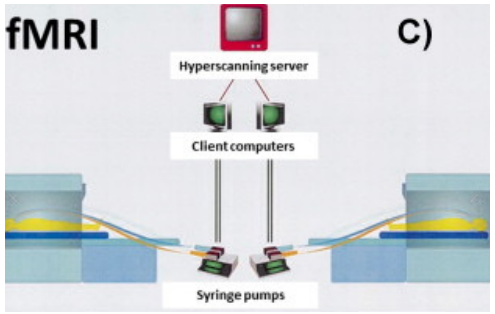




通过在交互情景下同时采集多名被试的神经信号，可以有效考察他们的群脑协同程度，即超扫描技术

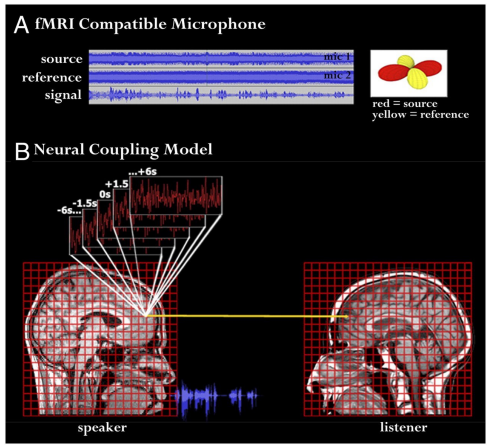
基于fNIRS的超扫描技术已成为探究自然互动的首选技术

首个超扫描研究



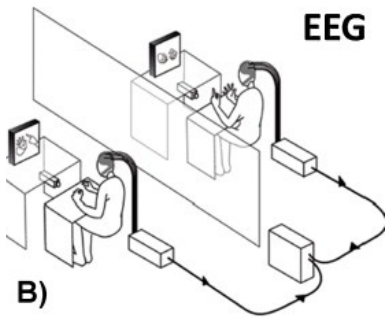
2002

伪自然互动
fMRI超扫描研究



2006

基于EEG
超扫描研究

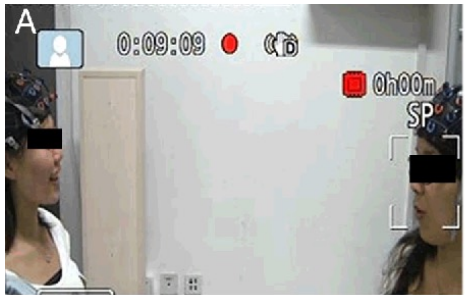


2010

基于fNIRS
超扫描研究

2012

真实自然互动
fNIRS超扫描研究



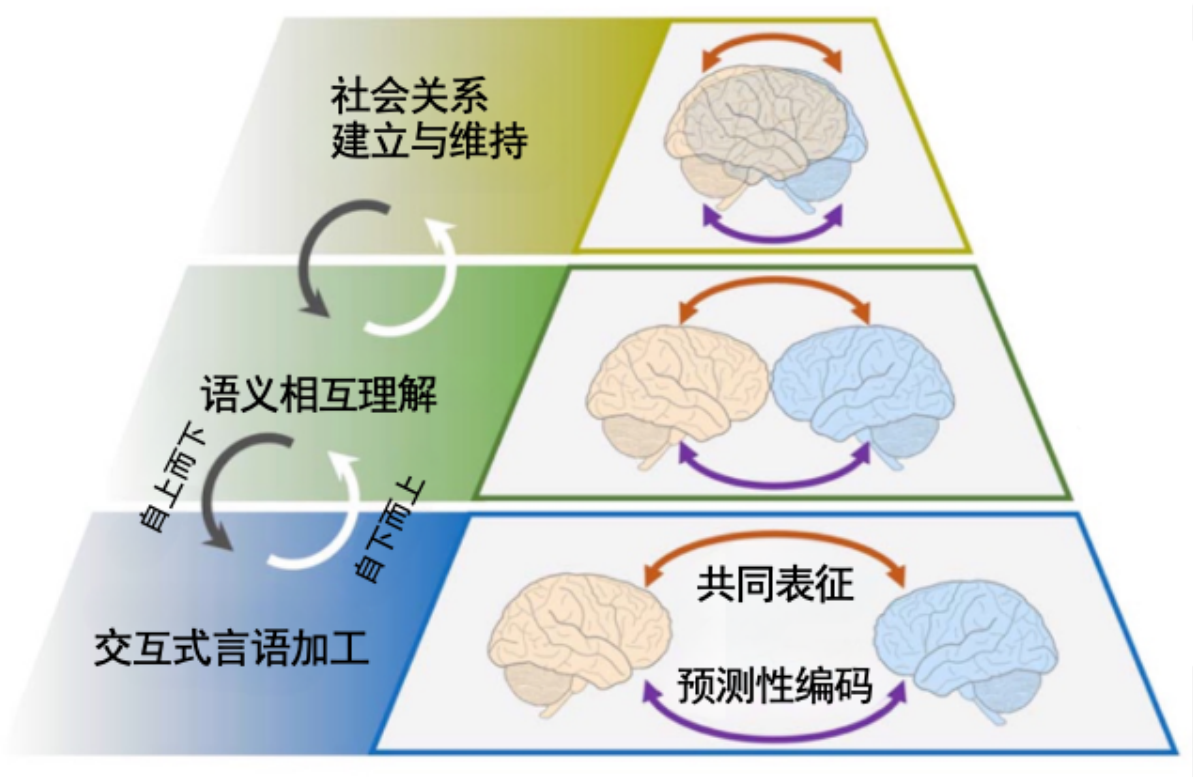
2012

2015

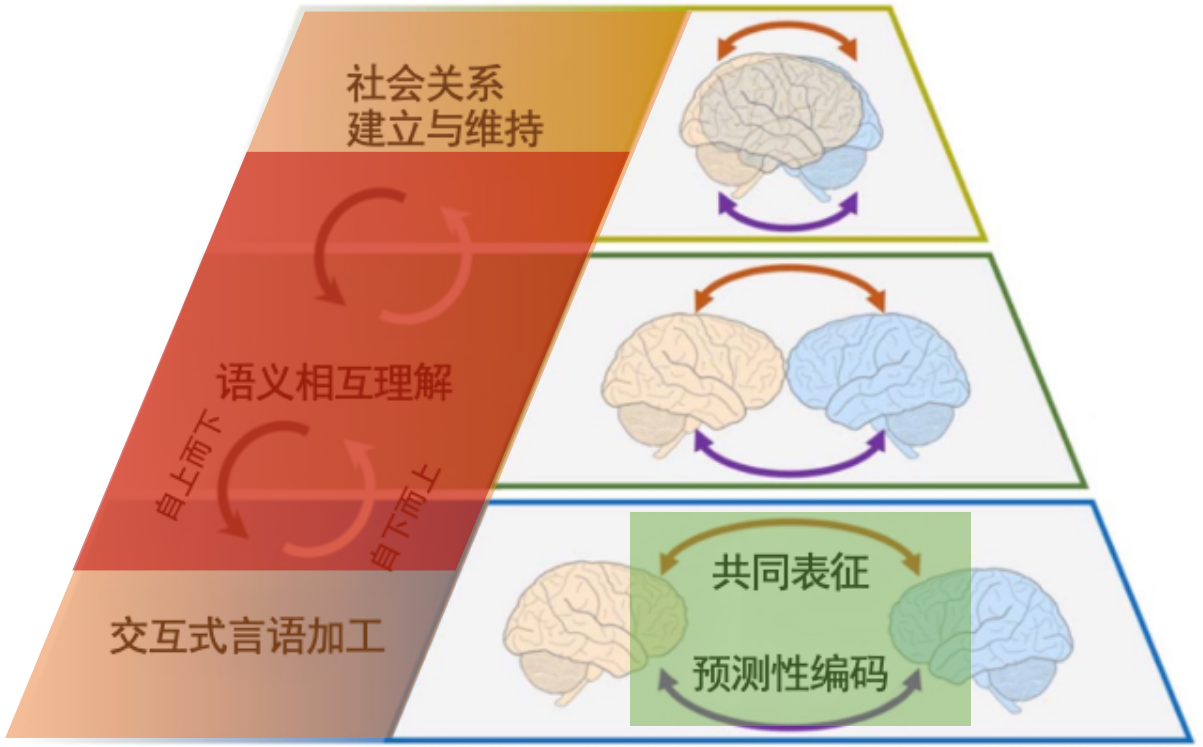
自然群体互动
fNIRS超扫描研究

重要理论

人际信息传播的层级模型



人际信息传播的层级模型的基本假设

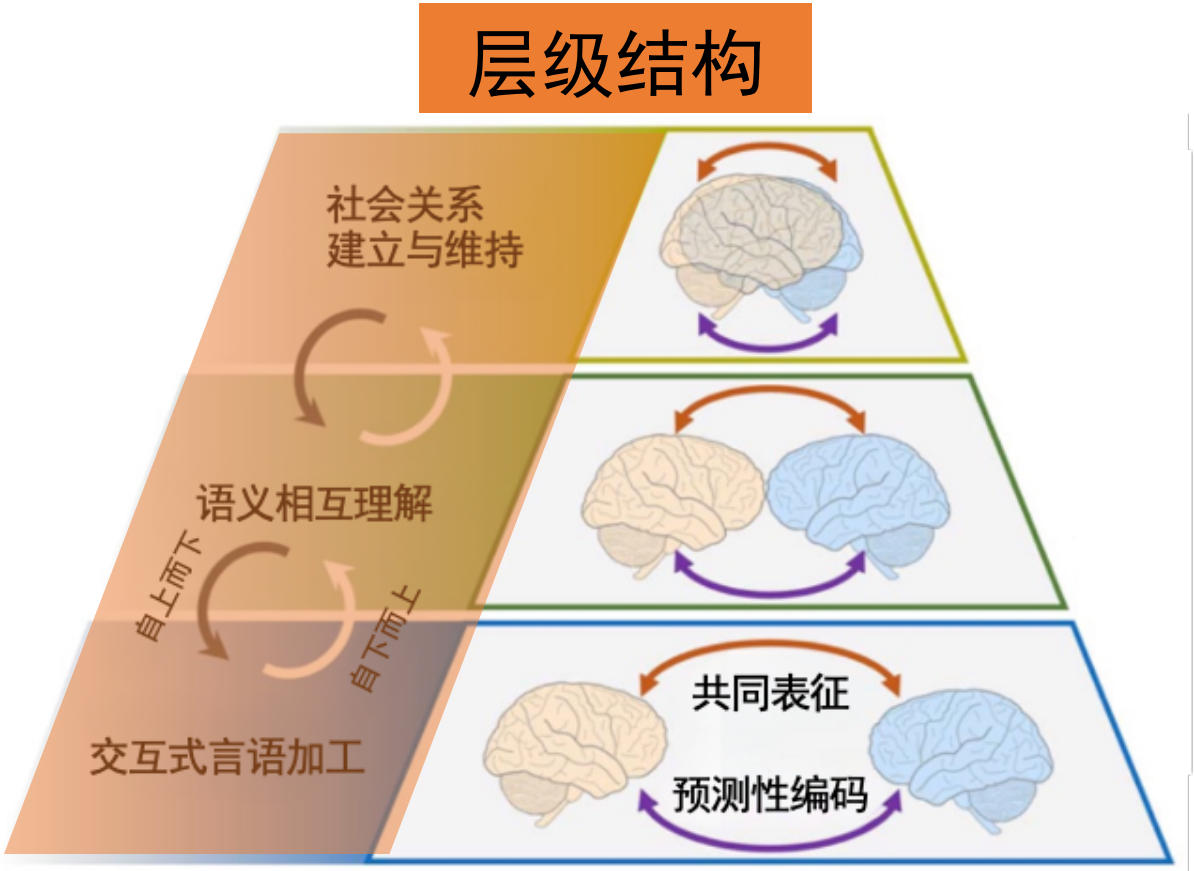


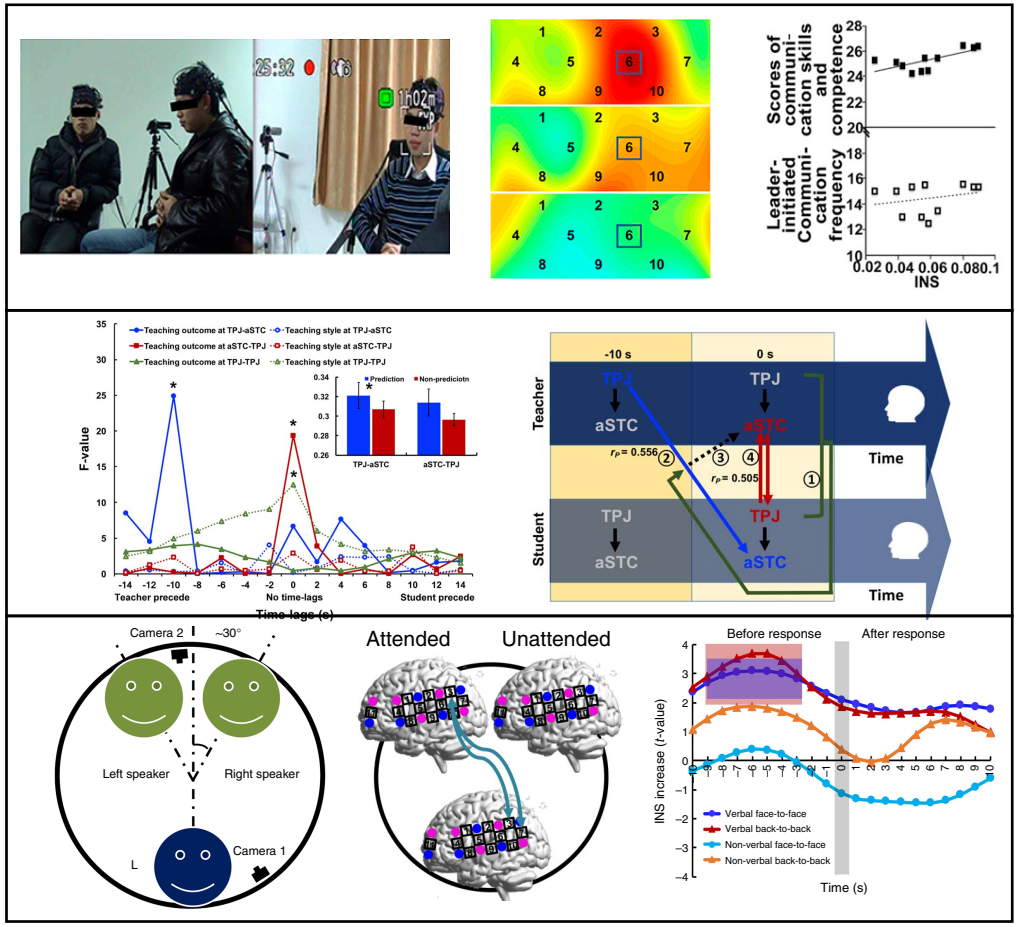
层级结构

层级关系

传播过程

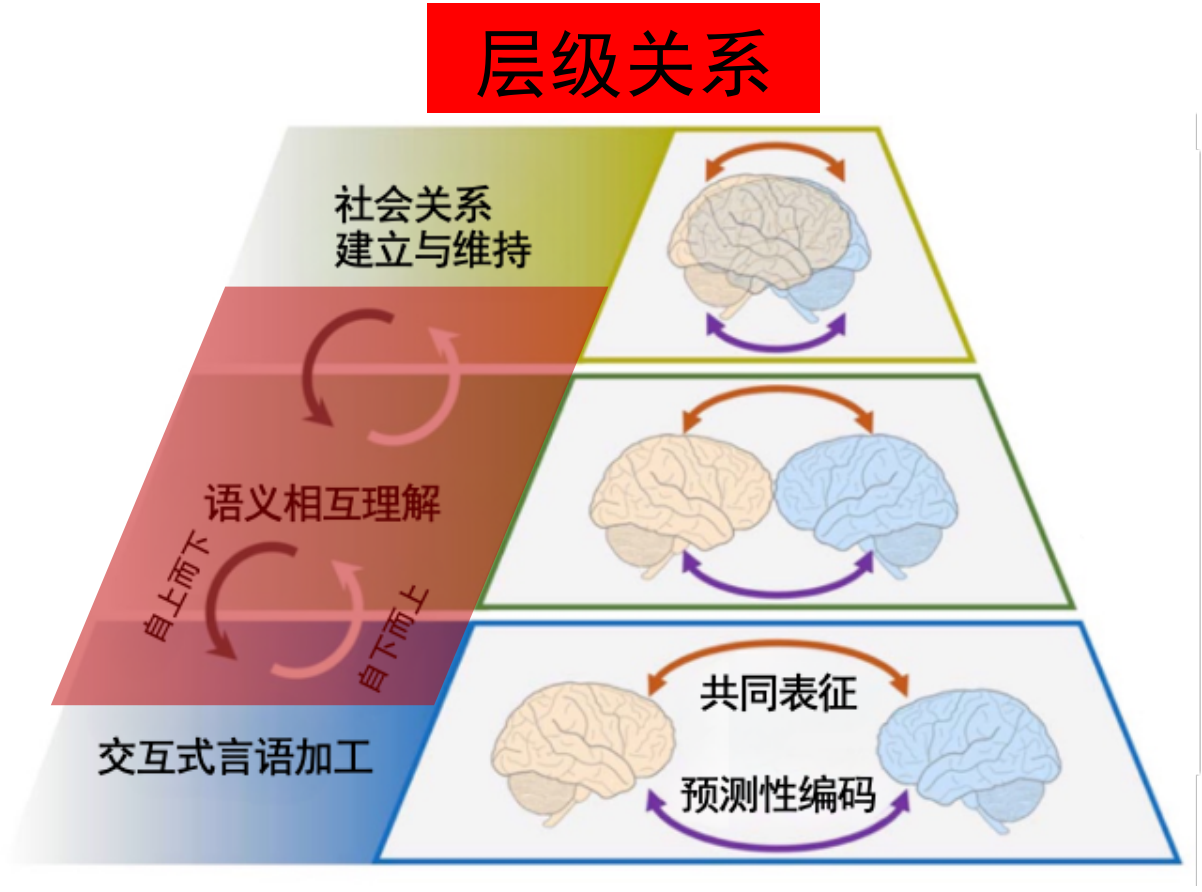
不同的认知层级均存在特异的群脑协同模式

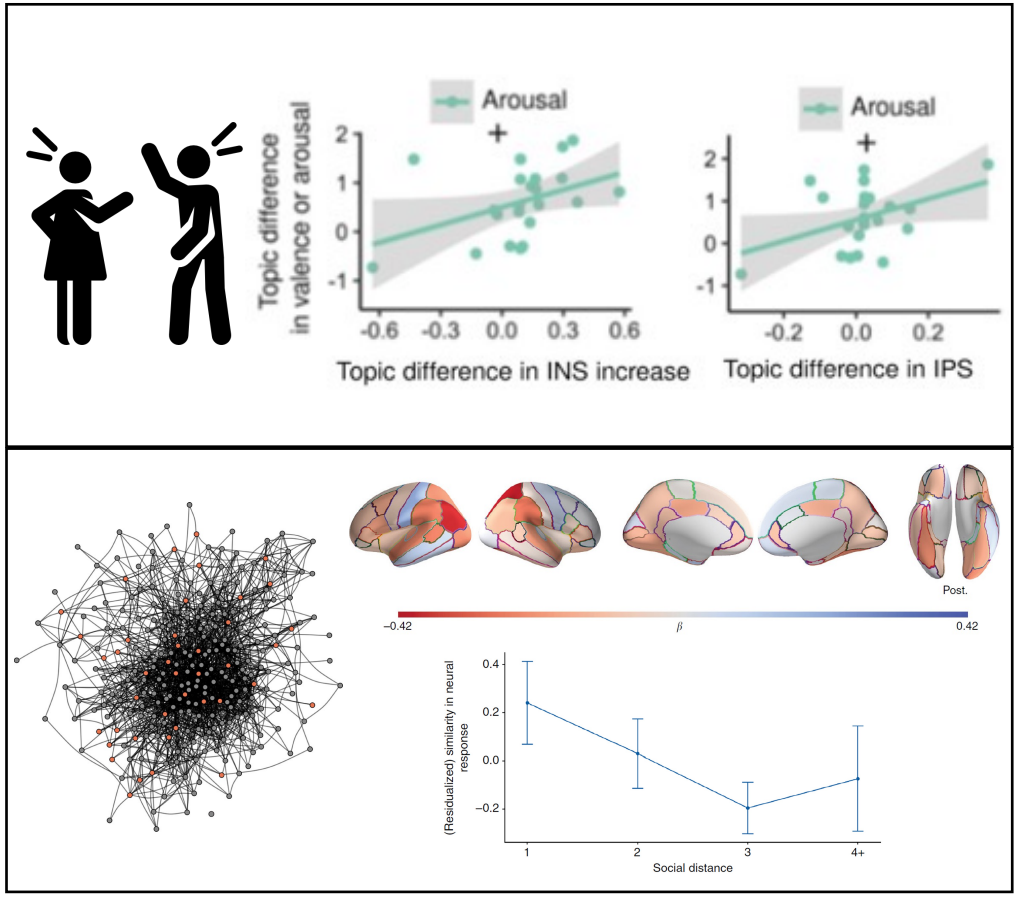




Jiang SCAN 2021; Jiang PNAS 2015; Zheng HBM 2018; Dai NC 20

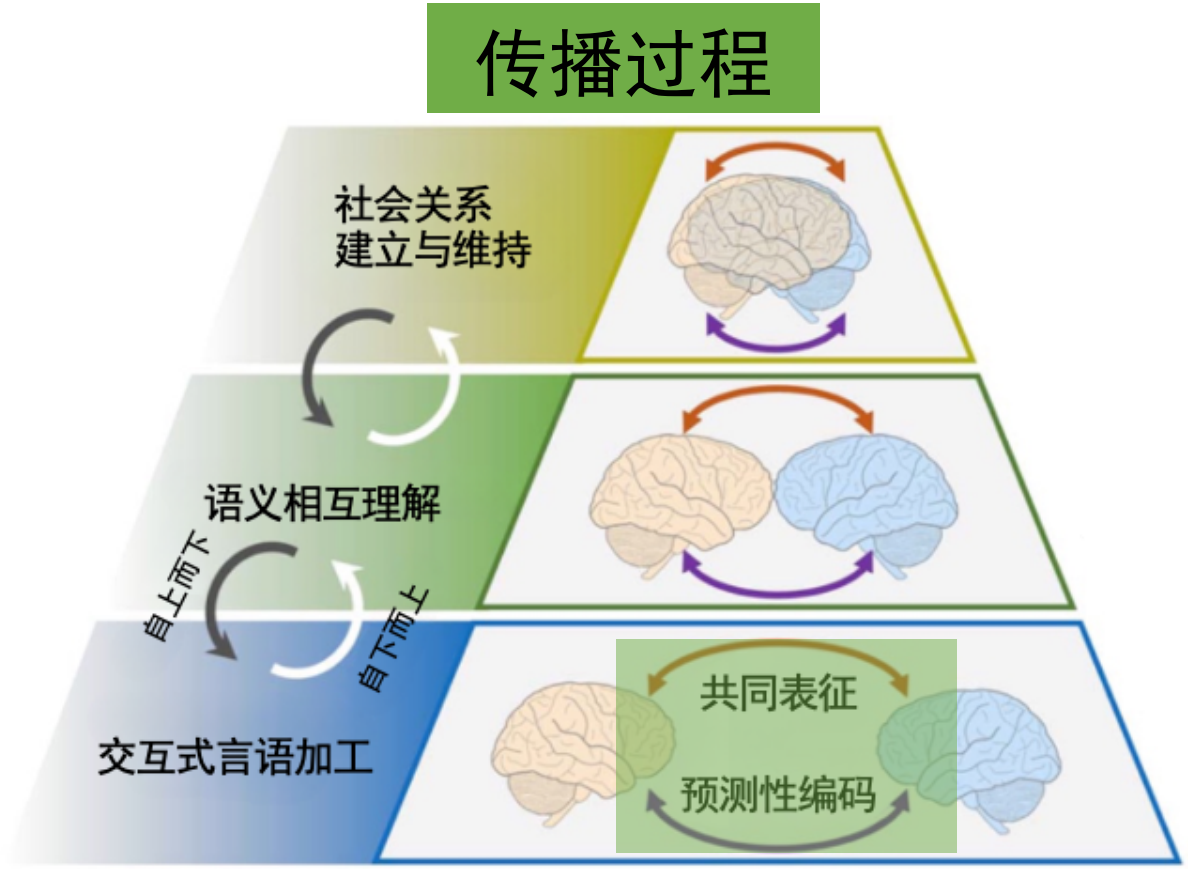
不同层级之间的群脑协同存在跨层级调节

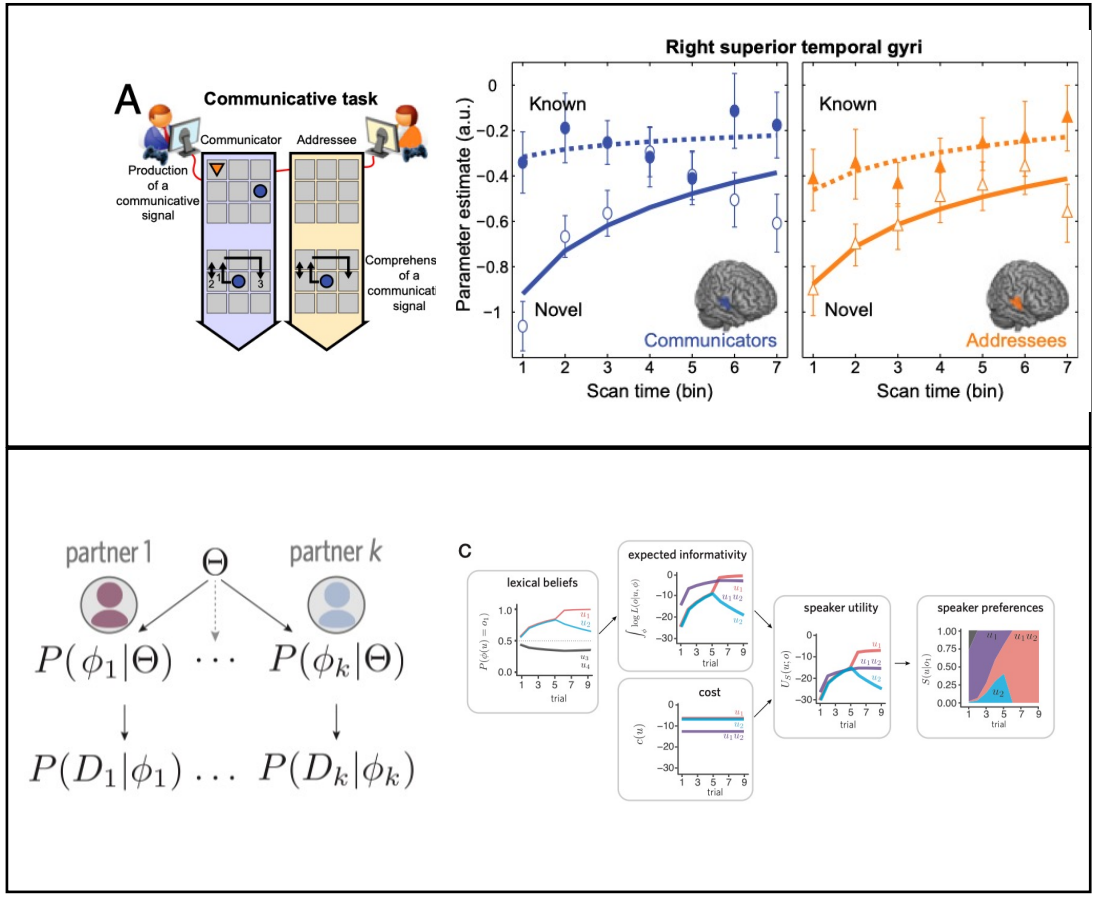




Long CC 2022; Parkinson NC 2018

通过共享表征构建和预测性编码实现多层级群脑协同





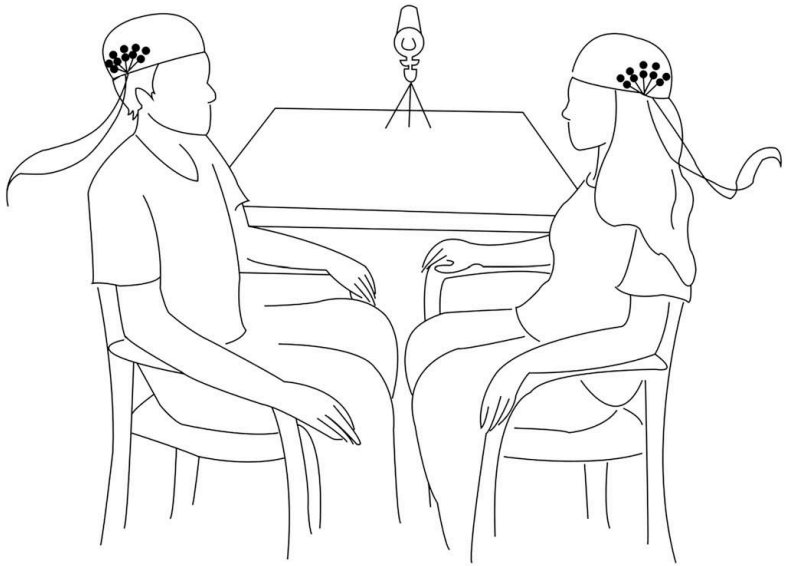
Stolk 2014 PNAS; Hawkins

情侣夫妻人际互动中情绪传播的特异性机制

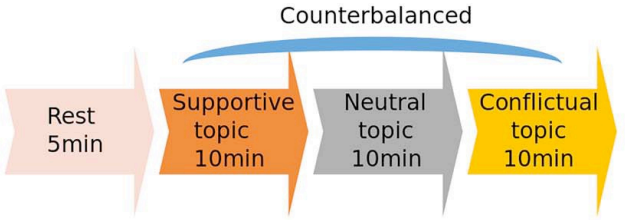
打是亲？骂是爱？
床头吵架床尾和？

实验情景与指标搭建

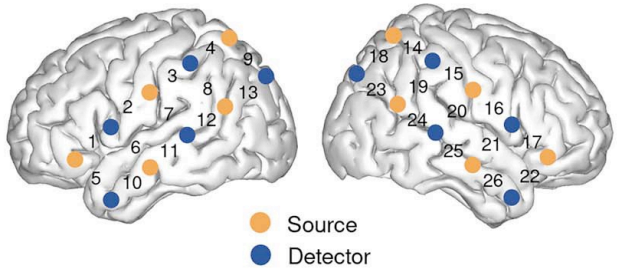
a



b



c



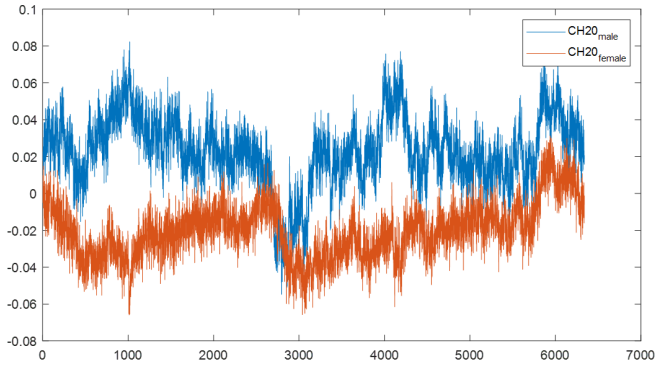
关系类型(情侣，异性朋友)

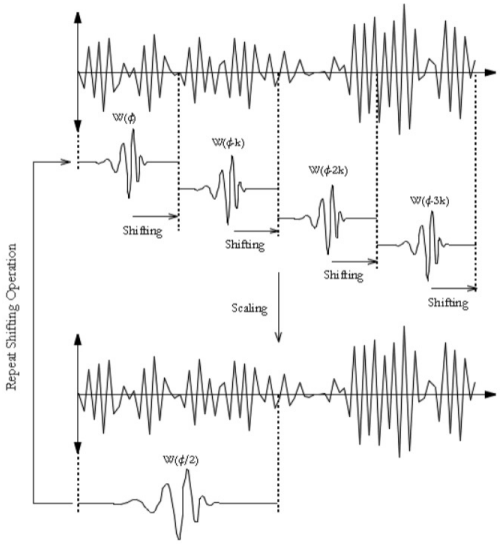
×

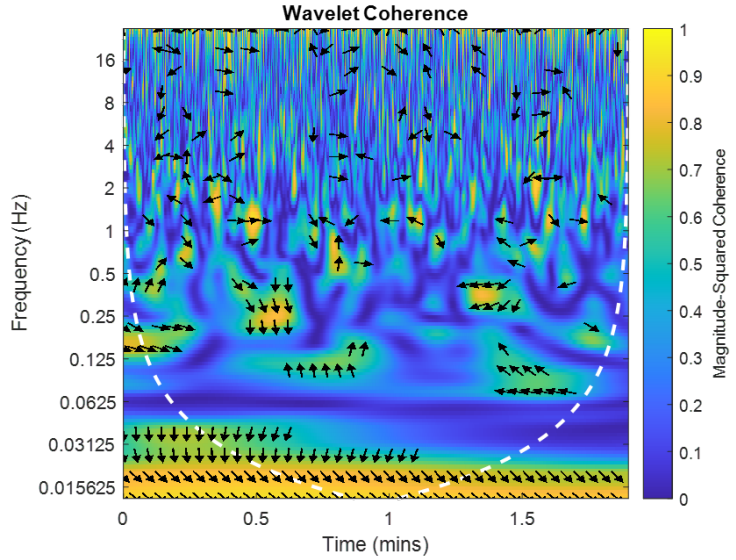
话题情景(中性话题，消极话题，积极话题)

- fNIRS数据
- 皮电数据
- 会话文本

通过脑间神经同步(INS)分析构建神经同步指标

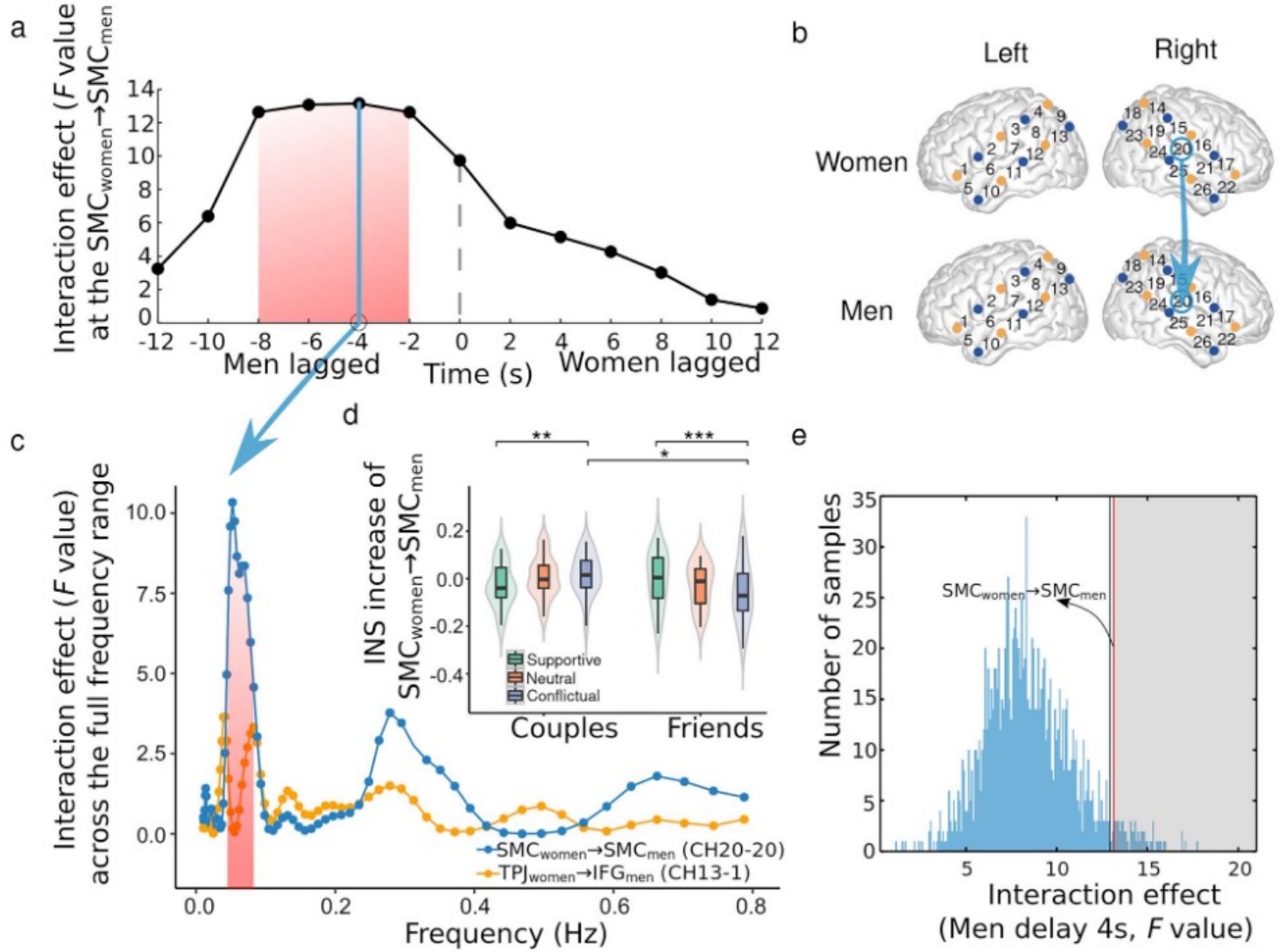






小波相关分析(wavelet coherence analysis)

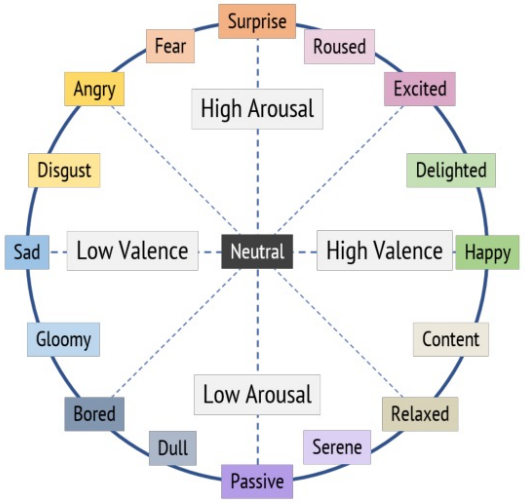
情侣在冲突话题下右侧运动区脑间神经同步更强



情绪在人际互动中的作用机制

通过自然语言处理技术与生理多导仪，构建会话情绪效价与唤醒度测量指标

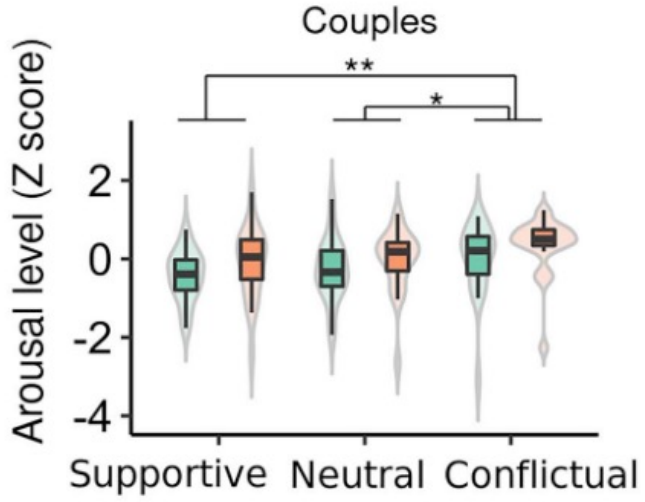
会话文本

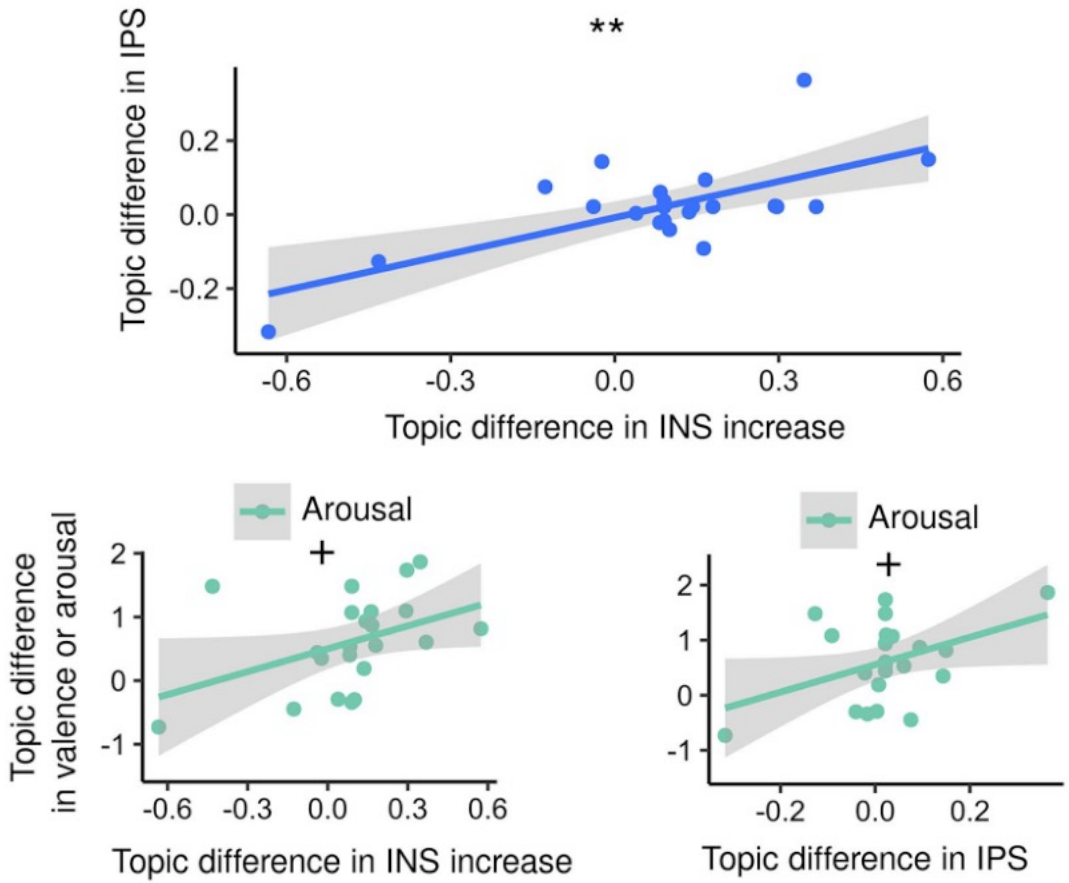


CVAW

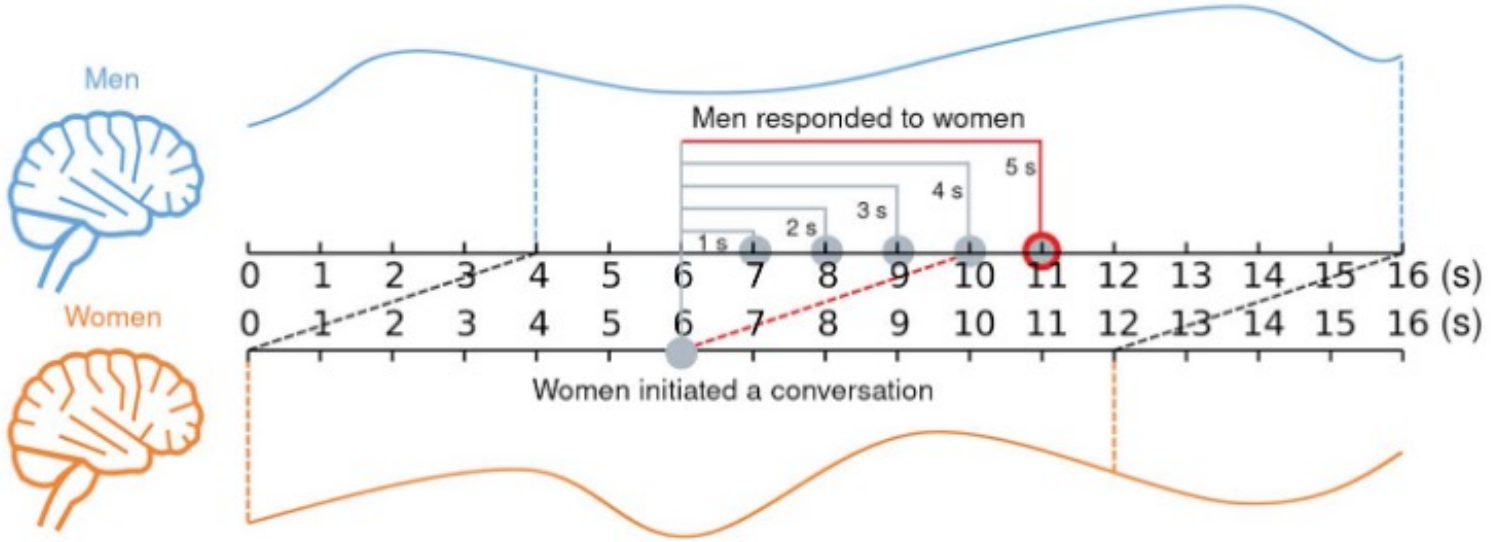
text_id	arousal	valence
1	0.8	1.2
2	-1.3	1.6
3	-0.2	0.2

情绪唤醒程度在冲突性话题讨论时更高，在三个数据模态之间彼此相关





抽取关键交流事件，检验情侣冲突交流模式

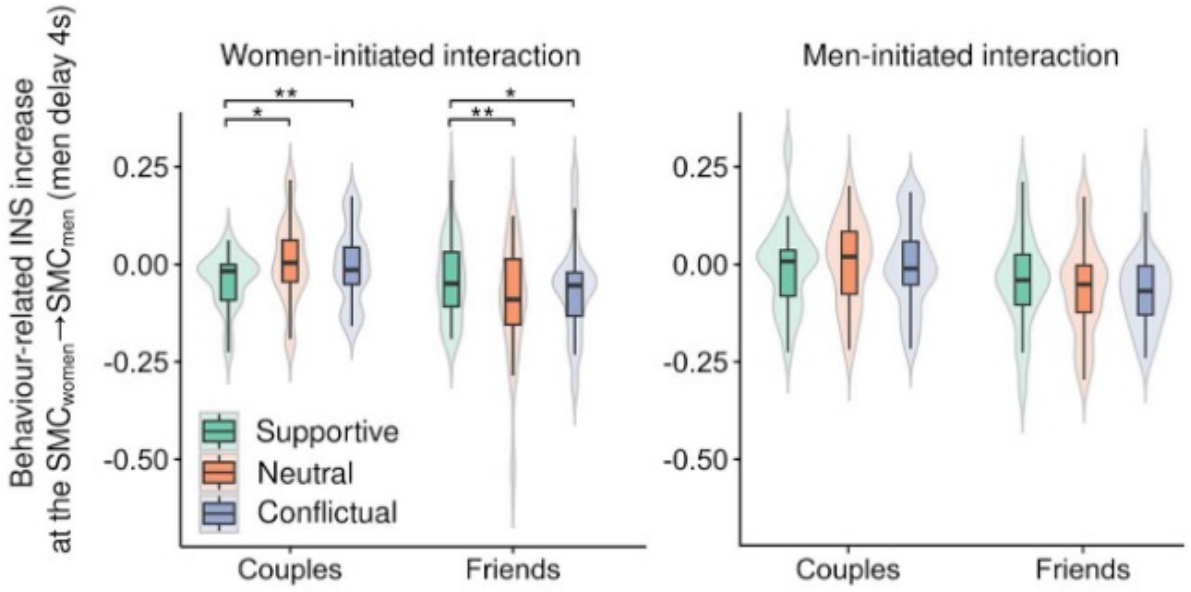


事件类别

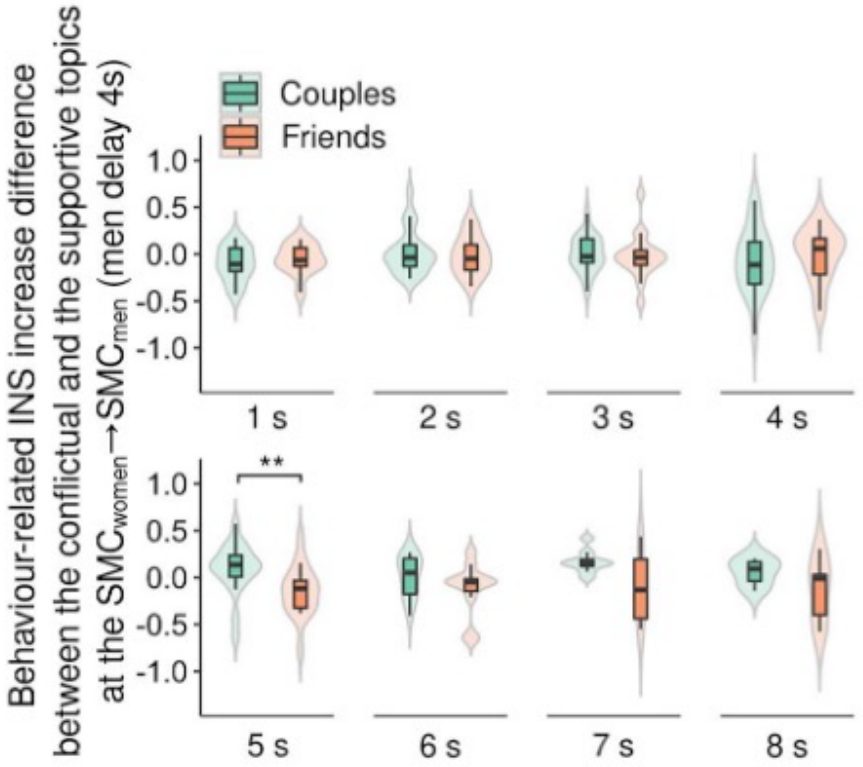
男性发起对话　　女性回应对话

女性发起对话　　男性回应对话

情侣冲突中“女性主导-男性回应”的交流模式



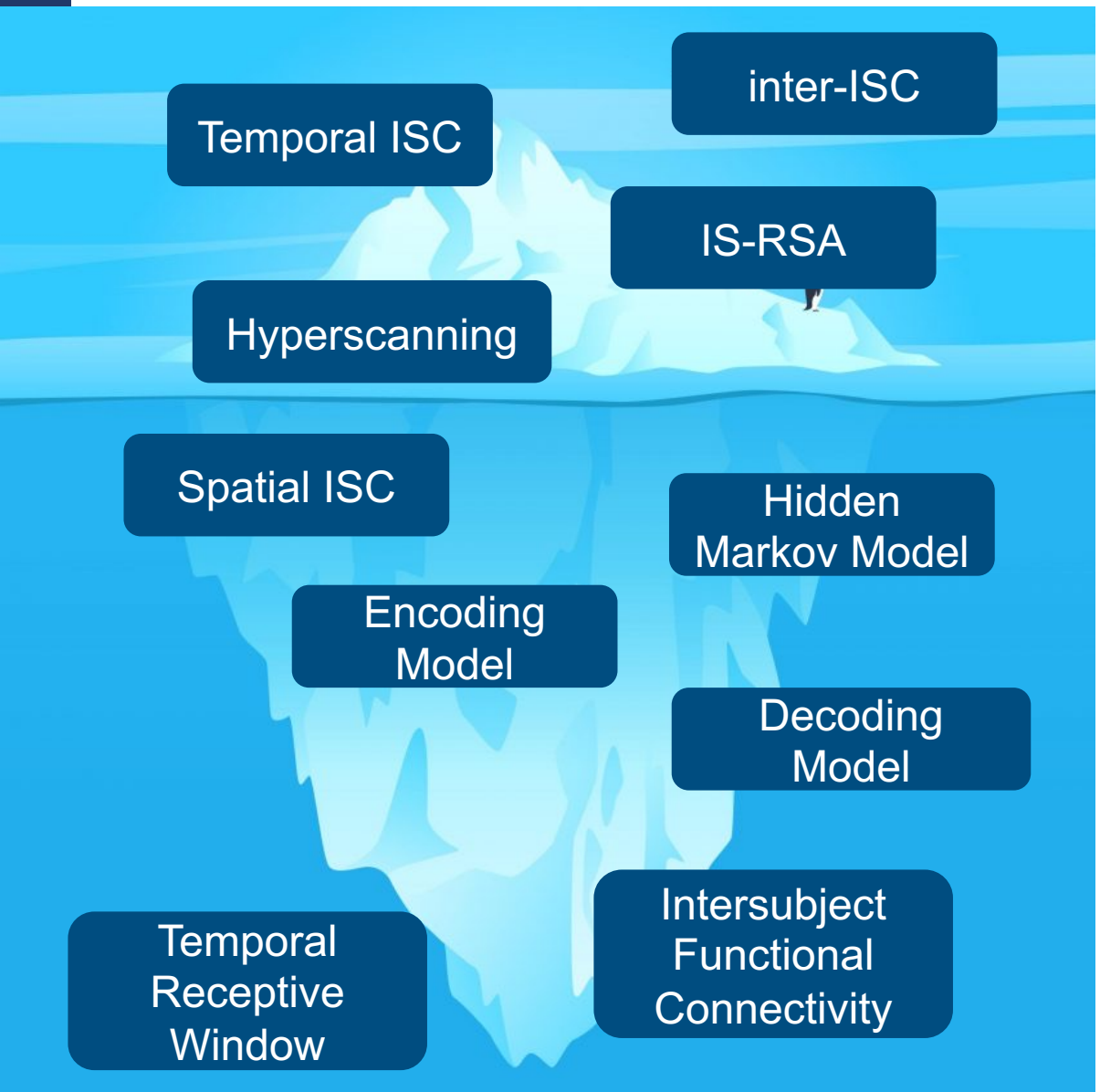
在女性发起对话的事件上存在更强的脑同步

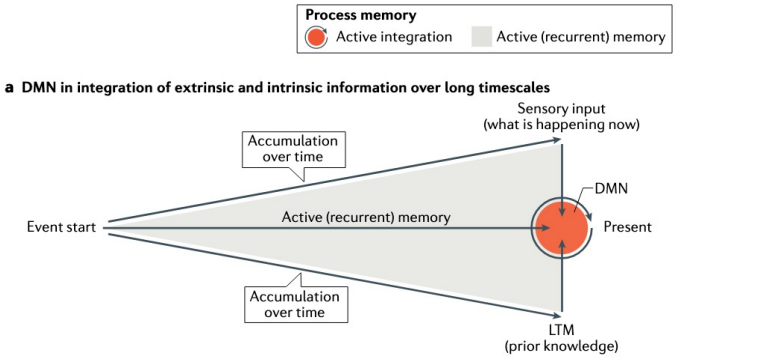


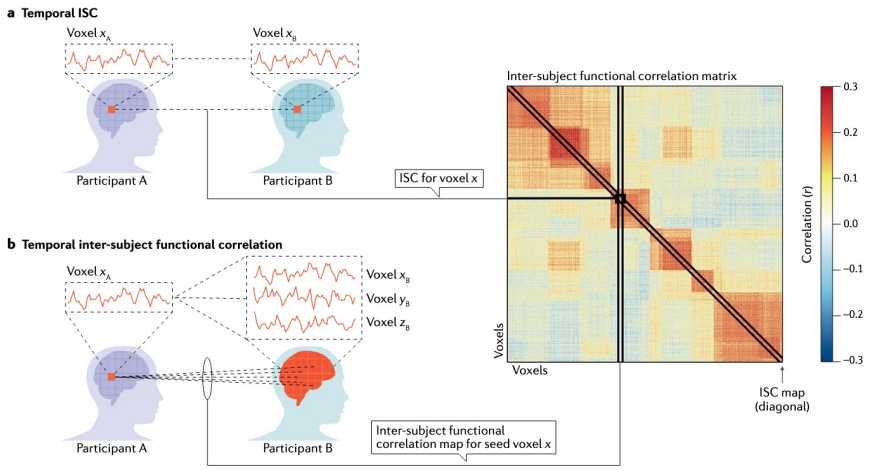
当男性在女性发起对话约5秒时做出回应的事件上脑同步更强

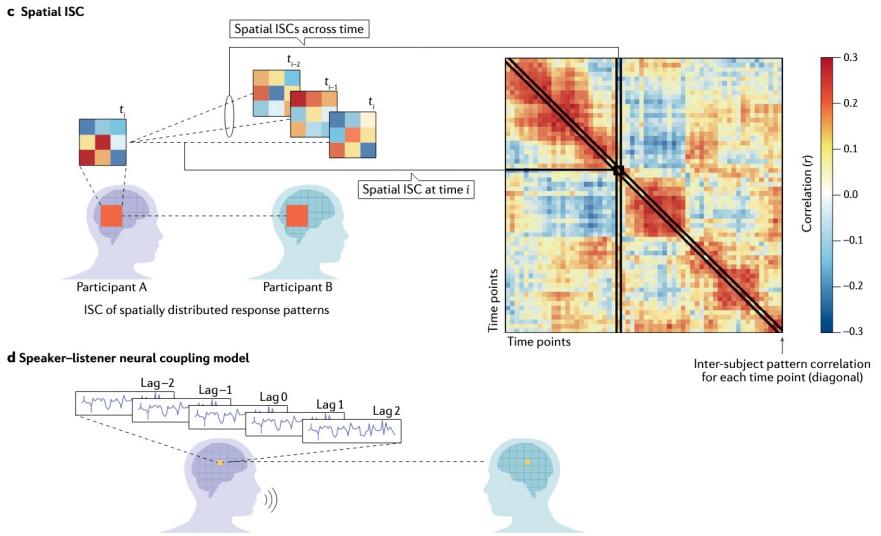
自然主义范式的未来

冰山一角









自然主义范式的未来

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Opinion

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Hierarchical process memory: memory as an integral component of information processing

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