Resting-State fMRI: Applications

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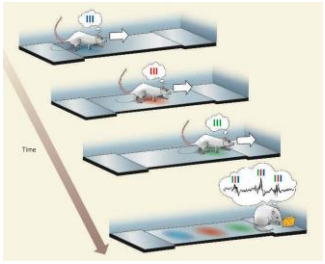
Outline

- Applications to Cognitive Science
- Applications to Brain Disorders

Applications to Cognitive Science

Off-line spontaneous brain activity and memory consolidation

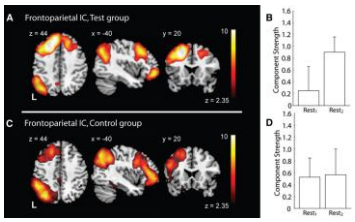


Reverse replay of behavioral sequences in hippocampal place cells during the awake state.

Foster and Wilson, 2006. Nature; Colgin and Moser, 2006. Nature

Applications to Cognitive Science

Resting-state fMRI and memory consolidation



Motor learning group

Control group

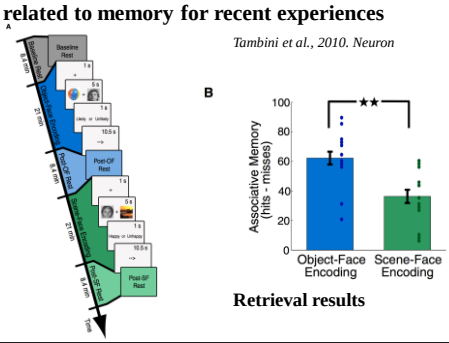
Motor learning but not motor performance modulated subsequent frontal-parietal resting-state network

Albert et al., 2009. Curr Biol

Applications to Cognitive Science

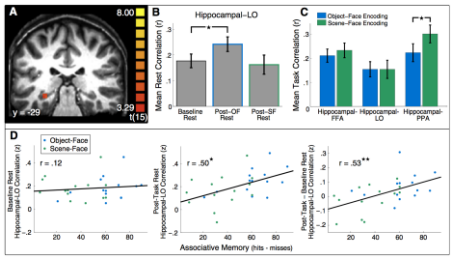
Enhanced brain correlations during rest are related to memory for recent experiences

Tambini et al., 2010. Neuron



Retrieval results

Applications to Cognitive Science



Tambini et al., 2010. Neuron

Applications to Cognitive Science

Episodic memory and Alzheimer disease:

- **Subtle change of episodic memory is the earliest cognitive deficit in AD** ***(Schwindt & Black, 1999, NeuroImage)***
- **Consistently decreased activation in AD patients during both encoding and retrieval stages of episodic memory** ***(Schwindt & Black, 2009, NeuroImage)***
- **Mechanism of episodic memory consolidation after encoding?**

Encoding
↓
Consolidation
↓
Retrieval

Applications to Cognitive Science

Resting-state fMRI, memory consolidation, APOE ε4

- **Question-1: Resting-state fMRI, hippocampus activity, and APOE ε4 healthy carriers?**
- **Question-2: Spontaneous activity modulation by episodic memory task in the brain regions for encoding?**

Applications to Cognitive Science

Participants:

- **917 students**

2/2	2/3	2/4	3/3	3/4	4/4
1	52	13	799	51	1

- **Two groups of healthy APOE carriers: ε4/3 vs. ε2/3, n = 20 vs 19, (half males), 18 – 23 yrs from BNU, match for IQ and education**

Wang, , Yan et al., 2012. PLoS ONE

Applications to Cognitive Science

Design

- Scanning sessions (3T Siemens):

S1	**Resting-state (Rest1)**	**8 min**
S2	Pictures (indoor or outdoor) (encoding)	5 min
S3	3D structure	8 min
S4	**Resting-state (Rest2)**	**8 min**
S5	Retrieval: old or new (2 runs)	10 min

- **Rest2/Rest1: spontaneous brain activity modulation by task**

Wang, , Yan et al., 2012. PLoS ONE

Applications to Cognitive Science

Behavior result: retrieval performance

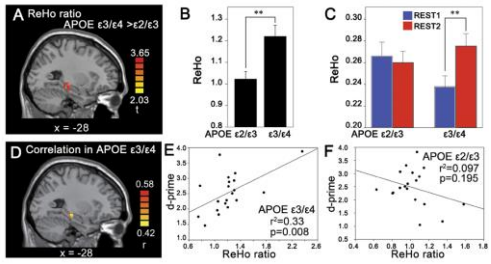
	d' mean	SD	t	p
2/3	2.46	0.68	-0.387	0.7
3/4	2.54	0.63		

No significant difference between the two groups

Wang, , Yan et al., 2012. PLoS ONE

Applications to Cognitive Science

Hippocampus



(P < 0.05, SVC)

Wang, , Yan et al., 2012. PLoS ONE

Outline

- **Applications to Cognitive Science**
- **Applications to Brain Disorders**

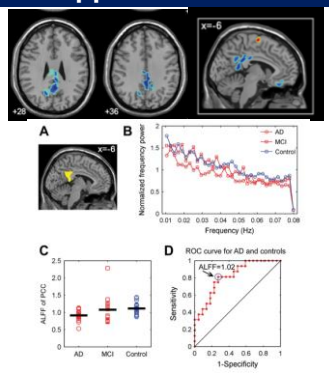
Applications to Brain Disorders

- Alzheimer's Dementia (AD)
- Depression
- Autism Spectrum Disorder (ASD)
- …

Applications to Brain Disorders

ALFF in AD

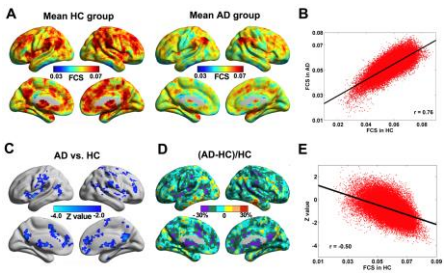
Applications to Brain Disorders



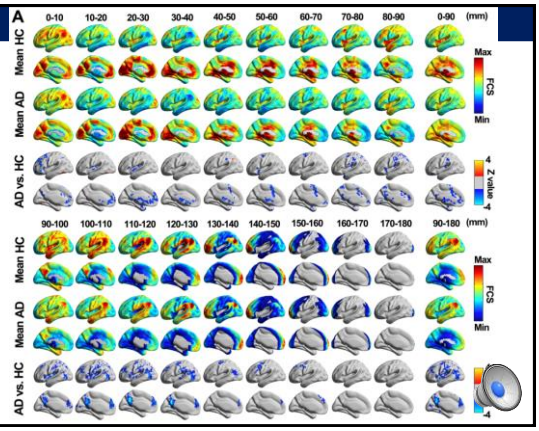
Wang*, Yan* et al., 2011, Hum Brain Mapp

Applications to Brain Disorders

Degree centrality in AD



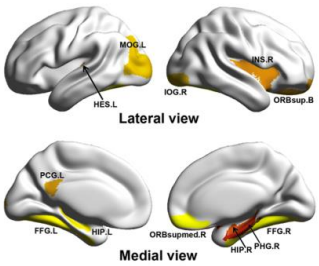
Dai, Yan et al., 2014. Cerebral Cortex.



Applications to Brain Disorders

Classification

- Multi-mo
  characteriz
- Features
  - ALFF
  - ReHo
  - Region
  - Gray m
- Accuracy: 89.47%

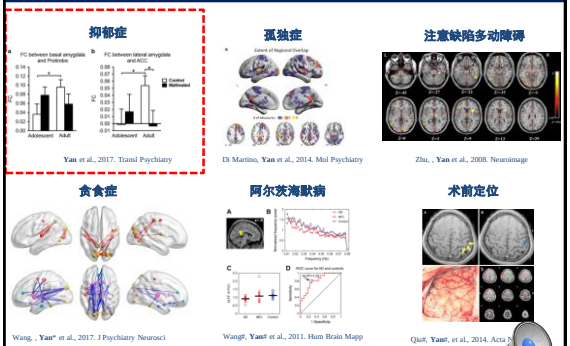


Dai#, Yan# et al., 2012, NeuroImage

Applications to Brain Disorders

- Alzheimer's Dementia (AD)
- Depression
- Autism Spectrum Disorder (ASD)
- …

广泛应用于脑疾病中



Yan et al., 2017. Transl Psychiatry
Di Martino, Yan et al., 2014. Mol Psychiatry
Zhu, , Yan et al., 2008. Neuroimage
Wang, , Yan* et al., 2017. J Psychiatry Neurosci
Wang#, Yan# et al., 2011. Hum Brain Mapp
Qiu#, Yan#, et al., 2014. Acta N

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MDD疾病负担重，诊断缺乏生物学客观标准

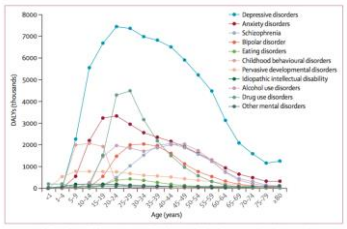

Figure 3: Disability-adjusted life years (DALYs) for each mental and substance use disorder in 2010, by age

Whiteford et al., 2013. Lancet

抑郁症（重性抑郁障碍，MDD）疾病负担居于首位

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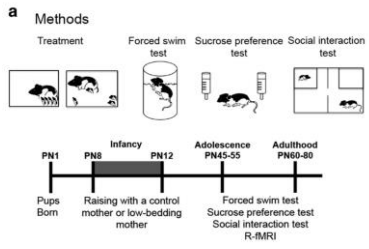
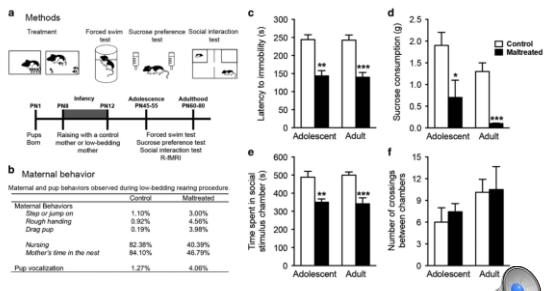
Depressive-like behavior in rat model of caregiver maltreatment



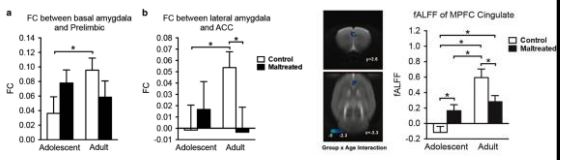
Yan et al., 2017. Transl Psychiatry

Depressive-like behavior in rat model of caregiver maltreatment



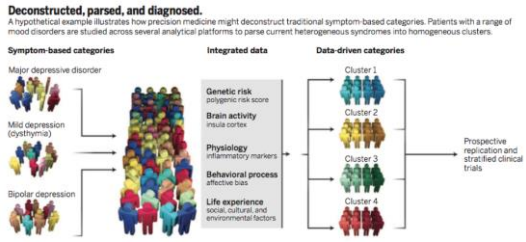
Yan et al., 2017. Transl Psychiatry

Depressive-like behavior in rat model of caregiver maltreatment



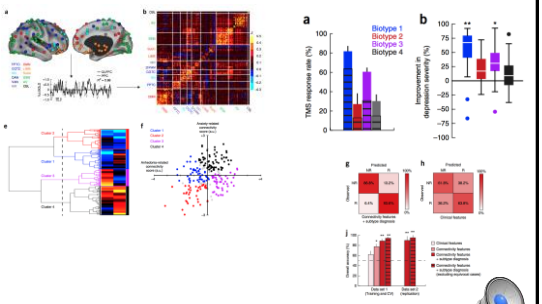
Yan et al., 2017. Transl Psychiatry

The R-fMRI Maps Project Consortium for Depression and Bipolar Disorders



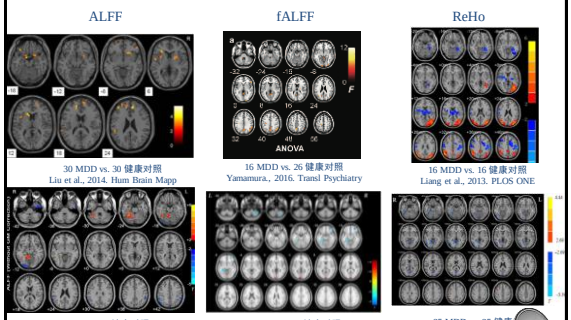
Insel and Cuthbert 2015. Science

Biotypes in Depression



Drysdale et al., 2016. Nat Med

MDD静息态功能磁共振研究



30 MDD vs. 30 健康对照
Liu et al., 2014. Hum Brain Mapp

16 MDD vs. 26 健康对照
Yamamura., 2016. Transl Psychiatry

16 MDD vs. 16 健康对照
Liang et al., 2013. PLOS ONE

18 MDD vs. 18 健康对照
Wang et al., 2012. PLoS ONE

22 MDD vs. 19 健康对照
Liu et al., 2013. J Affect Dis

25 MDD vs. 25 健康
Liu et al., 2017. J Af

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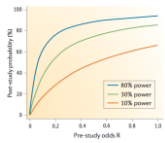
小样本研究遇到的问题

ANALYSIS

Power failure: why small sample size undermines the reliability of neuroscience

Button et al., 2013. Nat Rev Neurosci



- 统计力不足时，发现的结果为真的可能性很小
- 神经科学领域统计力约为8%-31%

ANALYSIS

Scanning the horizon: towards transparent and reproducible neuroimaging research

Poldrack et al., 2017. Nat Rev Neurosci

2015年，fMRI研究每组样本的中位数仅为19

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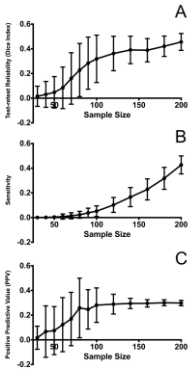
Sample Size Matters

Randomly draw k subjects from the "SWU 4" site in the CORR dataset, which has two sessions of 116 males and 105 females



Chen, Lu, Yan*, 2017. Human Brain Mapping

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抑郁症静息态功能磁共振多中心大数据研究

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研究方案

Year	First Author	Journal
2016	Wei Cheng	Brain
2016	Clifford I. Workman	Neuropsychopharmacology
2016	Yamamura, T	Translational Psychiatry
2016	Hermesdorf, M.	Human Brain Mapping
2016	Haichen Yang	Journal of Affective Disorders
2016	Shuang Zhang	BMC psychiatry
2016	Lian Du	The Journal of ECT
2016	Chenhan Lai	Brain Imaging and Behavior
2016	Lijuan Wang	Journal of International Medical Research
2016	Zhenghua Hou	Frontiers in aging neuroscience
2016	Dongsheng Lv	Journal of Affective Disorders
2016	Yunhui Chen	Data in Brief
2016	Xue Du	PsychiatryResearch:Neuroimaging
2016	Workman C.	Psychological Medicine
2016	Coutinho, J. F.	Brain Imaging and Behavior
2016	Borchardt,V	Human Brain Mapping
2016	Zhan Feng	Progress in Neuro-Psychopharmacology
2016	Ho N. S. P	Journal of Affective Disorders
2016	Chvandah Yang	Neural Plasticity
2016	Li Wang	Metabolic Brain Disorder
2016	Li Wang	Neuroscience Letters
2016	Song, Z	Translational Psychiatry
2016	Zhongwei Guo	Experimental Gerontology
2016	Lian Du	Scientific reports
2016	Liliana Ramona Den	European Archives of Psychiatry and Clin
2016	Zhenghua Hou	PsychiatryResearch:Neuroimaging
2015	Yu Chen	Journal of Affective Disorders
2015	Xiao Yang	Neuropsychiatric Disease and Treatment
2015	Wenbin Guo	Australian & New Zealand Journal of Psy
2015	Chenhan Lai	Journal of Affective Disorders
2015	Mingli Li,Chaohua	Journal of Affective Disorders
2015	Chunhong Liu	Behavioural Brain Research
2015	Ying Wang	Acta Psychiatrica Scandinavica
2015	Li Wang, Mingrui Xia	Human Brain Mapping
2015	Wenbin Guo	Journal of Affective Disorders
2015	Wenbin Guo	Journal of Affective Disorders
2015	Liu Chonghun	Brain research
2015	Hongna Zheng	BioMed Research International
2015	Yinfeng Zhang	Complementary Therapies in Medicine
2015	Yingying Yue	BioMed Research Internat
2015	Yingying Yin	Journal of Affective Disc
2015	Yingying Yin	Journal of Neural Trans
2015	Jinfeng Wu	Frontiers in human n
2015	Ying Wang	Bipolar Disorders
2015	Jakub Spál	Neuropsychopharmacology
2015	Desmond J. Oathes	Biological psychiatry
2015	Xi-Nian Zuo	Medicine

DPARSF引用1500余次

其中108项研究是抑郁症研究

获得国内24家医院33位精神科专家的支持

赵靖平 中南大学湘雅二医院

谢光荣 中南大学湘雅二医院

刘哲宁 中南大学湘雅二医院

王传跃 安定医院

陈纬 浙江大学邵逸夫医院

司天梅 北京大学第六医院

蒙华庆 重庆医科大学

臧玉峰 杭州师范大学

傅小兰 中科院心理所

刘勋 中科院心理所

……

2017年3月25日，抑郁症静息态功能磁共振多中心数据荟萃分析会议于中科院心理所成功召开

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抑郁症静息态功能磁共振多中心数据荟萃分析(REST-meta-MDD)计划参与单位

北京大学第六医院、北京安定医院、中南大学湘雅二医院、四川大学华西医院、东南大学附属中大医院、浙江大学医学院附属第一医院与附属邵逸夫医院、南京脑科医院、苏州广济医院、暨南大学附属第一医院、中国医学科学研究院、上海精神卫生中心、无锡市精神卫生中心、中国医学科学院、中国医科大学、重庆医科大学、安徽医科大学、山西医科大学、昆明医学院、西安交通大学、西南大学、复旦大学、杭州师范大学……

已成功累积1300例MDD与1128例正常对照数据，为全球最大的抑郁症静息态功能磁共振数据库

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REST-meta-MDD

表 1. REST-meta-MDD 计划参与研究单位以及数据构成情况

编号	参与研究单位	样本量	
		MDD	NC
1	安徽医科大学	51	36
2	北京大学第六医院	74	74
3	重庆医科大学附属第一医院	111	79
4	东南大学附属中大医院	139	113
5	暨南大学第一临床医学院	50	50
6	昆明医学院第一附属医院	32	31
7	山西医科大学第一医院	50	33
8	上海交通大学医学院附属精神卫生中心	28	26
9	首都医科大学附属北京安定医院	86	70
10	四川大学华西医院	63	61
11	苏州市广济医院	30	30
12	西安市中心医院	25	17
13	西南大学心理学部	282	251
14	浙江大学医学院附属第一医院	21	20
15	浙江大学医学院附属邵逸夫医院	38	49
16	中国医科大学第一临床医院	75	75
17	中南大学湘雅二医院	145	113

注：MDD：重性抑郁障碍；NC：健康对照

Yan et al., in prep.

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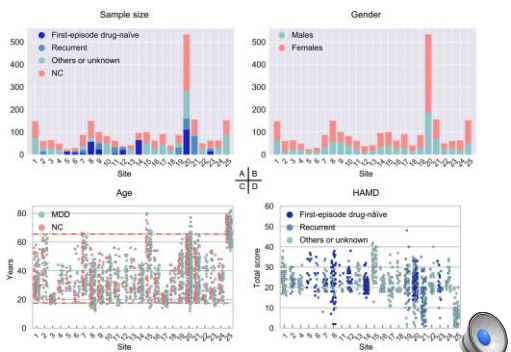
REST-meta-MDD



Yan et al., in prep.

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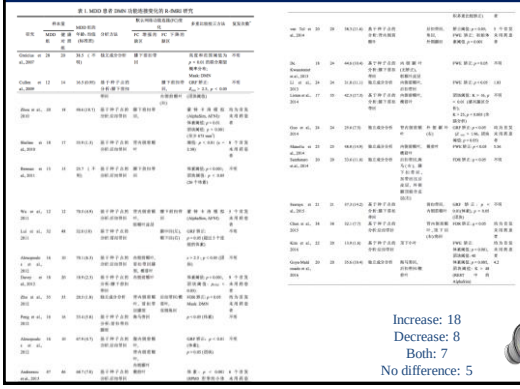
REST-meta-MDD



Increase: 18
Decrease: 8
Both: 7
No difference: 5

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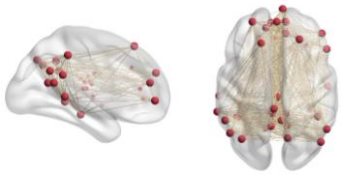
Within DMN Connection



Yan et al., in prep.

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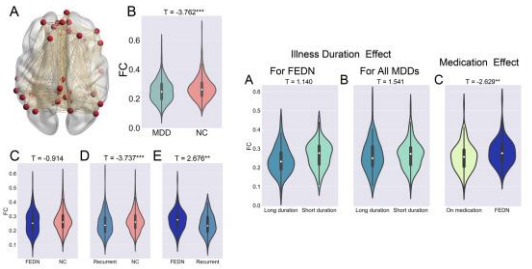
Within DMN Connection



Yan et al., under review.

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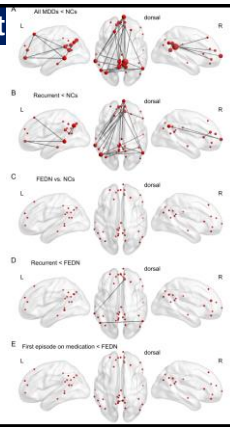
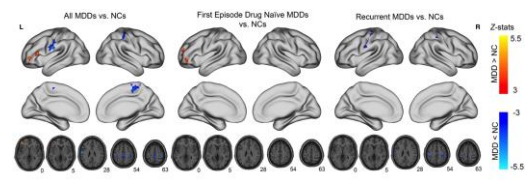
Wit…tion



Yan et al., under review.

40

REST-meta-MDD



Yan et al., in prep.

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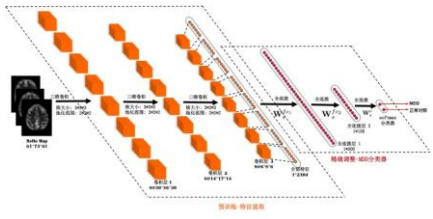
基于脑功能影像的MDD分类



采用深度学习3维卷积神经网络（3dCNN）模型进行训练：64%

SVM：65%

SVM on gray matter volume: 73.5%

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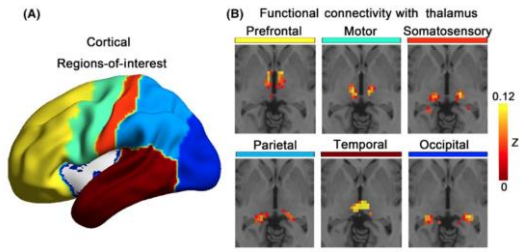
异常脑区与抑郁心理加工机制的关联

反刍思维是指对负性生活事件及其意义、原因、后果的反复思考

静息态 → 悲伤事件回忆 → 反刍思维状态 → 快乐事件回忆

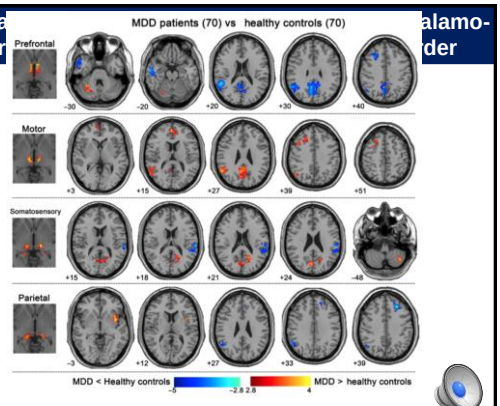
Nolen-Hoeksema et al., 2008. Perspect Psychol Sci; Christoff et al., 2016. Nature Rev Neurosci

Aberrant intrinsic functional connectivity in thalamo-cortical networks in major depressive disorder



Kong, , Yan*, , Si*, 2018. CNS Neurosci Ther

Aberra… cor… alamo-… der

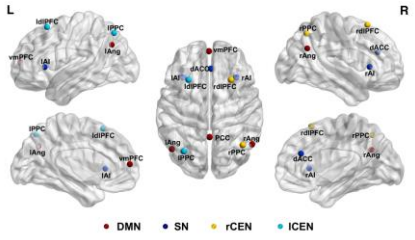


Kong, , Yan*, , Si*, 2018. CNS Neurosci Ther

Applications to Brain Disorders

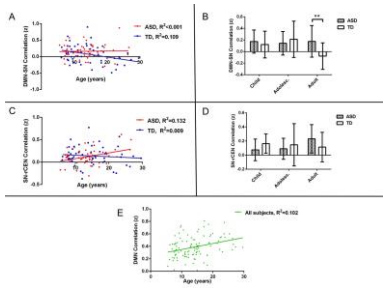
- Alzheimer's Dementia (AD)
- Depression
- Autism Spectrum Disorder (ASD)
- …

Altered Developmental Trajectories in Intrinsic Function between Default, Salience, and Executive Networks in High-Functioning Autism



Yang, , Yan*, in prep.

Altered Developmental Trajectories in Intrinsic Function between Default, Salience, and Executive Networks in High-Functioning Autism



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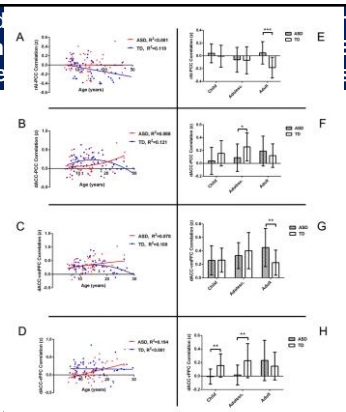
Altered Function Ne… …trinsic …Executive …sm



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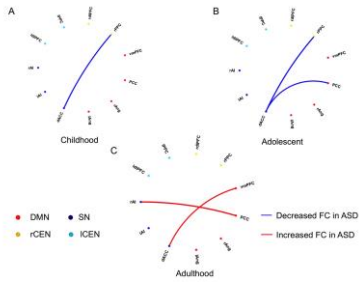
Altered Developmental Trajectories in Intrinsic Function between Default, Salience, and Executive Networks in High-Functioning Autism



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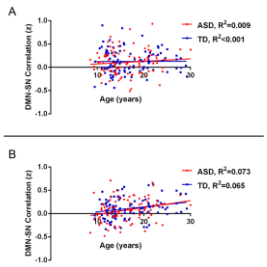

Yang, , Yan*, in prep.

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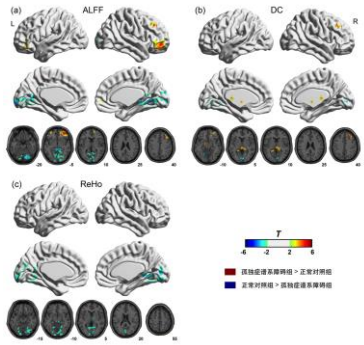
孤独症脑自发活动动态性及其整合的异常机制



Lu, , Yan*, in revision.

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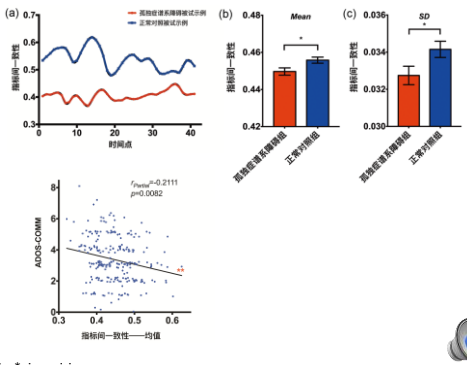
孤独症脑自发活动动态性及其整合的异常机制



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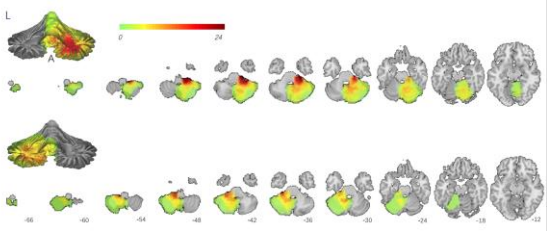
Physiological Significance of R-fMRI Indices: Can Functional Metrics Detect Structural Lesions (Brain Tumors)?



Fan, , Yan*, in prep.

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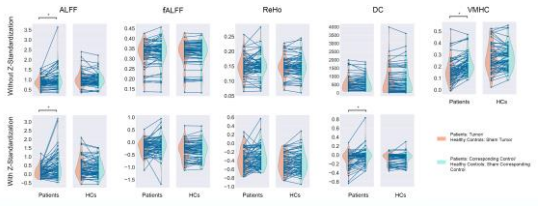
Physiological Significance of R-fMRI Indices: Can Functional Metrics Detect Structural Lesions (Brain Tumors)?



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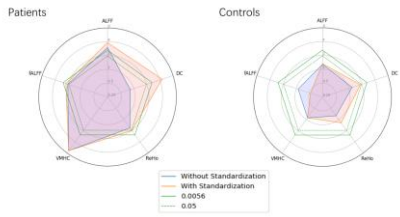

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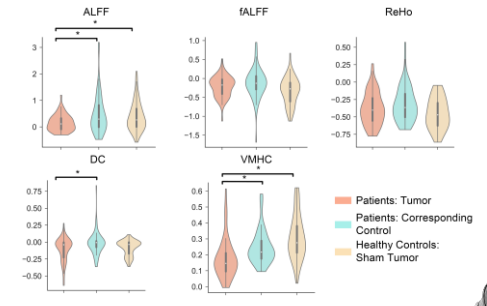
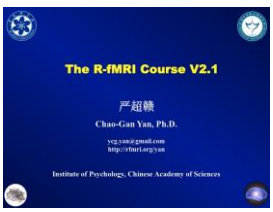


Fan, , Yan*, in prep.

Further Help

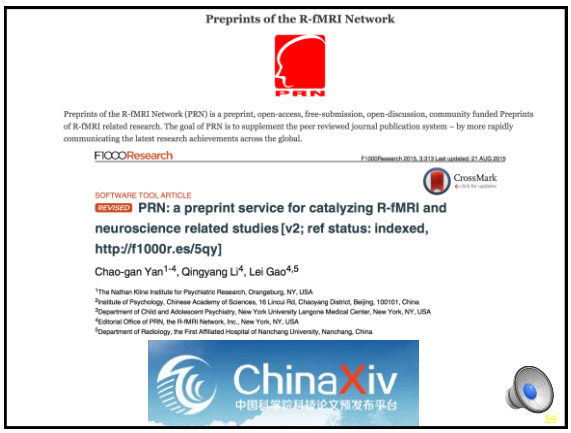


http://rfmri.org/Course

http://rfmri.org/wiki

The R-fMRI Journal Club

Official Account: RFMRILab



Preprints of the R-fMRI Network

Preprints of the R-fMRI Network (PRN) is a preprint, open-access, free-submission, open-discussion, community funded Preprints of R-fMRI related research. The goal of PRN is to supplement the peer reviewed journal publication system – by more rapidly communicating the latest research achievements across the global.

F1000Research F1000Research 2015, 3:313 Last updated: 21 AUG 2015

SOFTWARE TOOL ARTICLE

REVISED **PRN: a preprint service for catalyzing R-fMRI and neuroscience related studies [v2; ref status: indexed, http://f1000r.es/5qy]**

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数据分析与深度培训

静息态功能磁共振成像深度数据分析

功能磁共振成像越来越成为一种主流的科研手段，然而功能磁共振的数据分析却是一项具有高度挑战性的工作。海量的原始数据，繁多的分析步骤，复杂的分析方法都让研究者们无所适从。恰当的分析方法可以从普通的数据中挖掘出富有创新性的结果，而不适当的分析则可能让精心收集的数据黯然失色。深度大脑公司联合中国科学院 The R-fMRI Lab 的专业脑功能成像研究团队推出一站式功能磁共振数据分析解决方案，助您从容应对功能磁共振数据带来的挑战。

http://deepbrain.com

静息态功能磁共振成像数据处理深度特训

从您见到这条消息开始，您便将有机会与中国科学院 The R-fMRI Lab 的静息态功能磁共振专家团队共同探索大脑的奥秘！深度跟组特训期间，您将会亲身体验：

- 数据处理　专家指导下高效学习静息态功能磁共振成像数据处理
- 思路设计　与国际知名专家讨论形成研究思路
- 论文撰写　系统的 SCI 论文写作训练

The R-fMRI Lab

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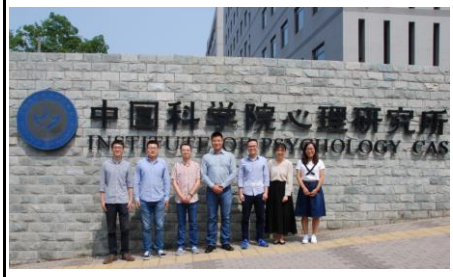
Acknowledgments



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Thanks for your attention!

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