

抑郁对社会决策的影响^{*}

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摘要 从社会决策角度出发, 依托博弈论的经典范式是研究抑郁症病人人际与社会功能障碍的一个切入点。Ruff 和 Fehr (2014) 提出在社会决策中存在三类情境, 即社会反馈、替代性评价、社会原则。我们从这个理论框架出发, 发现抑郁症病人在社会反馈加工中存在社会性快感缺失, 对社会拒绝的敏感性增强; 在替代性评价过程中, 共情和心理理论能力减弱; 抑郁症病人对决策中的社会原则(公平、合作)存在适应不良现象, 如过度利他性。未来的研究一方面可进一步探索抑郁症病人的社会性快感缺失现象, 另一方面可采用经颅电/磁刺激与脑成像技术结合或超扫描技术, 提高研究结果的解释力和生态效度。

关键词 抑郁症 社会决策 博弈论 心理理论 快感缺失

1 引言

抑郁症会深刻影响自身与他人的人际交互, 产生人际与社会功能障碍(Kupferberg, Bicks, & Hasler, 2016)。改善病人的人际和社会功能是当前抑郁症临床干预的重点之一(Hammen, 2005)。因此对于该问题的探讨有助于我们增加认识, 推动抑郁症临床治疗工作。

社会决策指在社会互动背景下的决策行为, 包括互惠、利他、合作等(古若雷, 施媛媛, 杨璟, 石晶, 蔡华俭, 2015)。以社会决策为切入点研究抑郁症病人的社会功能障碍的一大优势是可以依托神经经济学中博弈论(game theory)的模型和大量研究范式, 如最后通牒游戏(Rilling & Sanfey, 2011)。这些任务通常涉及多玩家交互式决策情境, 能对情境中的社会互换和社会功能进行量化研究(Hasler, 2012), 故具有传统社会认知实验范式所不能比拟的高生态效度(Wang, Yang, Li, & Zhou, 2015)。

社会决策的研究范围较为宽泛, Ruff 和 Fehr (2014) 将之归类到以下三类情境中: (1) 决策者衡量他人评价对自己的影响(本文简称为社会反馈(social feedback)); (2) 决策者替代性地评价(vicarious valuation)他人的决策行为和决策结果(本文简称为替代性评价); (3) 决策者对决策过程中规范性社会原则(normative social principles)

的评价(本文简称为社会原则)。目前已有综述从博弈论角度阐述抑郁症病人社会功能障碍(Wang et al., 2015), 这个角度可以归于 Ruff 和 Fehr (2014) 提出的第三类情境(社会原则)中, 然而在前两种情境中(社会反馈和替代性评价)也有同等重要的研究证据, 并可从多个角度论证抑郁症病人的社会功能障碍。因此, 我们认为 Ruff 和 Fehr 的理论框架能使得我们对抑郁症人际和社会功能障碍有更全面的认识。在接下来的论述中, 我们主要从行为学和功能性磁共振成像(functional magnetic resonance imaging, fMRI)等研究证据出发, 关注这三类社会决策情景下抑郁症病人的表现。

2 社会反馈

社会反馈包括决策者得到他人正性或负性的评价, 以及受到他人的接纳或拒绝等(Ruff & Fehr, 2014)。在社会交往中, 他人正面反馈会使我们感到愉悦, 大脑的奖赏系统(如腹侧纹状体)也相应得到激活(Izuma, Saito, & Sadato, 2008); 相反当收到他人负面反馈(例如排斥或拒绝)时则会产生被惩罚(punishment)的体验, 且此种体验的脑激活区与物理疼痛的脑激活区高度重叠(Kross, Berman, Mischel, Smith, & Wager, 2011)。接下来, 我们将论

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述抑郁症病人对社会交往中正性和负性社会反馈的加工。

对于正性的社会反馈或评价, 抑郁症病人表现为快感缺失, 即对愉悦的体验能力下降 (Rizvi, Pizzagalli, Sproule, & Kennedy, 2016)。这也被称之为“社会性快感缺失”, 即病人难以从积极的社会交往中寻求快乐, 并且难以维系社会纽带和亲近他人 (Kupferberg et al., 2016)。例如病人的社会性快感缺失量表的得分上明显高于正常人 (Olsen, Bjorkquist, Bodapati, Shankman, & Herbener, 2015), 对人际接纳有更少的积极情感反应 (Caouette & Guyer, 2016)。此外, 抑郁病人更多地采用社会退缩 (social withdrawal) 策略以避免人际交往中可能出现的失望以及社会排斥 (Allen & Badcock, 2003)。例如, 抑郁症病人在社会交往中主动性下降 (Schwartz-Mette & Rose, 2016)。与健康控制组相比, 高抑郁得分组对人际交往有更少的积极期待, 且表现出较少的助人行为 (Setterfield, Walsh, Frey, & McCabe, 2016)。值得注意的是抑郁症病人在面对金钱奖赏 (Pizzagalli et al., 2009) 或社会奖赏 (Hsu et al., 2015) 时均表现出伏隔核 (nucleus accumbens, NAcc) 激活比正常人弱的现象, 表明抑郁症病人的社会性快感缺失与金钱快感缺失存在相似的脑区激活异常。

抑郁症病人对于负性社会反馈敏感性增强 (Kupferberg et al., 2016)。作为一种典型的负性社会反馈, 社会拒绝被认为是抑郁的高风险因子之一 (Slavich, O'Donovan, Epel, & Kemeny, 2010)。Masten 等人 (2011) 研究发现, 社会拒绝诱发的膝部下前扣带皮层 (subgenual anterior cingulate cortex, sgACC) 的激活能预测青少年一年后的抑郁症状。此外, 抑郁症个体在面对负性社会评价时前额叶激活减弱, 因此难以有效调控负性评价所带来的痛苦。例如在听批评性话语时, 曾有抑郁史个体的背外侧前额叶 (dorsal lateral prefrontal cortex, dlPFC) 无法得到有效激活 (Hooley, Gruber, Scott, Hiller, & Yurgelun-Todd, 2005)。

综上所述, 抑郁症病人对于正性的社会交往或反馈会产生“社会性快感缺失”, 表现为 NAcc 激活减弱; 而在负性的社交情境, 如社会排斥、批评等则出现过度的敏感性, 表现为 sgACC 和前脑岛激活增强, 以及前额叶激活减弱。

3 替代性评价

替代性评价在正常人上已有大量研究 (Ruff & Fehr, 2014), 主要包括以下三个方面: (1) 替代奖惩 (vicarious experience of rewards and punishment), 指观察到他人正在接受奖赏或受到惩罚时, 自己虽然没有直接受到影响, 但也会产生相应的奖赏或惩罚反应。例如当个体看到他人在游戏中赢钱时, 腹侧纹状体激活增加, 且激活区域与自己赢钱时的激活区域重叠 (Mobbs et al., 2009); (2) 替代决策 (vicarious decision-making), 指决策者替代他人做与自身无关的决策。例如让被试事先学习他人的选择偏好, 并在接下来的延迟折扣任务 (选择即时低奖赏或延时高奖赏) 中代表他人选择 (Nicolle et al., 2012)。研究者认为腹内侧前额叶 (ventral medial prefrontal cortex, vmPFC) 与主要负责为自己决策, 而背内侧前额叶 (dorsal medial prefrontal cortex, dmPFC) 主要负责替代决策 (Sul et al., 2015); (3) 替代学习 (vicarious learning), 指在他人行为对自己当前决策没有任何直接影响的情况下, 决策者仍会汲取他人经验教训以指导自己未来的决策行为 (Ruff & Fehr, 2014)。例如在观看他人的风险决策后, 个体会学习他人的决策行为并改变自身的风险偏好, 这个改变过程激活了 dlPFC 与 dmPFC (Suzuki, Jensen, Bossaerts, & O'Doherty, 2016)。由于当前未有研究明确探讨替代性评价和抑郁症的关系, 因此接下来我们将从共情 (与替代奖惩密切相关) 和心理理论 (与替代决策及替代学习密切相关) 两个角度出发, 论述抑郁症病人的表现。

替代奖惩涉及共情 (Morelli, Sacchet, & Zaki, 2015), 即替代性体验和理解他人情感的能力, 因此有人认为对替代奖惩的研究实际上是对共情的研究 (Lockwood, 2016)。虽然目前并没有研究提及抑郁症和替代奖惩的关系, 但 Kupferberg 等人 (2016) 总结近期研究发现, 与正常人相比, 抑郁症病人的共情能力减弱。Fujino 等人 (2014) 发现抑郁症病人在观看手被针扎的视频时给出的疼痛评分比正常人低, 且左侧中部 ACC 和右侧的躯体感觉皮层激活减弱, 而左侧额下回激活增强。

在替代决策过程中, 被试需要事先学习他人的

①心理理论指的是理解和推测他人心理状态 (包括目的、欲望、信念) 的能力, 而共情指的是理解和体验他人情绪与感觉的能力 (Singer, 2006)。

决策偏好，然后代表他人作出决策（Nicolle et al., 2012）或模拟他人的决策（Suzuki et al., 2012），而在替代学习过程中，被试在观看他人的决策情境时会自发总结他人的决策偏好及经验教训以优化自身决策（Suzuki et al., 2016），这两种过程都包含了心理理论（Suzuki et al., 2012, 2016）。

心理理论^①指的是推测他人心理状态、信念、欲望和目的，并用于解释和预测他人行为的一种心智化（mentalizing）能力（Premack & Woodruff, 1978）。在社会决策框架中，心理理论可被定义为推测他人决策偏好的能力（Pulcu & Elliott, 2015）。研究发现替代决策和替代学习都激活了 mPFC，而该脑区正是心理理论的核心脑区（Sul et al., 2015; Suzuki et al., 2016）。

目前未有直接证据表明抑郁症病人存在替代决策和替代学习方面的异常，但行为学综述与元分析都表明抑郁症病人存在心理理论障碍（Bora & Berk, 2016; Weightman, Air, & Baune, 2014）。fMRI 元分析发现心理理论的核心脑区包括内侧前额叶（medial prefrontal cortex, mPFC）和双侧后部颞顶联合区（temporoparietal junction, TPJ）（Schurz, Radua, Aichhorn, Richlan, & Perner, 2014），而抑郁症病人在 vmPFC 和 TPJ 上存在结构与功能异常（Cusi, Nazarov, Holshausen, MacQueen, & McKinnon, 2012）。此外，抑郁症病人的心理理论障碍还涉及到左侧 dlPFC 激活减弱（Takei et al., 2014）。

综上所述，目前虽未有研究直接探讨抑郁对替代奖惩、替代决策，以及替代学习的影响，但有充分证据表明与这三种替代性评价密切相关的共情（与替代奖惩相关）和心理理论能力（与替代决策和替代学习相关）在抑郁症病人身上是受损的。这提示我们，在有共情和心理理论参与的替代性社会决策过程中，抑郁扮演着一个重要角色。

4 社会原则

第三种情境是决策者以规范性社会原则作为参照框架指导自己的决策行为（Ruff & Fehr, 2014）。通过博弈论经典范式，我们能更好地理解抑郁症患者的人际功能（King-Casas & Chiu, 2012）。下文分别从公平、合作、利他三个角度进行论述。

最后通牒游戏是研究公平感的常用范式（Rilling & Sanfey, 2011）。该任务模拟了一个金钱交易情景：当分配者提出金钱分配方案后，接受者若同意方案，

分配者和接受者即按照该方案获得金钱；接受者若拒绝方案，分配者和接受者都不能得到金钱。在该游戏中，公平程度能通过改变分配者的方案来操控，例如把一半的金钱分给接受者（公平方案），或者把较少的金钱分给接受者（不公平方案）（Gradin et al., 2015）。与正常人相比，一方面，作为接受者的抑郁症病人在面对公平方案时幸福感水平下降；并且面对公平程度逐渐增加的方案时，NAcc 和背侧尾核未能像正常人那样得到激活，表明病人在公平感和社会奖赏（他人善意）的加工上存在快感缺失（Gradin et al., 2015）。另一方面，病人在面对不公平方案时存在更多的负性情绪反应（Harlé, Allen, & Sanfey, 2010），倾向于把他人提出的方案视作不公平方案，表现出“负性偏向”（Wang et al., 2014）。

合作也是社会决策中的一种典型社会原则（Ruff & Fehr, 2014），经典范式是囚徒困境游戏（Ruff & Fehr, 2014）。在游戏中，两名玩家决定是与对方合作还是背叛对方。对于单个玩家来说，当自己选择合作而对方选择背叛时自己会受到最大的损失；当自己选择背叛而对方选择合作时则获得最大利益（此两种情形称为非互惠合作（unreciprocated cooperation））。但就双人的利益而言，最优决策是双方均选择合作（互惠合作（reciprocated cooperation）），而最劣决策则是双方互相背叛（不合作（noncooperation））（Rilling et al., 2008）。在该游戏中，抑郁症病人合作意愿下降（Surbey, 2011），表现出更多背叛行为（Pulcu et al., 2015），且难以维持互惠合作（Clark, Thorne, Hardy, & Cropsey, 2013）。Gradin 等人（2016）发现抑郁症病人在互惠合作条件下未能表现出正常人 NAcc 和背侧尾核激活增强的模式，表明病人难以从互惠的人际交往中寻求快乐。与正常人相比，抑郁症病人在非互惠合作时左侧的 dlPFC 激活减弱，表明病人在面临非互惠合作情境时存在认知控制和自上而下情绪调控的障碍（Gradin et al., 2016）。

利他在人群中具有普遍性（Bowles, 2006），反映了不惜牺牲个体利益也要贯彻特定社会原则（公平与合作）的过程（Ruff & Fehr, 2014），且至少包括利他奖赏（altruistic rewarding）和利他惩罚（altruistic punishment）两部分（Fehr & Fischbacher, 2003）。利他奖赏指的是个体倾向于奖励他人对社会原则的遵循行为（de Quervain et al., 2004）。与正常人相比，

抑郁症病人表现出过度的利他奖赏,例如在最后通牒游戏中,当抑郁症病人作为金钱方案的分配者时,会把更多的钱分给接受者(Destoop, Schrijvers, De Grave, Sabbe, & De Bruijn, 2012)。这种过度利他性的可能解释为:抑郁症病人一方面分配出更多的钱以避免接受者可能的拒绝,另一方面对金钱本身就存在快感缺失(Destoop et al., 2012)。然而也有研究发现不一致的结果,例如Zhang, Sun和Lee(2012)发现,抑郁症病人在信任游戏中表现出的利他行为比正常人少。这种结果不一致可能与实验范式的异质性有关。

与利他奖赏相反,利他惩罚^①指的是个体倾向于惩罚他人对社会规则的背弃行为(Fehr & Fischbacher, 2003)。利他惩罚之所以具有利他性,在于个体惩罚他人不良行为是为了让他人从中汲取教训并获益,进而维持长期稳定的公平或合作、增强群体凝聚力(Ruff & Fehr, 2014)。利他惩罚可有多种表现,例如在最后通牒游戏中接受者对分配者不公平方案的拒绝(Fehr & Fischbacher, 2003),或是在合作类游戏中对背叛者的惩罚(de Quervain et al., 2004)。其共同点都是以自己损失金钱为代价告诫分配者恪守公平与合作原则(Pulcu & Elliott, 2015)。先前提到抑郁症病人在最后通牒游戏中更倾向于拒绝不公平方案,此结果可能说明病人容易表现出更多的利他惩罚(Kupferberg et al., 2016)。病人不仅拒绝对自己不公平的方案,还会拒绝对自己过度公平的方案(Radke, Schafer, Muller, & de Bruijn, 2013),这也被认为是病人存在过多利他惩罚的表现(Kupferberg et al., 2016)。

综上所述,神经经济学的博弈论为我们研究抑郁症病人的人际与社会功能障碍提供了较成熟的理论框架和实验范式(Wang et al., 2014)。与正常人相比,抑郁症病人在公平、合作、利他等社会原则上存在一些适应不良现象,例如合作行为减少、存在过度利他性等。

5 未来研究展望

从前文的论述中我们可以看出,快感缺失是影响抑郁症病人社会决策的重要因素,且研究者们常用快感缺失对实验结果进行解释(Gradin et al., 2015)。以往研究仅把快感缺失定义为缺乏快乐体

验,但目前研究者认为快感缺失既表现为对奖赏的“喜好”(liking)减少,又表现为对奖赏的“渴望”(wanting)降低(Pizzagalli, 2014),且这些对抑郁症快感缺失的研究,大部分仅着眼于金钱奖赏(Rizvi et al., 2016)。基于本文所述,抑郁症病人在人际交往和社会功能上的障碍提示我们应该把更多的目光投向社会奖赏领域。当前对抑郁症病人社会性快感缺失的研究还停留在奖赏的“喜好”方面(Caouette & Guyer, 2016; Hsu et al., 2015),目前并不清楚病人在对奖赏的“渴望”上是否也存在快感缺失现象,即抑郁症病人社会性快感缺失是否还体现为对社会奖赏期待降低,或者追求社会奖赏的动机和努力消退?未来研究可以借鉴以往在金钱奖赏上的思路,进一步细化抑郁症病人的社会性快感缺失。

在社会决策的研究中还存在一个问题,即观测到的脑区激活在多大程度上能解释特定的决策行为(Ruff & Fehr, 2014)。一种解决办法是把脑成像技术(如fMRI)和无创性的脑刺激技术(如重复经颅磁刺激(repetitive transcranial magnetic stimulation, rTMS))结合起来,既能探讨目标脑区与行为的因果关系,又能考察刺激前后该脑网络中其他脑区的相应变化(Baumgartner, Knoch, Hotz, Eisenegger, & Fehr, 2011)。结合这两种技术研究抑郁症病人异常社会决策神经基础的价值在于:通过成像技术明确了病人社会决策相关的异常脑区之后,利用脑刺激技术兴奋或抑制该异常脑区,并对比真刺激组和假刺激组在社会决策相关任务中的行为、功能磁共振等指标的变化,从而揭示病人特定脑区以及背后脑功能网络异常与社会决策行为异常之间的因果关系进而提高对结果的解释力。此外,这类研究对抑郁症亚型区分(Downar et al., 2014)以及脑刺激技术治疗抑郁症(Dunlop, Hanlon, & Downar, 2016; Kalu, Sexton, Loo, & Ebmeier, 2012)还具有重要指导意义。例如Downar等人(2014)通过fMRI发现,奖赏通路(包括腹侧背盖区、纹状体、以及vmPFC)的功能连接强度能区分出抑郁症的两种亚型:一种表现为享乐功能(hedonic function)完好,且对dmPFC-rTMS治疗有反应(responder);另一种表现为享乐功能受损,且对dmPFC-rTMS治疗无反应(nonresponder)。。

最后,博弈论经典任务虽具有较强的社会交互性,但在封闭的实验室进行单人实验容易使这些任务的生态效度受到限制。超扫描(hyperscanning)

^①此处的“惩罚”既包括自己的利益牺牲,又包括对他人的惩罚(Fehr & Fischbacher, 2003)。

技术可实现多人交互式实验设计,对多人神经活动进行同步扫描记录并计算不同人之间神经活动的相关性(Babiloni & Astolfi, 2014)。在社会决策中,该技术能真实还原决策过程中的人际交互情景并发挥博弈论范式社会交互性强的特点。未来研究可以把社会决策任务和超扫描技术相结合以更深入地探索抑郁症病人的人际交往障碍,提高研究的生态学效度。

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The Influence of Depression on Social Decision-Making

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Abstract Depression is associated with poor interpersonal and social functions. To improve the social dysfunction is the key component of successful intervention in depressed patients. Therefore, the review of this topic can further our understanding and promote potential clinical practice.

To understand depressed patients' interpersonal and social dysfunction in the context of social decision-making, an advantage is that researchers can use game theory paradigms from neuroeconomics to examine interpersonal and social dysfunction in patients with depression. Ruff and Fehr (2014) proposed three classes of situations in social decision-making. First, it refers to assess how other individuals' valuation or feedback affect the agent's own well-being ("social feedback" for short). This class of social decision-making includes situations in which the agent experiences social rewards or punishment from others, such as social acceptance or social rejection. The second class concerns situations in which an individual vicariously values choice options and outcomes for another individual, i.e., vicarious experiences of social rewards and punishment, vicarious social decision-making, and vicarious social learning ("vicarious valuation" for short). The third class comprises situations in which an individual values his or her behavior in a reference frame of normative social principles ("social principle" for short).

Based on the three classes of the aforementioned situations, the current review summarized recent behavioral and fMRI studies on social decision-making in healthy adults as well as in patients with depression. For the situation of "social feedback", depressed individuals showed social anhedonia for positive social interaction and social reward, which may be due to reduced response from the nucleus accumbens. In contrast, patients had increased sensitivity to negative social interactions, such as social rejection or exclusion, which is associated with increased activation in the neural network of social pain. For the situation of "vicarious valuation", although we found no direct deficits in depression, depressed individuals showed deficits in empathy (which is relevant to vicarious rewards and punishment) and the theory of mind (which is relevant to vicarious decision-makings and vicarious learnings). For the situation of "social principle", when depressed individuals guided their behavior to comply with normative social principles (e.g. fairness, cooperation, altruism), these individuals demonstrated maladaptive behaviors, such as hyper-altruism and reduced cooperative behavior.

According to the previous results reviewed above, this paper proposed three unsolved problems and associated possible solutions. First, although depressed individuals showed multifaceted anhedonia, such as reduced rewarding experience of desire, anticipation, motivation, effort and pleasure, most of current studies used money as incentives. We argued that a shift from monetary to social stimuli was needed in clinical research to improve our understanding of social anhedonia in depressed individuals. Second, it is not clear whether the observed neural responses are causally necessary for social decision-making. The combination of non-invasive brain stimulation tools, such as repetitive transcranial magnetic stimulation (rTMS), and brain imaging methods can resolve this issue. In this context, researchers can investigate the causal effect of rTMS on the behavioral changes in the stimulated brain regions. Third, the hyperscanning technique which has a high ecological validity is suggested to be used in the future social decision-making studies; because it allows the inter-human experimental designs and can simultaneously record neural activities of interactive subjects.

Key words depression, social decision-making, game theory, theory of mind, anhedonia