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TO ELUCIDATE THE NEUROLOGICAL BASIS FOR THE ABERRANT BEHAVIORAL RESPONSE OBSERVED IN MDD PATIENTS

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Abstract

Researchers in the "second study looked into the brain correlates of social decision-making in persons who suffer from MDD. It was observed that their brain activity during hazardous decision making (high vs. low) and choices of conduct (benevolence vs. deceit) were tracked using a 3T MRI scanner while they were participating in the modified trust game. The participants in this study were fifteen MDD sufferers and fifteen healthy controls. The behavior tendencies of both groups were very similar to those seen in research one. Researchers discovered that, as compared to those with a low chance of developing the disorder, MDD patients displayed hyper responsiveness in the insula, which is a brain region important in decision-making. When clinical participants were deceiving others, they showed reduced differentiated activity in the caudate nucleus and increased differentiated activity in the dorso lateral prefrontal cortex, respectively. Participants who were in good health, on the other hand, showed greater activity in the middle frontal lobe, which is involved in the interplay between risk and decision. These findings suggest that a sad mood has an impact on both the poor reward processing and the inflexible adaptation of actions to changing environmental situations. In MDD patients, these" neurological dysfunctions are responsible for their distorted social decision-making. Based on the observations that "MDD patients' social decision-making is affected both in terms of behavioral pattern and in terms of brain activity, it has been established that mood can influence social decision-making processes and that depression is related with increased risk. Because our findings provide neural evidence of social decision-making in MDD patients, they will shed light on the interaction between mood and social cognition. They will also help us gain a better understanding of possible mechanisms explaining the relationship between depressed moods and the social deficits that are present in people with MDD. This understanding will aid in the development of cost-effective treatments for persons suffering from emotional disorders in the future.

Keywords: MDD, interpersonal context, relationship, behavioral difference, emotional disorders, social cognition.

1. INTRODUCTION

Depression was shown to be "consistently associated with decreased social functioning (McCullough, 2003). Those suffering from MDD are preoccupied with and distressed by their dysfunctional relationships with others (Barrett & Barber, 2007; Hickey et al., 2005; Lam et al., 2003; Schuck et al., 2003; Lam, Schuck, Smith, Farmer, and Checkley, 2003), and they lack sufficient social support to resolve their interpersonal difficulties (Wildes, Simons, & Harkness, 2002). However, the ability to interact with others and maintain

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positive social and interpersonal functioning has been identified as a key component of successful depression treatment interventions (Cornette et al., 2009; Gotlib et al., 2004; Hammen, 2005; Roffman et al., 2005). It appears from these data that sadness and social functions are closely related.

An important component of social functioning is the capacity to make a decision in the context of a social encounter. In recent years, a growing body of literature has demonstrated that emotion plays a significant influence in social decision-making (Fehr, 2008; Kano et al., 2011; Polman & Ruttan, 2012). Positive affect, in general, leads to an optimistic and trusting perception of external events, and as a result, it may encourage benevolent and helpful acts. Negative affect, on the other hand, is connected with a pessimistic and sceptical appraisal of social information, according to the research (Forgas, 2002; Forgas & East, 2008). The link between depression and social decision-making has only been studied in a few research, and it has not been determined if depressed mood has a" separate impact on social decision-making from the influence produced by general bad mood.

Making persons with "depression complete activities that require them to make decisions in the setting of social interactions is one method of understanding social decision-making in this group of people. The prisoner's dilemma game (PDG, Koenigs et al., 2007; Rilling et al., 2008; Rilling et al., 2002), the ultimatum/dictator game (UG, Gorman &Kehr, 1992; Guth, Schmittberger & Schwarze, 1982; Kahneman, Knetsch, &Thaler, 1986), and the trust game are examples of experimental task paradigms that have been developed to measure social decision making (TG, King-Casas et al., 2005; McCabe, Houser, Ryan, Smith, & Trouard, 2001). After being exposed to ultraviolet light, MDD patients were shown to accept more unfair offers than healthy individuals, despite the fact that they were extremely uncomfortable with the offers (Harlé et al., 2010). This conclusion was in conflict with their prior observation of the healthy participants who had been induced with melancholy, who were more likely to reject the unjust offers than the unhealthy ones (Harle & Sanfey, 2007). As a result of this discovery, depression appears to have a distinct influence on decision-making that is distinct from the overall emotional state. There would be a need for more research in order to better understand the link between depression and social decision-making. This would include using different paradigms and undertaking rigorous controls to eliminate confounding factors.

As part of this study, MDD patients were asked" to participate in a trust and reciprocity task, which required them to cooperate with one another, make risky decisions, lie, and adjust their behaviour in response to other people's responses. This task, developed by McCabe and colleagues (2001) and King-Casas et al. (2001), was used to assess the trust and reciprocity of MDD patients (2005). Participants take on the role of the investor by making a financial contribution to the other participant, who serves as the trustee. Following the monetary appreciation, the trustee returns a portion of the money to the investor in order to respect the investor's trust. As long as the interaction is ongoing, both parties will come to an arrangement in which the trustee will get larger quantities of

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investment and the investor will receive higher rates of payback. As a result, each participant would receive bigger benefits, creating a reciprocal connection between them. "If the contact between the participants is one-time, it was expected that both players would act selfishly, resulting in no investment being made by the trustee and no payback being paid to the investor. However, empirical research has revealed that the vast majority of participants favour reciprocation (Sanfey, 2007). It was also proven in the PG paradigm that this reciprocation occurs (Sally, 1995). This suggests that social decision-making may be influenced not only by the participants' own self-interest, but but by their benign motives for the well-being of other persons as well. In this study, all participants were expected to take on the position of trustee and to receive a monetary investment from an outside source (a computer programme mimicked woman). The investor had requested that the trustee return a part of the earnings to him or her. Due to the fact that the investor was unaware of the amount of profit made, the trustee had the discretion to determine whether to repay more than (defined as benevolent" conduct), equal to (designated as honest behavior), or less than (defined as deceitful behavior) the desired amount.

2. LITERATURE REVIEW

The study of social decision-making "has received a great amount of attention in the field of neuropsychology since it is a more complicated process that includes several regions in the human brain. Different experimental tasks have been developed to examine the brain processes linked with social decision-making, according to the researchers. Sanfey et al. (2003) found that in the Ultimatum Game (UG) paradigm, which measures "fairness," the insula was a critical region that encoded the perception of "fairness" and predicted subsequent decisions on whether to accept or reject (van't Wout et al., 2006; van't Wout et al., 2003; van'tWout et al., 2003). Activity in caudate nucleus was related with the sense of "trust" and the reciprocal actions in both the UG and the Prisoner's Dilemma Game (PDG), which were used to measure trust (Koenigs et al., 2007; Rilling et al., 2008; Rilling et al., 2002; Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004b; Wardle et al., 2013). It is possible to assume that emotion, which has the same brain mechanism as decision-making, might likewise have a substantial impact on decision-making in the social environment.

According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, MDD was described as a clinical mental disease that was characterized by a consistent occupancy of low mood and other symptoms over a period of time (DSM-IV, American Psychiatric Association, 1994). In comparison" to men, women have a higher frequency of MDD and more severe symptoms; as a result, MDD is referred to be a "women's problem" (Marecek, 2006). Aside from having a depressed mood, MDD sufferers are also characterized by pessimism and a lack of drive, among other characteristics.

Considering that social and "interpersonal functioning have been shown to be important components of successful depression interventions (Cornette et al., 2009; Gotlib,

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Krasnoperova, Yue, and Joormann, 2004; Hammen, 2005; Roffman, Marci, Dougherty, and Rauch, 2005), it is important to investigate the relationship between MDD and social functioning. A number of research have looked at the impairments in various elements of social decision-making that are associated with sad mood in different ways. First and foremost, MDD patients demonstrate a negative cognitive bias, which means that they are more likely to be concerned with negative stimuli while disregarding or dismissing good ones (Elliott, Zahn, Deakin, & Anderson, 2011; Keedwell, Andrew, Williams, Brammer, & Phillips, 2005). Second, the sad state of mind heightened the need to prevent future damage or financial loss (Smoski et al., 2008; Yuen & Lee, 2003). Finally, MDD patients have a deficiency in cognitive and affective resources, which are required to support decision-making processes (Kerestes et al., 2012; Kertzman et al., 2010) These areas were shown to be the most strongly impacted by the prefrontal-amygdalar-pallidostriatal–mediothalamic mood regulating circuitry network (MRC, Anand, Li, Wang, Gardner, & Lowe, 2007; Anand et al., 2005a; Anand et al., 2005b; Drevets, 2000a, 2000b; Drevets et al., 1997). MDD has been associated with frontostriatal impairment in reward processing, which has been proposed as a trait marker of susceptibility (Dichter, Kozink, McClernon, &Smoski, 2012). Patients with MDD displayed hypo activity in the caudate nucleus during the choosing of an option when compared to matched controls (Smoski" et al., 2009), while patients who had received treatment exhibited hyperactivity in this area with the expectation of rewards (Smoski et al., 2009). (Dichter et al., 2009). In another investigation, it was discovered that the hyperactivity in these areas had been restored following the therapeutic therapy (Schaefer, Putnam, Benca, & Davidson, 2006).

More specifically in the brain "regions involved in social decision making, such as the caudate nucleus, the anterior insula, and the VMPFC (Butters & Gallinat, 2009; Cardoner & Gallinat, 2007; Drevets, Price, & Furey, 2008; Soriano-Mas et al., 2011), as well as altered activities during resting state.

Taking into consideration the foregoing debate, we posed the following questions: Specifically, we investigated whether MDD" patients exhibited a similar pattern of risk-avoidant behaviors in the social decision-making task as they did in the economic decision-making task; whether there were any factors other than risk that might be affected by depressed mood in social decision-making (for example, fairness); and whether there were any neural substrates underlying the behavioral changes in MDD patients. Through the investigation of these topics, we can undoubtedly enhance our understanding of the brain mechanisms underlying MDD, which may have major implications for the development of therapies to help those suffering from the disorder.

3. RESEARCH GAP

In this study, we looked into the "ability of MDD patients to make social decisions. A modified Trust Game assignment was administered to both MDD patients and healthy control participants, in which they were required to make their own judgments about how much to return the investor after receiving a loan from the bank. Responding fraudulently

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by returning less than necessary or benevolently by repaying more than required, are both possibilities. MDD patients made fewer and lower ratios of choices on both deceitful and benign options as compared to healthy participants, according to the findings. This data lends credence to our predictions that MDD patients displayed less charitable and less deceitful reactions than healthy controls. Furthermore, they did not aim to maximize their profit by returning the investor a sum that was less than the amount originally recommended. A further difference between MDD patients and healthy controls was that MDD patients did not adjust their deceit to the various degrees of danger. The general pattern of data shows that MDD patients are less motivated to alter their behaviors in response to changes in the social environment. This is supported by the outcomes of the study. The findings might be seen as evidence that MDD patients suffer from impaired cognitive and emotional processing, a condition that has been frequently documented in the literature in the past (Harvey et al., 2005; Ritchey, Dolcos, Edding ton, Strauman, & Cabeza, 2011).

Executing either a beneficent or deceitful reaction in a social environment involved cognitive emotional processing that was far more difficult than just returning the indicated amount, as demonstrated in this research. It is necessary for the participant to evaluate the risk and payment combination while responding deceptively or benevolently in the hopes of attaining an optimal balance between risk and reward. They" evaluated the difference between the amount of actual repayment and the needed amount in the meanwhile before making a decision, and they may also take the benefit to the investor into account when making their choice. When participants opt to cheat or return the investor more than the needed amount of money, the cognitive burden on the participants will be significantly enhanced. Following that, we may infer that "MDD patients were more likely to stay with the necessary payment rather than changing the amount to account for dishonest or beneficent replies, which would place a further strain on their already limited cognitive and emotional resources. However, it appears that this is not the case with MDD patients, since a lower proportion of either benign or deceptive decisions was seen in this group. In order for the MDD patients' unique behavioral patterns to have been confined only" by their limited cognitive and affective resources, it is necessary to consider the following.

4. RESEARCH OBJECTIVE & METHODOLOGY

The goal of this paper is:

- To determine the neurological "correlates of the abnormal behavioral reaction found in MDD" patients.

On the screen for "each attempt was the amount of investment (x, an integer chosen from four intervals: 10–20, 30–45, 55–70, and 75–90), followed by the appreciated investment (Nx, N being the appreciated multiplier, a rational number chosen from four intervals: 1–1.2, 1.4–1.6, 2.4–2.6, and 2.8–3). It will be displayed on the screen for 2 seconds, and will indicate the proportion (R) of the total amount that the trustee was requested to

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reimburse the investor, as well as the likelihood (P) that the investor would discover how much the trustee really paid back. It was requested that the participant put in an acceptable amount of money that she would like to be reimbursed for in the answer phrase. If the amount of payback was greater than the amount sought (RNx), it was referred" to as "benevolent repayment." However, if the amount provided was less than the amount asked, the response was deemed "deceptive." To put the choice into action, the participant would hit the space bar.. She then waited for another 2 seconds to find out whether her "deception had been caught by the investor and whether the money she had earned during this experiment had been returned to her. If the fraudulent act is discovered, any money gained during the trial will be forfeited to the government.

Three R values were used in this task" as requested repayment proportions (20 percent, 50 percent, and 80 percent) representing the “fairness,” which could be defined as “beneficial,” “equal,” or “unfair.” "The three R values were used in this task as requested repayment proportions (20 percent, 50 percent, and 80 percent). The risk was determined by two P values, which corresponded to a 25 percent (low) and a 75 percent (high) probability of being identified, respectively. 96 trials were conducted for each of the four conditions, totaling 96 trials when the levels of R, P, N, and x were added together" (3 2 4 4 = 96). All trials were given to participants in a random manner.

The dependent variables used in this "study was the frequency of choice and the ratio of choices made by participants. The frequency of choice was defined as the number of times a kind of option (benevolent or deceitful) was made in comparison to all other choices, showing the subject's qualitative preference for benevolence or deception in the situation. Additionally, the ratio of choice distinguished between quantitative and qualitative preferences in choosing. Alternatively, if a participant chose to deceive, the ratio of choice was defined as the difference between the amount actually repaid and the amount that should have been repaid in relation to the maximum amount that the participant might obtain if she played deceit. The ratio of choice in the case of benevolence, on the other hand, was the difference between the amount actually repaid and the amount that should have been repaid, divided by the maximum amount that could be repaid to the investor benevolently. It is a structured psychiatric interview that was developed by Sheehan and colleagues (1998) for the assessment of DSM-IV and ICD-10 mental illnesses. When" used in clinical trials and epidemiological research, it may be used as a brief but reliable structured diagnostic interview as well as a first step in outcome "evaluation in clinical settings. Crane et al. (2007) asserted that this interview is suited for experimental investigations since it requires significantly less time than the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (SCID, First, Spitzer, Gibbon, & Williams, 1996). The MINI has been translated into Chinese by the Taiwanese Society of Psychiatry, who did so with an emphasis on sensitivity and specificity in order to improve its use (Si et al., 2009). It would take roughly 15 minutes to complete the project.

The Beck Depression Inventory-II (BDI-II) (Beck, Steer, and Brown, 1996) is a

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quantitative assessment of the severity of depression. In this 21-item questionnaire, participants would be asked to describe their emotional, cognitive, and somatic symptoms of depression. The Chinese version was created by the Chinese Behavioral Science Corporation, which also translated the original (2000). In a few investigations (Byrne, Stewart, and Lee, 2004; Yeung et al., 2002), the validity and reliability of the instrument" for Chinese people were demonstrated.

5. DATA ANALYSIS & FINDINGS

The purpose of this "paper was to characterize how decision-making changes in the setting of social interaction, as well as the brain processes that underlie these changes. In the first research, a modified interpersonal trust-reciprocity game was used, in which 50 female patients with serious depressive disorders and 49 healthy women were asked to make judgments about how much money to return an investor. The decision of the participant was influenced by risk (the likelihood of being caught) and fairness (the proportion of payment that was needed). MDD patients made dishonest judgments less frequently and in smaller proportions than healthy individuals, especially when the risk was low and the payback proportion was large, as compared to the healthy participants, according to the findings. When the repayment percentage was low or medium, MDD patients made beneficent reactions (paying more than was necessary) in a less frequent and smaller proportion than when the repayment proportion was high. These findings revealed that MDD" patients responded in a different manner while interacting with others than non-depressed controls. Using the same paradigm as study one, a "functional imaging investigation was undertaken in order to examine the brain correlates of the altered behavioral reaction found in the MDD patients in the second research. A total of 15 MDD patients and 15 healthy controls were recruited for this study. Patients in the low-risk condition made misleading judgments less frequently and in lower proportions than those in the high-risk condition, which was similar with the findings of research one.

Furthermore, the MDD patients required longer response times while making the false selections, but the relationship between risk and choice was only detected in healthy individuals, not in MDD patients. Behavioral data revealed that low mood was associated with robust risk avoidance as well as deficiencies in the adjustment of decision-making in line with risk, which were both seen in the data. In MDD patients, hypo activity in the insula, which is linked with high risk, and hypo activity in the DLPFC, which is related with deceptive decision, was identified at the neural level. The patients' reduced differentiated activity in the striatal area was consistent with earlier results suggesting hyperactivity in this region of the brain. These findings imply that impairments in social decision-making may contribute to the social dys functioning found in MDD patients, which is consistent with previous research. As a result, social decision making requires the recruitment of additional processes in two ways: first, participants were required to apprehend and understand the behaviors of others; second, participants were required to consider the benefits and costs of others, a process known as social empathy, in order to make decisions" for other people.

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Individuals are "necessary to watch and grasp the actions of others in order to form a foundation for decision-making. Despite the fact that such social components are not always present in experimental contexts, a vast body of empirical data indicates that the environment of decision making has a major impact on the result of decisions. Participants responded differently to computer-simulated human relationships than they did to the real thing (McCabe et al., 2001). Participants' responses were more emotional when they were told that their partners were human beings, as opposed to when they were not. They were more altruistic when they received a partner's generosity, but they were more critical when they received a partner's fraud. As opposed to playing against the computer, they tended to reject unfair offers from human opponents in UG and collaborate with human opponents in PDG more frequently while playing against human opponents (McCabe et al., 2001). As a result, the brain areas associated with theory of mind were particularly sensitive to the presence of a human partner (McCabe et al., 2001; Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004a). When the probability of winning was held constant, healthy" participants showed more aversive responses to the potential risk posed by another human player than they did to the potential risk posed by the computer-partner, indicating that they were less risk-taking in the former condition than in the latter (Moretto, Sellitto, & di Pellegrino, 2013). In research one, there was no statistically "significant difference between the groups when there was no other human participant engaged, but the MDD patients displayed considerably more risk avoidance when the decision making involved other humans. When it comes to social contact, this suggested that emotional state had a dominating role, which was consistent with the prior claim that decision-making is more emotion-based when dealing" with other people.

6. CONCLUSION

With regard to social "decision-making, we investigated the neurological correlates of decision making in the present research. In the high risk condition, the behavioral findings were similar to those found in study one, with the exception that there was no statistically significant difference between MDD patients and controls in the frequency of deception, while MDD patients had a significantly lower frequency of deception relative to the healthy participants in the low risk condition. Furthermore, when comparing the amount of repayment or the ratio of repayment given by MDD patients with those given by healthy participants, no statistically significant differences were found in the high-risk condition, but suggestive differences approaching the level of significance were found in the low-risk condition. In contrast to the first study, we discovered a statistically significant interaction between group and choice on reaction times in this trial, independent of the amount of risk. It's worth noting that the interaction between risk and choice on response time was only found in healthy volunteers, not in patients with major depressive disorder. Only the sorts of decisions made by the MDD patients had an effect on their response time, which was measured. When compared to benign options, they required more time to come up with a decision to lie and to carry out that decision. Prefrontal–amygdalar–pallidostriatal–mediothalamic mood regulating circuitries were shown to be the most

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significant brain correlates of these behavioral alterations in this study (MRC). It was discovered that MDD individuals had a hypersensitivity to danger in their insula. The reduced activity" in the caudate nucleus, which reflects a defective sensitivity to social reward, and the impairments in managing the cognitive resource, which reflects hyperactivity in the prefrontal cortex, both contributed to the aberrant pattern of choice observed in MDD patients.

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9. Availability of data and materials:

The datasets used and/or analyzed during the present study are available from the corresponding author upon reasonable request.

10. Authors' contributions:

Zyingxin Yi, were principally responsible for the conception and design of the study. Asita A/P Elengoe and Pushpalata Vadlamudi supervised and monitored the project.

11. Ethics approval and consent to participate: NA (Not applicable).

12. Consent Patient for publication: NA (Not applicable).

13. Competing interests: As Corresponding author, I on behalf of co-authors do state that there is no any conflict of interest involved in the paper.

References

1. Fiorillo, C. D., Tobler, P. N., & Schultz, W. (2003). Discrete coding of reward probability and uncertainty by dopamine neurons. *Science, 299*(5614), 1898-1902.
2. Glimcher, P. W., & Rustichini, A. (2004). Neuroeconomics: The consilience of brain and decision. *Science, 306*(5695), 447-452.
3. Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., &Camerer, C. F. (2005). Neural systems responding to degrees of uncertainty in human decision-making. *Science, 310*(5754), 1680-1683.
4. Knutson, B., Bhanji, J. P., Cooney, R. E., Atlas, L. Y., &Gotlib, I. H. (2008). Neural responses to monetary incentives in major depression. *Biological Psychiatry, 63*(7), 686-692
5. Lee, D. (2008). Game theory and neural basis of social decision making. *Nature neuroscience, 11*(4), 404-409.
6. Northoff, G., & Hayes, D. J. (2011). Is Our Self Nothing but Reward? *Biological Psychiatry, 69*(11), 1019-1025.
7. Pizzagalli, D. A. (2011). Frontocingulate Dysfunction in Depression: Toward Biomarkers of Treatment Response. *Neuropsychopharmacology, 36*(1), 183-206.
8. Platt, M. L., & Glimcher, P. W. (1999). Neural correlates of decision variables in parietal cortex. *Nature, 400*(6741), 233-238.
9. Polman, E., &Ruttan, R. L. (2012). Effects of Anger, Guilt, and Envy on Moral Hypocrisy. *Personality and Social Psychology Bulletin, 38*(1), 129-139
10. Polman, E., &Ruttan, R. L. (2012). Effects of Anger, Guilt, and Envy on Moral Hypocrisy. *Personality and Social Psychology Bulletin, 38*(1), 129-139.

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11. Rawal, A., Collishaw, S., Thapar, A., & Rice, F. (2013). 'The risks of playing it safe': a prospective longitudinal study of response to reward in the adolescent offspring of depressed parents. *Psychological Medicine, 43*(1), 27-38.
12. Rilling, J. K., &Sanfey, A. G. (2011). The Neuroscience of Social Decision-Making. *Annual Review of Psychology, 62*(1), 23-48.
13. Rilling, J. K., Goldsmith, D. R., Glenn, A. L., Jairam, M. R., Elfenbein, H. A., Dagenais, J. E., Murdock, C. D., &Pagnoni, G. (2008). The neural correlates of the affective response to unreciprocated cooperation. *Neuropsychologia, 46*(5), 1256-1266.
14. Rilling, J. K., Gutman, D. A., Zeh, T. R., Pagnoni, G., Berns, G. S., & Kilts, C. D. (2002). A neural basis for social cooperation. *Neuron, 35*(2), 395-405.
15. Rilling, J. K., Sanfey, A. G., Aronson, J. A., Nystrom, L. E., & Cohen, J. D. (2004a). The neural correlates of theory of mind within interpersonal interactions. *NeuroImage, 22*(4), 1694-1703.
16. Sanfey, A. G. (2007). Social decision-making: Insights from game theory and neuroscience. *Science, 318*(5850), 598-602.
17. Seo, H., & Lee, D. (2012). Neural basis of learning and preference during social decision-making. *Current Opinion in Neurobiology, 22*(6), 990-995.
18. Stevens, J. S., &Hamann, S. (2012). Sex differences in brain activation to emotional stimuli: A meta-analysis of neuroimaging studies. *Neuropsychologia, 50*(7), 1578-1593.
19. Strigo, I. A., Matthews, S. C., & Simmons, A. N. (2013). Decreased frontal regulation during pain anticipation in unmedicated subjects with major depressive disorder. *Translational Psychiatry, 3*.
20. Swick, D., Ashley, V., &Turken, U. (2008). Left inferior frontal gyrus is critical for response inhibition. *Bmc Neuroscience, 9,* 102.
21. Thura, D., &Cisek, P. (2014). Deliberation and Commitment in the Premotor and Primary Motor Cortex during Dynamic Decision Making. *Neuron, 81*(6), 1401-1416.
22. Vartanian, O., Kwantes, P. J., Mandel, D. R., Bouak, F., Nakashima, A., Smith, I., & Lam, Q. (2013). Right inferior frontal gyrus activation as a neural marker of successful lying. *Frontiers in Human Neuroscience, 7*.
23. Wardle, M. C., Fitzgerald, D. A., Angstadt, M., Sripada, C. S., McCabe, K., & Luan Phan, K. (2013). The Caudate Signals Bad Reputation during Trust Decisions. *PLoS ONE, 8*(6).
24. Wiebking, C., Bauer, A., de Greck, M., Duncan, N. W., Tempelmann, C., &Northoff, G. (2010). Abnormal body perception and neural activity in the insula in depression: An fMRI study of the depressed "material me". *World Journal of Biological Psychiatry, 11*(3), 538-549
25. Wing, V. C., Rabin, R. A., Wass, C. E., & George, T. P. (2013). Correlations between executive function, decision-making and impulsivity are disrupted in schizophrenia versus controls. *Psychiatry Research, 205*(1-2), 168-171.
26. Yen, Y. C., Rebok, G. W., Gallo, J. J., Jones, R. N., &Tennstedt, S. L. (2011). Depressive Symptoms Impair Everyday Problem-Solving Ability Through Cognitive Abilities in Late Life. *The American Journal of Geriatric Psychiatry, 19*(2), 142-150.
27. Yokota, S., Taki, Y., Hashizume, H., Sassa, Y., Thyreau, B., Tanaka, M., & Kawashima, R. (2013). Neural correlates of deception in social contexts in normally developing children. *Frontiers in Human Neuroscience, 7*.
28. Zhang, H. J., Sun, D., & Lee, T. M. (2012). Impaired social decision making in patients with major depressive disorder. *Brain and Behavior, 2*(4), 415-423.