



The influence of cooperation and defection on social decision making in depression: A study of the iterated Prisoner's Dilemma Game



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ARTICLE INFO

Keywords:

Interpersonal
Bias
Learning
Emotion
Negative affect
Anxiety

ABSTRACT

This study evaluated the influence of self-reported levels of depression on interpersonal strategic decision making when interacting with partners who differed in their predetermined tendency to cooperate in three separate computerized iterated Prisoner's Dilemma Games (iPDGs). Across 29 participants, cooperation was lowest when interacting with a predominantly defecting partner and highest when interacting with a predominantly cooperating partner. Greater depression severity was related to steadier and continued cooperation over trials with the cooperating partner, seeming to reflect a prosocial response tendency when interacting with this partner. With the unbiased partner, depression severity was associated with a more volatile response pattern in reaction to cooperation and defection by this partner. Severity of depression did not influence cooperation with a defecting partner or expectations about partner cooperation reported before the task began. Taken together, these data appear to show that in predominately positive interactions, as in the cooperating partner condition, depression is associated with less volatile, more consistent cooperation. When such clear feedback is absent, as in the unbiased partner condition, depression is associated with more volatile behavior. Nonetheless, participants were generally able to adapt their behavior accordingly in this dynamic interpersonal decision making context.

1. Introduction

Depression is a prevalent mental disorder characterized by dysphoric mood, loss of interest or pleasure in activities, and accompanying symptoms such as hopelessness and low energy, which together cause significant distress or impairment in normal functioning (American Psychiatric Association, 2013). Depression has been associated with various affective and cognitive distortions and underlying neurobiological changes (Clark et al., 2009). For instance, clinically depressed individuals have shown impairments in recognizing happy facial expressions (Rubinow and Post, 1992), as well as faster responding to sad versus happy targets in an affective go/no-go task (Erickson et al., 2005; Murphy et al., 1999). Depression has further been associated with a memory bias favoring the recall of negative information (Brittlebank et al., 1993; Joormann et al., 2009), as well as the tendency to underestimate instances of reward and to overestimate both instances of punishment (Nelson and Craighead, 1977) and the likelihood of failing after negative performance feedback (Elliott et al., 1997). This orientation toward negatively valenced stimuli and behavioral feedback is likely to have implications for how depressed

individuals respond to emotionally charged information in social situations (Joiner, 1995; Nepon et al., 2011).

Theorists studying interpersonal behavior have focused on the importance of an individual's efficacy as a group member (Argyris, 1965) and the ability to adapt behaviors to obtain desirable social outcomes (Libet and Lewinsohn, 1973). This highlights the importance of strategic decision making in interpersonal contexts, which can be quantified by paradigms borrowed from behavioral game theory. In a task known as the iterated Prisoner's Dilemma Game (iPDG; Axelrod and Hamilton, 1981), each of two players works toward the supposed goal of earning points or money by choosing independently to *cooperate* or *defect* over the course of multiple trials. Defecting while one's partner cooperates results in the largest individual payoff for the defector but a zero payoff for the cooperator. Mutual cooperation results in second-highest, but equal, individual payoffs. Mutual defection results in equal, but second-lowest, individual payoffs. Given this scenario, choosing to cooperate is risky, because the other player may choose to defect and in doing so will gain the highest individual pay-off, leaving you with nothing. Choosing to defect, on the other hand, results in a sure pay-off, the value of which will be higher or lower depending

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on whether the other player decides to cooperate or defect, respectively. For this reason, the optimal game theoretical decision would be for both players to defect, even though this amounts to a suboptimal outcome because the earnings for both players would be higher if both decided to cooperate. Despite the risk associated with choosing to cooperate, cooperative play frequently occurs, even in situations where individuals interact only once (Berg et al., 1995; Camerer, 2003; Sally, 1995), and allows each player to establish a positive reputation, resulting in the more advantageous option of reciprocal cooperation over multiple iterations of the game (Andreoni and Miller, 1993). Thus, whether an individual is willing to make a risky social decision (e.g. to cooperate) or not (e.g. to defect) is influenced by how the other player has acted previously (Nowak, 2006). Therefore, players' decisions are influenced by how they interpret, respond to, and learn from this type of social information.

Alterations in social information processing due to cognitive distortions, such as those associated with depression, may result in aberrant strategic decision making in social contexts (Harlé et al., 2010). For instance, McClure et al. (2007) found that adolescents with anxiety and depressive disorders responded more cooperatively in an iPDG to cooperative partners compared to adolescents without these disorders. In contrast, Surbey (2011) found a negative correlation between intentions to cooperate in a vignette-based PDG task and severity of participants' self-reported depression symptoms. Similarly, Clark et al. (2013) reported an association between low levels of self-reported depression and a reduced tendency to maintain mutual cooperation in an iPDG, and Pulcu et al. (2015) reported that participants with current clinical depression defected significantly more in an iPDG than either healthy controls or those with depression in remission. Taken together, previous research investigating depression and PDG play appears to favor an association between depression and non-cooperative behavior.

However, an important aspect of social behavior is the repeated nature of interactions, and expectations about another person's behavior guide future interactions. More specifically, having positive or negative social and moral perceptions of another person influences a player's willingness to make a risky decision to cooperate and trust that person (Delgado et al., 2005; van 't Wout and Sanfey, 2008). Furthermore, Chang et al. (2010) demonstrated that although this willingness to make a cooperative decision to trust someone may initially depend on implicit beliefs about reciprocity, these beliefs can be updated based on repeated interactions. However, to the best of our knowledge, no previous studies have assessed the relationship between depression and the ability to adapt to varying cooperative response patterns over the course of repeated interactions in an iPDG. We thus aimed to extend previous research by implementing an iPDG in which participants may adapt their cooperation based on experience gained when repeatedly interacting with different partners. In particular, the present study evaluated repeated decision making in individuals reporting different levels of depression severity when confronted with three partners who differed in their predetermined tendency to cooperate (or defect) in separate iPDGs. Based on prior research associating depression with biases toward negative information in learning and memory (e.g. Joormann et al., 2009; Nelson and Craighead, 1977), in addition to the literature discussed above linking depression to higher average defection in the PDG, we hypothesized that depressive symptoms would be associated with a more rapid transition to defecting as a response tendency when interacting with a partner who mostly defected, which is a negatively valenced social interaction.

We did not anticipate depression to impact decisions to cooperate when repeatedly interacting with a partner who mostly cooperated due to the strategic options available when playing the iPDG with such a partner. Namely, we expected that participants would equally recognize the benefit of mutual cooperation—resulting in the decision to cooperate—and the potential to personally gain by defecting against such

a partner—resulting in the decision to defect. We further evaluated whether there was a relationship between levels of depression and expectations about partner cooperation before participants played the games. Given the typically high comorbidity between depression and anxiety symptoms (Kessler et al., 2005), we also assessed the influence of self-reported anxiety symptoms on decision making in these iPDGs.

We further hypothesized that participants, regardless of self-reported depression levels, would alter their response patterns to reflect the general response tendency of their partners over repeated trials. For instance, participants may follow so called 'tit-for-tat-like' or 'win-stay, lose-shift-like' strategies (Nowak and Sigmund, 1993). Thus, we expected that participants would transition to the lowest level of cooperation when interacting with a partner who mostly defected, acquire the highest cooperation when interacting with a partner who mostly cooperated, and maintain intermediate cooperation when interacting with a partner who did not display a clear preference for cooperation or defection (i.e. cooperating 50% of time).

Following an approach similar to those of prior studies (Clark et al., 2013; Haley and Strickland, 1986; Surbey, 2011), we assessed self-reported severity of depression to reflect the idea that depression is a continuum rather than an all-or-nothing phenomenon. Many people will experience symptoms of depression to varying degrees throughout their lives without actually meeting clinical criteria for a depressive disorder. Although symptoms may not meet the severity of clinical threshold, behavioral changes may be noted (Judd et al., 1996). Investigating a population including individuals meeting criteria for depression as well as those with subclinical symptom levels can provide important insight into behavioral alterations through a more inclusive lens.

2. Methods

2.1. Participants

Thirty-one participants were recruited from the Providence, Rhode Island metro area by online advertisements. Exclusion criteria were current alcohol or drug dependence, history of a psychotic episode or disorder, neurological conditions (e.g. head trauma, loss of consciousness), and age above 60 years. To ensure recruitment of individuals along the range of depression/anxiety symptoms, we recruited participants with and without a history of depression/anxiety.

After signing informed consent, all participants completed the Mini International Neuropsychiatric Interview (MINI) 5.0.0 for DSM-IV (Sheehan et al., 1998) to determine the presence of depression and/or other mental health disorders. Two participants were excluded from the sample due to responding affirmatively to exclusion criteria (including, but not limited to, substance dependence and psychotic disorders), resulting in a group of 29 participants. This experiment was part of a larger research study on understanding the connections between depression and economic behaviors funded by NSF, and participants received monetary compensation based on their performance on components of the entire experimental procedure in addition to a show-up fee. The Brown University Institutional Review Board (IRB) approved all study materials and procedures, consistent with the Declaration of Helsinki.

2.2. Materials

2.2.1. Self-reported depression and anxiety

Self-reported depression levels were assessed with the Beck Depression Inventory (BDI; Beck et al., 1979). One question on suicidality, item 9, was removed due to IRB regulations. Given its high comorbidity with depression, self-reported levels of anxiety were assessed using the Beck Anxiety Inventory (BAI; Beck and Steer, 1990).

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