

Cooperation Patterns in Depression: Insights From a Meta-Analysis of Responsive and Expressive Social Interactive Paradigms Postprint

Authors: Jin, Yuening, Gu, Ruolei, Feng, Chunliang, Zhang, Churuo, I am ready to translate your academic paper. Please provide the Chinese text containing the ··paragraph wrappers, LaTeX formulas, and citation commands that you would like me to translate., Zhou, Yuan

Date: 2025-09-27T19:53:30+00:00

Abstract

The use of high-ecological validity social interactive paradigms to study social impairments in depression has burgeoned in recent 10 years. However, abnormal social behaviors in depression have exhibited substantial yet unexplained variations, ranging from reduced to increased cooperation. We proposed an attentional focus theory and introduced a novel classification of social interactive paradigms, distinguishing between responsive (attentional focus on others) and expressive (attentional focus on self) paradigms. This framework systematically elucidates the underlying reasons for reduced and increased cooperation in depression. Depression encompasses current depressive episodes, remitted depression, and subclinical depressive symptoms in undiagnosed individuals. We systematically searched Web of Science, PsycInfo, and PubMed and performed a three-level meta-analysis on 44 studies with 71 effect sizes. We found an overall significant negative association between depression and cooperation, and a significant moderation effect of the responsive versus expressive category. Depression was negatively associated with cooperation in responsive paradigms overall and in each individual responsive paradigm (Cyberball game, responder-role Ultimatum Game, Prisoner's Dilemma, and investor-role Trust Game). Depression was positively associated with cooperation in expressive paradigms overall and in the trustee-role Trust Game, and a trend of positive association in allocation tasks. In our multiple-moderator analysis, while controlling for other significant single moderators, the responsive versus expressive category remained significant, explaining 66.32% of the total variations in effect sizes. Our study completed the half-missing landscape of social dysfunctions in social interactive paradigms in depression, which may help practitioners develop different social rehabilitation strategies tailored to responsive and expressive social

scenarios.

Full Text

Preamble

Cooperation Patterns in Depression: Insights From a Meta-Analysis of Responsive and Expressive Social Interactive Paradigms

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1.1. Association of Increased Cooperation with Depression is Missing from Previous Reviews

Social dysfunction in individuals with depression encompasses multiple aspects of social capabilities and can persist after recovery from depressive symptoms (Porcelli et al., 2019; Rhebergen et al., 2010). Studies have demonstrated a robust trend toward decreased self-reported social connections and social activities among individuals with depression (Hodgetts et al., 2017; Porcelli et al., 2020; Saris et al., 2017). Real-time social interaction paradigms, including economic games and socially interactive tasks, serve as core tools for examining abnormal behavioral patterns associated with depression in laboratory settings. However, studies employing these paradigms paint a complex and heterogeneous picture, with tremendous variability observed in the relationship between depression and cooperative behaviors, ranging from reduced to increased cooperation. In these studies, depression refers to current depressive episodes, remitted depression, and subclinical depressive symptoms in undiagnosed individuals.

Depression has often been associated with decreased levels of cooperation, as indicated by lower acceptance rates among depressed individuals in the responder-role Ultimatum Game (UG) (Caculidis-Tudor et al., 2021; Carbajal et al., 2017; Fernandes et al., 2022; Jin et al., 2022; Pulcu et al., 2015; Radke et al., 2013; Scheele et al., 2013; Wang et al., 2014), reduced trust investments toward others in the trustor-role Trust Game (TG) (Friðriksson et al., 2022; Jin et al., 2023; Kubo et al., 2021; Wehebrink et al., 2018), and fewer cooperative behaviors in the Prisoner's Dilemma (PD) (Clark et al., 2013; Haley & Strickland, 1986; Surbey, 2011). However, many studies have also found that individuals with depression display increased cooperation, devoting more effort or resources to others even at their own expense, as observed in the trustee-role TG (Cáceda et al., 2014; Ong et al., 2017; Shao et al., 2015) and various resource allocation paradigms (Destoop et al., 2012; Scheele et al., 2013; Wu et al., 2020).

Despite this behavioral pattern being frequently reported in empirical studies, increased cooperation has been notably absent from recent syntheses of social dysfunction in depression over the past decade (Duggal et al., 2021; Kupferberg et al., 2016; Kupferberg & Hasler, 2023). Previous theoretical frameworks and meta-analyses have primarily focused on the withdrawal aspect of social interaction changes, demonstrating associations between depression and detachment, reduced social communication, empathy deficiencies (Kupferberg et al., 2016), negative changes in interpersonal behavior (Kupferberg & Hasler, 2023), and social withdrawal across multiple life domains (Duggal et al., 2021). The rich behavioral evidence of increased cooperation in depression, along with the conditions under which reduced versus increased cooperation occurs, has been largely overlooked. Currently recognized contributing factors to this heterogeneity—primarily sample characteristics such as age, gender, region, and treatment coverage (Alarcón & Forbes, 2017; Wang et al., 2024)—cannot fully account for when and why reduced versus increased cooperation emerges. This highlights the critical need for a new theoretical framework that addresses both withdrawal behaviors and the literature gap on increased cooperation, thereby presenting a complete landscape of social dysfunction in depression. Such a framework would facilitate the development of tailored intervention strategies for different forms of social dysfunction. Moreover, in response to calls for research using high ecological validity paradigms to study social dysfunction in depression (Billeke et al., 2013; Robson et al., 2020; Rosenström, 2013; Wang et al., 2015), a growing number of studies have been conducted in recent years, necessitating synthesis and theoretical integration to advance our understanding.

1.2. A Unified Attentional Focus Theory to Identify When Reduced Versus Increased Cooperation Occurs

We propose a unified attentional focus theory to identify the critical boundary conditions under which reduced or increased cooperation may occur in patients with depression (Fig. 1A [Figure 1: see original paper]). Traditional social cognition theories, including social cognitive theory, self-referent theory, and

theory of mind, have consistently identified the self and others as the two primary targets of attentional focus in social interactions (Bandura, 1989; Kaplan, 1986; Leslie et al., 2004). Based on this division of attentional focus, we developed a novel classification of social interaction situations according to whether attention is focused on the self or others. This classification can be applied to various common social interaction paradigms used in clinical and general populations, with different psychological processes expected to be triggered by these two foci. Specifically, shifts in attentional focus toward the self or others trigger expressive or responsive processes. The reciprocal nature of social interaction requires individuals to (1) observe how others treat them and decide how to respond, eliciting a responsive process, and (2) decide how to treat others, eliciting an expressive process (Salazar et al., 2022; van Doorn & Taborsky, 2012). Although these processes are often intertwined through reciprocal interactions, they represent distinct mental processes in terms of attentional focus targets. Responding to others requires focusing attention externally and automatically processing their behavior, whereas expressing self-attitudes requires focusing attention internally and automatically evaluating one's influence on others.

We suggest that either mental process gains salience depending on the intrinsic characteristics of social scenarios, with one notable characteristic being the presence of social defection. Humans are innately motivated to detect potential defection that hampers cooperation and resource aggregation, preparing to respond to defection to increase survival probability (Bowles & Gintis, 2004). The detection of social defection is often automatic (Bargh et al., 2012; Fehr & Gächter, 2002), shifting individuals' attentional focus toward others in the external environment. Thus, individuals primarily observe what others do and consider how to respond—an other-focused responsive process (Fig. 1B). Conversely, in the absence of others' social defection behaviors or intentions, individuals tend to direct attention toward themselves, triggering controlled thoughts concerning how much devotion should be directed at others to exert influence and secure beneficial outcomes (e.g., relationship building and resource securing). This constitutes a self-focused expressive process (Fig. 1B).

Based on the presence of social defection, we classified paradigms into responsive or expressive categories. In responsive paradigms, social defection can be presented in three ways. First, the paradigm may involve explicit expression of defection behavior by other individuals, including rejection behavior (e.g., the Cyberball Game) or offers of unfair treatment (e.g., responder-role UG), which makes participants focus on others and consider how to respond. Second, other individuals may be implicitly motivated to defect through payoff structures, meaning that either the other individual or both parties benefit more from the non-cooperation option (i.e., the non-reciprocating option for the trustee in the investor-role TG, the defecting option for both players in the PD, and the minimizing investment option for all players in the Public Goods Game and Minimum-Effort Game). Third, participants may be in a disadvantaged position due to wrongdoings or poor performance and likely to be blamed, condemned, or defected against by others (e.g., the BLAME paradigm: self-wrongdoing con-

dition and TEAM).

Expressive scenarios can be triggered in several ways: (1) the scenario does not involve responses from interactive targets (i.e., standard Dictator Game, donations, helping tasks, effort expenditure paradigms), eliminating the need to observe others; (2) other individuals are motivated to cooperate due to being morally indebted (e.g., BLAME paradigm: others' prior wrongdoings condition); (3) other individuals have equal expected gains under cooperation versus defection decisions (e.g., trustee-role TG), making them unmotivated to defect; and (4) other individuals discourage defection norms through punishment or rejection (e.g., Punishment Game and proposer-role UG). Appraising others' behavior does not gain attentional salience in safe social environments, allowing self-focused expressive processes to become more salient. Detailed categorization and rationale for each paradigm are provided in Supplementary Material S1. The key characteristics of each paradigm are listed in Table 1 .

Beck' s negative triad of depression—encompassing negative views about the self, world (including others), and future—has demonstrated profound explanatory power for social behaviors in depression (Beck & Bredemeier, 2016). Incorporating this theory, we expect different directions of change in cooperation associated with depression across these two processes. We posit that depression may be associated with withdrawal behavior and reduced cooperation when the primary concern is responding to others, whereas depression may be associated with increased cooperation when the central focus is expressing attitudes toward social interactions (Fig. 1B). The heterogeneous behavioral manifestations observed in depression may stem from the same core negative schemata about the self. Beck' s theory posits that negative automatic assumptions about the self (e.g., “I am not good,” “I am not lovable”) (Segal, 1988) are activated in social contexts, leading to distorted thoughts at immediate levels of information processing (Chahar Mahali et al., 2020). Empirical studies indicate these distortions include: (1) negative interpretation bias toward others' ambiguous facial cues, language, and attitudes, perceiving them as potential threats (Everaert et al., 2017; Hirsch et al., 2016; Nieto et al., 2020); and (2) increased need for reassurance-seeking (Joiner Jr et al., 1999), heightened fear of rejection (Ehnavall et al., 2014), and diminished self-efficacy in positively influencing others (Locke et al., 2017).

Distortions in other-focused information processing toward negative biases may heighten perceptions of external threats (Rozin & Royzman, 2001), which elicit interpersonal withdrawal (Ike et al., 2020). However, social cognition theory of human agency posits that perceived self-efficacy plays a central role in self-regulation of motivation, meaning that effort expended in expressive processes is influenced by self-efficacy (Bandura, 1989). Therefore, distortions in self-focused information processing are expected to result in increased giving or cooperative tendency as a compensatory response to perceived low self-efficacy (i.e., deficiencies in popularity, acceptance, and ability to positively influence others). As responsive processes primarily involve distortions in other-focused information

processing and expressive processes involve distortions in self-focused information processing, we hypothesized that responsive processes would lead to reduced cooperation, whereas expressive processes would result in increased cooperation among individuals with depression.

1.3. Aim of the Current Study

We conducted a meta-analysis to directly examine the moderating effect of responsive versus expressive paradigms on the relationship between depression and cooperative behavior in social interactions. Meta-analysis is widely used to address heterogeneity and divergence in previous results, enabling comprehensive assessment of consistency (Gurevitch et al., 2018; Kotov et al., 2010; Müller et al., 2018). Our primary aim was to elucidate heterogeneity in interpersonal interactions wherein depression is associated with complex behavioral patterns. We sought to determine whether the responsive versus expressive paradigm serves as the primary determinant explaining variability in cooperative behaviors associated with depression, while considering other sample characteristics (e.g., age, sex, medication, symptom severity) (Alarcón & Forbes, 2017; Wang et al., 2024) and study design factors (e.g., iterative versus single-shot) (Jin et al., 2022) identified in previous research. We extensively incorporated studies encompassing individuals currently experiencing depressive episodes, those in remission, and undiagnosed populations to test our hypotheses while accounting for sample heterogeneity. We also investigated cooperative tendencies within each responsive versus expressive interactional scenario to further test our hypotheses. Following previous meta-analyses investigating relationships between mental disorders and cognitive processes (Everaert et al., 2017; Olatunji et al., 2017), we included both categorical studies (on current and remitted patients) and correlational studies as they all address the cooperation-depression relationship. Our research questions were: (1) Can responsive versus expressive categorization of social interaction paradigms explain variance in cooperative behavior associated with depression? (2) What cooperative tendencies are associated with depression in the most frequently used responsive and expressive social interaction paradigms? (3) What is the explanatory power of the responsive versus expressive categorization compared with other sample characteristics and study design factors?

2.1. Search Strategies

We extensively searched Web of Science, PsycInfo, and PubMed using various combinations of paradigm- and depression-related keywords to identify relevant articles. To ensure comprehensive coverage of social interaction paradigms, we conducted multiple independent searches employing different variations of paradigm-related keywords. These included: (1) directly listing names of common game theory paradigms involving social interactions: (ultimatum game OR dictator game OR trust game OR prisoner's dilemma OR public goods game OR impunity game OR justice game OR stag hunt OR harmony game OR snowdrift

game OR economic game OR game theory paradigm OR chicken game) AND (depress* OR dysphor); (2) *directly listing other non-game theory paradigms involving social interactions: (cyberball OR chatroom game OR social feedback task OR cooperation task OR competition task) AND (depress OR dysphor); (3) searching for characteristics of social interaction paradigms: (real person OR immersive OR ecological validity) AND (social OR interact OR interperson) AND (depress OR dysphor); and (4) searching for the altruistic or prosocial dimensionality of social behaviors to prevent missing studies, as cooperation belongs to the broader category of prosocial or altruistic behaviors: (prosocial OR altruist) AND (social OR interact* OR interperson) AND (depress OR dysphor*)*. In addition to topic-related keywords, we searched for frequently occurring authors. The search was conducted on October 30, 2023, and updated on March 17, 2025. Each article was assessed based on the following inclusion and exclusion criteria.

2.2. Inclusion and Exclusion Criteria

The following inclusion criteria were applied to select relevant articles for this meta-analysis. First, articles must be full-text reports written in English. Second, participants must believe they are interacting with real persons, with partner behaviors attributed to real people or computer programs. Questionnaires measuring general cooperative tendencies were excluded. Third, eligible articles must have a categorical or correlational design. Categorical design articles included at least one group of participants with current depression, remitted depression, dysthymic disorder, or self-reported elevated depressive symptoms, along with at least one group of healthy individuals without psychopathology. Clinical status was assessed through clinical interviews by trained psychiatrists, with diagnostic criteria for depressive or dysthymic disorders met according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV or DSM-5) (American Psychiatric Association, 1994, 2013). Remitted depression was assessed through clinical interviews by trained psychiatrists. Elevated depressive symptoms were measured using validated questionnaires (e.g., Beck Depression Inventory-II, Patient Health Questionnaire). Correlational design articles examined the relationship between degree of cooperation in social behaviors and depression severity. Fourth, studies included adult samples aged 18 years or older, as the meta-analysis focused exclusively on adults and excluded adolescent samples due to differences in cooperative tendencies (Eisenberg et al., 2005) and differential impacts of depression on cooperation between adults and adolescents (Alarcón & Forbes, 2017). Finally, for intervention studies, social interaction paradigms were administered at baseline.

Articles were excluded if they met any of the following criteria: (1) non-empirical review articles; (2) depressive samples with principal diagnoses other than depression; (3) depressive mood induced by experimental manipulation; (4) adolescent samples below 18 years; (5) articles reporting only subjective feeling ratings without observable social behavior measures; (6) social behavior measures

not aligned with the cooperation-defection dimension; and (7) non-independent samples that performed the same experiment as other eligible studies.

2.3. Article Selection

Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Fig. 2 [Figure 2: see original paper]), 7,235 records were identified from databases using keywords through March 17, 2025. After removing duplicates, 5,027 records remained. ASReview (version 1.2) (<https://asreview.nl/>) facilitated screening based on topic relevance of titles and abstracts. ASReview is an AI-aided, open-source tool for systematic reviews that uses state-of-the-art active learning techniques to accelerate screening of large numbers of records. The project begins with a human reviewer manually labeling 20-30 records as relevant or irrelevant; based on this information, ASReview ranks the relevance of remaining records and presents them sequentially to human reviewers for labeling according to topic relevance.

A total of 4,843 irrelevant records were removed during title and abstract screening, yielding 184 relevant records. YJ and CZ conducted independent title and abstract screening, achieving an inter-rater reliability of .980. Inconsistencies were discussed and resolved. All 184 full-text records were accessed, and YJ and CZ independently reviewed them against inclusion and exclusion criteria, achieving an inter-rater reliability of .944. After resolving inconsistencies, 51 studies were deemed eligible. Of these, 8 articles lacked sufficient detail to calculate effect sizes and variances, leaving 43 articles.

Additionally, 589 records were identified from frequently occurring authors in the 43 eligible articles (see Supplementary Material S2 for search results). Based on titles and abstracts, nine relevant articles were identified using ASReview, which ranked topic relevance. Full-text review of these nine articles against inclusion criteria identified one additional eligible article, resulting in 44 eligible articles total.

2.4. Data Coding System

YJ and CZ independently coded author information, publication year, sample information, task information, and article quality, and independently calculated effect sizes. Results were compared and inconsistencies resolved. Article quality was assessed using a checklist developed by Everaert et al. (2017), specifically tailored for clinical studies and adapted from Downs and Black's checklist (1998). The checklist evaluates clarity of study objectives, measurement of primary outcomes, clarity of sample characteristics, sample representativeness, sample homogeneity, clarity of task descriptions, measurement reliability and validity, participant engagement, control of confounders, appropriateness of statistics, clarity of main findings, random variability estimates, probability value reporting, data dredging, and power sufficiency. Quality ratings ranged from 0 to 18. Sample characteristics documented included sample size for each participant

group, mean age, proportion of female participants, depression status (current, remitted, or undiagnosed), depression severity (mild, moderate, or severe), and medication status (medicated or non-medicated). Depression severity was categorized based on cutoff scores from respective depression scales. Paradigm information recorded included original paradigm name, paradigm category (responsive or expressive), whether it was one-shot or iterative, and move order (first, second, or simultaneous moves).

Paradigms were classified into responsive and expressive categories based on the following criteria. Responsive paradigms involve potential defection in partners' behaviors—either explicit or implicit—that shifts participants' attention toward their partners. Potential defection can be presented as: (1) explicit defection behavior, including rejection by others (e.g., Cyberball Game) or unfair treatment in offers (e.g., responder-role UG); (2) implicit motivation to defect through payoff structures where other individuals or both parties benefit more from non-cooperation options (i.e., non-reciprocation for trustees in investor-role TG, defection in PD, minimizing investment in PG and Minimum-Effort Game); or (3) participants in disadvantaged positions due to prior wrongdoings or poor performance who are likely to be blamed or defected against (e.g., BLAME paradigm: self-wrongdoing condition and TEAM).

Conversely, expressive paradigms involve absence of potential social defection, making participants focus more on expressing their own cooperative attitudes and influencing others. These include: (1) scenarios without responses from interactive targets (e.g., standard DG, donations, helping tasks, effort expenditure paradigms); (2) others motivated to cooperate due to moral debt (e.g., BLAME paradigm: others' prior wrongdoings condition); (3) others having equal benefits for cooperation versus defection (e.g., trustee-role TG), making them unmotivated to defect; and (4) others discouraging defection through punishment or rejection (e.g., Punishment Game and proposer-role UG).

We aggregated proposer-role UG, DG (including standard DG and Punishment Game), and various donation paradigms (costly and non-costly) under allocation paradigms, as they involve similar resource allocation processes and trigger expressive processes. Detailed categorization justifications for each paradigm (responder-role UG, proposer-role UG, DG, investor-role TG, PD, Minimum-Effort Game, PG, TEAM, BLAME, trustee-role TG, helping task, effort expenditure task, donation, and Cyberball Game) are provided in Supplementary Material S1.

Uniform indicators of cooperative behavior were coded for each paradigm. For responder-role UG, the indicator was average acceptance rate; for investor-role TG, average investment rate; for PD, average collaboration rate; for Minimum-Effort Game, effort amount contributing to collective outcomes; for Cyberball Game, ball-tossing rate to the excluder; for PG and TEAM, average contribution rate to the group and teaming rate with a partner, respectively; for BLAME, apology rate (self-wrongdoing condition) and verbal attack rate on friends (other-wrongdoing condition); for trustee-role TG, average return rate;

for allocation paradigms, average proportion of offers to others; for effort expenditure and helping tasks, effort amount benefiting others and average assistance rate, respectively. Articles not reporting necessary indicators were not coded to avoid definitional confounding (e.g., Mukherjee et al., 2020 did not report average acceptance rate in responder-role UG).

2.5. Meta-Analytic Procedures

Meta-analyses were conducted using the metafor package in R, version 1.4.1106 (Viechtbauer, 2010). We used Hedges' s g , suitable for small-sample studies, as the effect size measure (Hedges & Olkin, 1985). A positive Hedges' s g indicated higher cooperation in individuals with current or remitted depression compared to healthy controls (categorical studies) or among individuals with higher depression levels (correlational studies), and vice versa. Convertible statistics (e.g., chi-square with sample size; mean with standard deviation; F , t , and p values) were transformed into Hedges' s g with variance using Comprehensive Meta-analysis V3.3.070 software. Effect sizes with standardized residuals larger than 3 in absolute magnitude may be considered outliers (Wang et al., 2022). No observations exceeded this threshold, so no outliers were identified.

Estimating overall effect size: A three-level random-effects model with restricted maximum likelihood estimation was adopted (Assink & Wibbelink, 2016) to account for interdependence of multiple effect sizes from the same sample undergoing different experiments within a study, and occasionally from different studies treated as having the same study ID (i.e., Jin et al., 2022; Jin et al., 2023; Gradin et al., 2015; Gradin et al., 2016). The three-level analysis simultaneously estimated between-subjects variance at Level 1, within-study variance at Level 2, and between-study variance at Level 3, accounting for the hierarchical data structure and providing comprehensive overall effect size estimation.

To assess model fit, the full model (M1) was compared with simpler models: one not estimating Level-2 within-study variance (M2) and one not estimating Level-3 between-study variance (M3). One-sided log-likelihood-ratio tests determined significance of within- and between-study variance components by comparing M1 to M2 and M3. Distribution of total variance across three levels was calculated (Cheung, 2014), allowing examination of variance proportions attributed to each level.

Heterogeneity analysis: Within the optimal model, heterogeneity analysis was conducted using Cochran' s Q -test to evaluate heterogeneity extent across studies regarding the depression-cooperation association. Heterogeneity magnitude was indicated by I^2 , with levels evaluated as: <25% low, 25%-50% moderate, and >50% high heterogeneity (Borenstein, 2009). High heterogeneity across all studies prompted selection of a random-effects model for subsequent moderator analyses, which accounted for between-study variability and explored potential moderators explaining effect size heterogeneity.

Single-moderator analysis: Single-moderator analysis investigated potential moderating effects of hypothesis-relevant and hypothesis-irrelevant factors on effect sizes. Paradigm category (responsive vs. expressive) was included as a moderator, with I^2 calculated for each category to assess within-category heterogeneity. Original paradigms were also specified as moderators. Additional single-moderator analyses examined hypothesis-irrelevant factors including demographic information (mean age, sex composition, country), clinical information (depression severity, medication, depression status), task information (one-shot vs. iterative, move order, real-person vs. computer-programmed, mutual vs. single-directional), and study information (categorical vs. correlational).

Multiple-moderator analysis: Random-effects meta-regression examined relative contributions of responsive versus expressive social interactions and other peripheral task characteristics (i.e., one-shot vs. iterative, move order) in explaining variance in effect sizes. This analysis simultaneously specified these factors as moderators, allowing them to compete in explaining variability. Our aim was to test the hypothesis that task nature (responsive vs. expressive) would centrally account for group differences in cooperation. Contributions of responsive versus expressive categories were compared with other significant hypothesis-irrelevant moderators from single-moderator analysis, with significant moderators included to avoid collinearity. Variance inflation factor was calculated to detect potential multicollinearity.

Publication bias analysis: Potential publication bias was examined across all studies and within responsive and expressive paradigms through multiple approaches. First, funnel plots displaying Hedges' g and standard error for each article were visually inspected for asymmetry, indicating potential bias. Second, the trim-and-fill method (Duval & Tweedie, 2004) corrected effect sizes and confidence intervals by accounting for missing studies implied by funnel plot asymmetry. Finally, Egger' s test directly assessed funnel plot asymmetry significance, quantitatively evaluating publication bias.

Supplementary analysis: As depression scores of undiagnosed individuals in correlational studies were all below moderate depression, a sub-analysis using only categorical studies was conducted to examine replicability of primary results (i.e., decreased cooperation in responsive paradigms and increased cooperation in expressive paradigms).

3.1. Sample Characteristics

The meta-analysis included 44 studies comprising 36 categorical and 8 correlational studies. Categorical studies involved 1,454 current and remitted patients ($n = 35.40$, 67.65% female). Correlational studies included 726 undiagnosed individuals ($n = 26.17$, 60.42% female). Studies were conducted across multiple countries: Australia ($n = 1$), Belgium ($n = 1$), China ($n = 9$), Germany ($n = 6$), Hungary ($n = 1$), Iceland ($n = 1$), Japan ($n = 2$), Portugal ($n = 1$), Romania ($n = 2$), Switzerland ($n = 1$), United Kingdom ($n = 6$), Uruguay ($n = 1$).

= 1), and United States ($n = 12$). Approximately 30 studies (68.18%) were published in the last 10 years (2015-2025).

Among 71 effect sizes examined, the most frequent behavioral tasks were: responder-role UG (19 effect sizes, 26.76%), trustor-role TG (7, 9.86%), PD (10, 14.08%), Cyberball Game (4, 5.63%), trustee-role TG (7, 9.86%), and allocation paradigms (15, 21.13%). Article quality ratings ranged from 10 to 16, with an average score of 13.18, indicating acceptable quality. Individual study ratings are presented in Supplementary Material S3. Sample characteristics are listed in Table 2 .

3.2. Overall Effects of Depression on Cooperation

One-sided log-likelihood-ratio tests comparing the full model with reduced models yielded significant within-study variance (M1-M2: $LRT = 14.41$, $p < .001$) and non-significant between-study variance (M1-M3: $LRT = 0.00$, $p = 1.00$). Variance decomposition revealed that sampling variance at Level 1, within-study variance at Level 2, and between-study variance at Level 3 accounted for 44.13%, 55.87%, and 0.00% of total variance, respectively. Thus, M3 was selected for subsequent analysis, including only sampling variance (Level 1) and within-study variance (Level 2) while excluding between-study variance (Level 3).

The selected model yielded a significant overall effect size ($k = 71$; Hedges' $s_g = -.095$, $SE = .048$, 95% $CI = [-.188, -.001]$, $z = -1.99$, $p = .047$), indicating a significant negative effect of depression on cooperation (Fig. 3 [Figure 3: see original paper]). Overall heterogeneity was substantial ($Q(70) = 157.05$, $p < .001$; $I^2 = 55.43\%$), suggesting potential moderators underlying observed variations in cooperative behavior.

3.3. Moderator Analysis

Single-moderator analysis: We investigated contributions of single potential moderators to effect size variance, including hypothesis-relevant and hypothesis-irrelevant factors. For hypothesis-relevant moderators, the responsive versus expressive paradigm showed significant moderating effect ($Q(1) = 28.88$, $p < .001$), as did original paradigm type ($Q(12) = 55.06$, $p < .001$).

Regarding responsive versus expressive paradigms, depression negatively affected cooperation in responsive paradigms ($k = 45$; Hedges' $s_g = -.255$, $SE = .049$, 95% $CI = [-.350, -.160]$, $z = -5.25$, $p < .001$). Conversely, in expressive paradigms, depression positively affected cooperation ($k = 26$; Hedges' $s_g = .164$, $SE = .061$, 95% $CI = [.044, .283]$, $z = 2.69$, $p = .007$). These findings support our hypothesis that paradigm type influences depression's effect on cooperation. I^2 was 7.71% for responsive paradigms and 60.59% for expressive paradigms, indicating that classification successfully reduced heterogeneity in responsive paradigms while substantial heterogeneity remained in expressive paradigms.

For paradigm types, average effect sizes were computed only for paradigms with $k \geq 4$. Depression showed significant or marginally significant negative effects on cooperation in Cyberball Game ($k = 4$; Hedges' $s g = -.446$, $SE = .151$, 95% $CI = [-.741, -.150]$, $z = -2.95$, $p = .003$), PD ($k = 10$; Hedges' $s g = -.251$, $SE = .106$, 95% $CI = [-.458, -.043]$, $z = -2.37$, $p = .018$), investor-role TG ($k = 7$; Hedges' $s g = -.201$, $SE = .111$, 95% $CI = [-.417, .016]$, $z = -1.81$, $p = .070$), and responder-role UG ($k = 19$; Hedges' $s g = -.166$, $SE = .072$, 95% $CI = [-.308, -.024]$, $z = -2.30$, $p = .022$). Conversely, depression showed marginally significant positive effects on cooperation in allocation tasks ($k = 15$; Hedges' $s g = .142$, $SE = .080$, 95% $CI = [-.015, .298]$, $z = 1.78$, $p = .076$) and significantly positive effects in trustee-role TG ($k = 6$; Hedges' $s g = .275$, $SE = .125$, 95% $CI = [.031, .520]$, $z = 2.21$, $p = .027$).

Moderating effects of hypothesis-irrelevant moderators are shown in Table 3. Among these, age and move order showed significant effects. Age was associated with more positive effects of depression on cooperation. Mean effect sizes differed significantly between simultaneous and first-move conditions, with depression negatively related to cooperation in simultaneous-move conditions. Several simple effects were identified: higher cooperation among individuals with moderate depression severity in simultaneous-move, iterative, real-person interaction, and mutual interaction paradigms. No other moderating effects were significant.

Multiple-moderator analysis: The responsive versus expressive paradigm remained significant when controlling for other significant moderators from single-moderator analysis (Table 4). The explained variance in the responsive or expressive paradigm was 66.32%. All variables had variance inflation factor values < 2 , indicating no multicollinearity issues.

3.4. Publication Bias Analysis

Visual inspection of the funnel plot (Fig. 4A [Figure 4: see original paper]) and Egger' s test investigated potential publication bias across all studies. The trim-and-fill method suggested no significant asymmetry (Kendall' s tau = $-.009$, $p = .913$), and Egger' s test indicated no significant funnel plot asymmetry ($z = -.44$, $p = .658$), suggesting no significant publication bias.

Within responsive paradigms, trim-and-fill suggested no asymmetry (Kendall' s tau = $.045$, $p = .667$), and Egger' s test indicated no significant asymmetry ($z = .57$, $p = .567$). Within expressive paradigms, trim-and-fill indicated no asymmetry (Kendall' s tau = $.049$, $p = .724$), and Egger' s test observed no significant asymmetry ($z = -.44$, $p = .660$). Funnel plots for responsive and expressive paradigms are shown in Figs. 4B and 4C, respectively.

3.5. Supplementary Analysis

A sub-analysis of categorical studies exclusively (excluding 14 effect sizes from correlational studies) yielded 57 effect sizes. The responsive versus expressive paradigm showed significant moderating effect ($Q(1) = 25.08, p < .001$). Depression negatively affected cooperation in responsive paradigms ($k = 34$; Hedges' $g = -.258, SE = .058, 95\% CI = [-.371, -.145], z = -5.25, p < .001$) and positively affected cooperation in expressive paradigms ($k = 23$; Hedges' $g = .192, SE = .069, 95\% CI = [.057, .326], z = 2.79, p = .005$), replicating results from combined categorical and correlational studies.

4. Discussion

This three-level meta-analysis identified plausible explanatory factors contributing to heterogeneity in reduced and increased cooperation associated with depression during social interactions. Depression in these studies refers to current depressive episodes, remitted depression, and subclinical depressive symptoms in undiagnosed individuals. Consistent with our hypothesis, the responsive versus expressive paradigm significantly moderated the depression-cooperation relationship. Specifically, depression was generally negatively related to cooperative behaviors in responsive paradigms and positively related to cooperation in expressive paradigms. The responsive versus expressive category was a non-negligible explanatory factor whose moderating effect remained significant even after controlling for other task and sample characteristics. Furthermore, depression was negatively related to cooperation in each responsive paradigm (Cyberball Game, PD, investor-role TG, responder-role UG) and showed either positive relationships (trustee-role TG) or trends toward positive relationships (allocation tasks) in each expressive paradigm with at least four effect sizes. This aligns with the overall trend across multiple responsive or expressive paradigms and provides further support for our hypothesis.

Our findings support attentional focus theory as a plausible explanatory factor for heterogeneity in the depression-cooperation relationship, surpassing the influence of peripheral demographic and task characteristics. In line with this theory, cooperation levels decreased overall and within specific social interactions where appraising potential defection from others' behavior and considering responses gained salience. Heterogeneity in cooperation patterns of depression in these situations was low ($I^2 = 7.71\%$), suggesting relatively uniform cooperation patterns. These situations included Cyberball Game, PD, investor-role TG, and responder-role UG, which involved partners whose behavior implied social defection risk. In Cyberball Game, the excluder's refusal to toss the ball clearly represented social defection; in TG, the trustee's potential non-reciprocity implied defection by maximizing their own gain at the investor's expense; and in UG, the allocator's predominantly unfair splits constituted social defection. In each situation, attentional resources must monitor partners' non-cooperation-prone behavior, requiring individuals to safeguard their own interests. Focusing attention on others elicits a responsive process where individuals automatically

monitor how to respond. Depressive schemata in responsive situations lead to distorted other-focused information processing, primarily involving negative interpretation bias and pessimistic inferences about others' attitudes (Gara et al., 1993), resulting in lower cooperation.

Conversely, depression was associated with or marginally associated with increased cooperation overall and within specific social interactions primarily involving expression of cooperative tendencies. These paradigms included allocation tasks, trustee-role TG, and other tasks. In donations, standard DG, and helping tasks, partners were not expected to respond, eliminating the need to perceive partners' attitudes. In proposer-role UG and Punishment Game, partners discouraged defection through punishment or rejection. In trustee-role TG, partners as investors were not motivated toward defection (with equal expected payoff for high versus low investment options), minimizing attention to others. Focusing attention on the self elicits an expressive process where individuals are more concerned with expressing their own attitudes. Depressive schemata in expressive situations lead to distorted self-focused information processing, primarily involving increased reassurance-seeking (Starr, 2015), heightened fear of rejection (Liu et al., 2014), and diminished self-efficacy in positively influencing others (Segrin, 2000). Social cognitive theory of human agency posits that increased cooperation is a compensatory response to low self-efficacy (Bandura, 1989). However, heterogeneity in cooperation patterns in expressive paradigms was high ($\eta^2 = 60.59\%$), possibly due to limited effect sizes in the expressive category (26) and heterogeneity within expressive paradigms. Specifically, expressive paradigms differ in mutual versus single-directional interactions and presence or absence of punishment, which might influence cooperative motivation differently.

The responsive versus expressive categorization could predict cooperation direction changes in depression and potentially explain cooperation changes related to other mental disorders and personality traits in the general population. Within this framework, social defection in responsive situations might elicit higher stress-related perceptions and inflammatory hyperactivity among individuals with anxiety disorders or those high in trait anxiety (Won & Kim, 2020), neuroticism (Schmidt et al., 2018), or avoidance-goal orientation (Whinghter et al., 2008), resulting in more social avoidance and less cooperation. Conversely, absence of social defection in expressive situations might induce higher cooperation among individuals with approach-goal orientation due to coherence between the expressive situation nature and approaching goals. Previous meta-analyses observed substantial heterogeneity in relationships between personality traits and cooperative behavior (Thielmann et al., 2020); the responsive versus expressive category may provide alternative explanations beyond recognized situational affordances (exploitation, reciprocity, temporal conflict, dependence under uncertainty).

We found additional meaningful moderators. Consistent with Wang et al. (2024), age moderated the depression-cooperation relationship, with older age associ-

ated with more positive effects of depression on cooperation. Previous research found positive correlations between age and altruism (Sparrow et al., 2021), cooperative behavior in various economic games (Matsumoto et al., 2016), and empathy (Bailey et al., 2020). The increasing trend of cooperative motivation with age may reduce depression's negative effects on cooperation. Additionally, significant depression-cooperation relationships existed in simultaneous-move conditions. Inspection revealed all 11 effect sizes in simultaneous-move conditions belonged to the responsive category, while 19 of 27 effect sizes in first-move conditions belonged to the expressive category. Thus, simultaneous-move conditions reflected responsive processes, and significant differences between simultaneous and first-move conditions may reflect responsive versus expressive category differences. Furthermore, lower cooperation was observed for individuals with moderate depression severity (20 of 27 effect sizes in responsive category) and in iterative (23 of 28 in responsive), real-person (10 of 11 in responsive), and mutual interaction paradigms (43 of 52 in responsive), likely due to overlap with the responsive category. Depression's association with lower cooperation in iterative, real-person, and mutual interactions could be explained by alternative theories. First, social signal transduction theory suggests depression relates to hyperactivation of inflammatory immune system components in response to social adversities (Slavich & Irwin, 2014); thus, immersive social interactions elevate potential inflammation and harm avoidance behavior (Eisenberger et al., 2017). Second, depression relates to negatively biased views of interpersonal feedback present in iterative, real-person, and mutual paradigms, which may result in social withdrawal (Weeks et al., 2009).

Our study revealed a generally negative relationship between depression and cooperation across all paradigms, possibly due to more effect sizes for responsive (45) than expressive paradigms (26). This reflects the prevalence of responsive paradigm studies investigating abnormal social functioning in depression, contributing to the prevailing consensus regarding social withdrawal behaviors. Reviews have predominantly focused on withdrawal behaviors occurring primarily in responsive scenarios with potential defection, such as social exclusion, responses to unfairness, and negative expression detection (Kupferberg et al., 2016; Kupferberg & Hasler, 2023). The opposite direction—increased cooperation in depression—has been largely overlooked. Only Wang et al.'s (2024) recent meta-analysis identified increased cooperation in cooperation paradigms. While theories such as social risk hypothesis, interpersonal theory of depression, and social signal transduction theory have associated social dysfunction with abnormal coping to social adversities (Kupferberg & Hasler, 2023), theories explaining altered behavioral tendencies in scenarios without potential adversities are lacking. We propose equal emphasis on both responsive and expressive scenarios in future research to provide comprehensive understanding of social behavior in depression.

Excluding correlational studies in supplementary analysis, the paradigm category showed significant moderating effects in categorical studies. Depression negatively affected cooperation in responsive paradigms and positively affected

cooperation in expressive paradigms, replicating results across categorical and correlational studies. These findings indicate observed effects apply across populations with varying depression severity, from minimal to severe.

Classifying social interaction situations into responsive or expressive categories has practical implications. By categorizing broader social contexts based on key situational characteristics, we can predict cooperation direction changes associated with depression. This approach has practical value for practitioners involved in social rehabilitation of individuals with depression. Social rehabilitation should include both responsive and expressive situations, establishing diverse virtual social interactive situations with and without social defects for patients to practice social skills. Therapists could focus on adjusting different negative schemata (other- and self-related) and coaching different social skills (coping strategies for social defection and reducing reassurance-seeking behaviors) in responsive versus expressive situations.

This study had limitations. First, while we observed cooperation pattern differences consistent with attentional focus theory, included studies do not provide direct empirical evidence regarding attentional mechanisms. Future research should directly test this explanation and juxtapose alternative explanations. For instance, social withdrawal with defection risk and increased cooperation without defection risk might reflect higher conformity to task expectations in depression (Katkin et al., 1966). Second, we could not assess moderating effects of certain sample characteristics (e.g., education years, anxiety symptoms, suicide attempts) due to limited data. Third, our meta-analysis focused specifically on abnormal cooperative behaviors in real-time social interactions; future studies should investigate subjective cooperative inclinations by examining self-reported attitudes, as cooperation involves both behaviors and subjective willingness. Fourth, our findings suggested significance of responsive versus expressive processes without directly testing causal relationships; future studies should manipulate the significance of these processes to formally investigate causality. Fifth, lacking cognitive function assessments in most studies prevented analysis of associations between cognitive function and cooperation. Among eligible studies, 10 reported no between-group cognitive differences, and 1 reported significant impairments. Future research should assess how cognitive dysfunction potentially elicits attentional allocation alterations and subsequent cooperative behavior changes. Sixth, including correlational studies with undiagnosed individuals whose average depressive symptoms were below moderate depression could affect effect size estimations. Although supplementary analyses replicated primary findings, future meta-analyses should more rigorously focus on clinical samples as this field grows.

5. Conclusion

This study proposed attentional focus theory and a new classification of social interaction paradigms (responsive vs. expressive) to systematically account for when and why reduced versus increased cooperation occurs. Through meta-

analysis of 44 studies with 71 effect sizes, we found depression negatively related to cooperation in responsive paradigms and positively related in expressive paradigms. Depression was negatively related to cooperation in each responsive paradigm (Cyberball Game, responder-role UG, PD, investor-role TG) and positively related (trustee-role TG) or trended toward positive relationships (allocation tasks) in each expressive paradigm with $d = .04$ effect sizes. After controlling for other significant moderators, the responsive versus expressive category emerged as a significant moderator, explaining 66.32% of total variance. Our study completed the half-missing landscape of social dysfunction in expressive social scenarios in depression, providing valuable insights for practitioners to develop distinct social rehabilitation strategies for responsive and expressive situations.

Acknowledgements

We thank Associate Professor Yan Mu, Professor Shenghua Luan, and Professor Xun Liu from the Institute of Psychology, Chinese Academy of Sciences, and Professor Jian Li from Peking University for valuable suggestions.

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Funding Sources

This work was supported by the STI2030-Major Projects (2021ZD0200600) and the National Natural Science Foundation of China (Nos. 81771473, 82171535, and 72033006).

Data Availability

Data will be made available upon reasonable request from the corresponding author. Codes are publicly available at <https://doi.org/10.57760/sciencedb.psych.00567>

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Figure Captions

Fig. 1. Attentional focus theory. (A) Two mental processes in reciprocal interactions: the other-focused responsive process and self-focused expressive process. (B) Attentional focus on others or the self influences the salience of the two mental processes. The dominance of the two mental processes, driven by negative cognitive schemata, implies different depression-cooperation relationships.

Fig. 2. PRISMA flow chart for the study selection process (as of March 17, 2025).

Fig. 3. Effect sizes in the depression-cooperation relationships across all studies.

Fig. 4. Funnel plot for the depression-cooperation relationship (A) in all studies, (B) within responsive paradigms, and (C) within expressive paradigms. Abbreviations: Allocation: Allocation Tasks; Cyberball: Cyberball Game; PD: Prisoner's Dilemma; TGI: Trust Game (Investor-role); TGT: Trust Game (Trustee-role); UGR: Ultimatum Game (Responder-role).

Note: Figure translations are in progress. See original paper for figures.

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