Journal of Psychiatric Research 176 (2024) 293–303

Contents lists available at ScienceDirect

Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/jpsychires

Social decision-making in major depressive disorder: A three-level meta-analysis☆

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ARTICLE INFO

Keywords:
Major depressive disorder
Social decision-making
Trust
Cooperation
Altruistic punishment

ABSTRACT

Major Depressive Disorder (MDD) is frequently associated with social dysfunction and impaired decision-making, but its impact on social decisions remains unclear. Thus, we conducted a series of meta-analyses to examine the effects of MDD on key social decision phenomena, including trust, altruistic punishment, and cooperation. We searched Web of Science, PubMed, PsycINFO, and Embase up to December 2023, using Hedges' g to compare social decision-making between MDD patients and healthy controls (HCs). Meta-analytic results showed that MDD patients exhibited a significant reduction in trust (Hedges' $g = -0.347$, $p < 0.001$), no significant difference in altruistic punishment (Hedges' $g = 0.232$, $p = 0.149$), and an increase in cooperative behaviors (Hedges' $g = 0.361$, $p = 0.002$) compared to HCs. The moderation analysis revealed that age ($p = 0.039$) and region ($p = 0.007$) significantly moderated altruistic punishment, with older MDD patients and those from Asian and European regions having larger MDD-HC contrast than others. Regarding cooperation, moderation analysis indicated that age ($p = 0.028$), years of education ($p = 0.054$), and treatment coverage ($p = 0.042$) were significant moderators, indicating larger MDD-HC contrast in older, less-educated and better-treated people. These findings suggest MDD has different impacts on different social decisions, highlighting the need for fine-tuned therapeutic interventions that address these differences. The data also underscores the importance of considering demographic and treatment-related variables in managing MDD, which could inform personalized treatment strategies and improve social functionality and patient outcomes.

1. Introduction

Major Depressive Disorder (MDD) is one of the most prevalent mental health challenges globally (Citrome et al., 2019; Vos et al., 2015), not only severely impacting the emotional and cognitive functions (Maleki et al., 2020; Teo et al., 2013) but also influencing their social interactions and decision-making abilities (Kupferberg et al., 2016; Rhebergen et al., 2010). Understanding the characteristics of social behavior in MDD patients, particularly how they build trust relationships, handle injustice, and cooperate with others, is crucial for the comprehensive treatment and support of this population.

1.1. Trust, altruistic punishment, and cooperation

Decision-making in social contexts is crucial for human development and survival, significantly affecting our daily lives (Killick et al., 2023; Larrick, 2016). Questions like "Should I trust him?", "Should I cooperate with him?", and "How should I respond to injustice?" frequently arise in our daily lives. These issues involve trust, altruistic punishment, and cooperation, which support the functioning of a wide range of relationships, including dyads (Alarcon et al., 2018; Andersen & Kumar, 2006), groups (Fehr et al., 2002), and societies at large (Nowak, 2006). Trust, defined as the belief in others' benevolent intentions (Balliet and Van Lange, 2013), is essential for the emergence and sustainability of cooperative behaviors, as it reduces the perceived risks of exploitation in collaborative interactions (Yamagishi and Yamagishi, 1994). Altruistic punishment, wherein individuals voluntarily bear costs without direct return, to uphold social norms and collective interests (Emanuele et al., 2008), can facilitate cooperation across larger groups where personal acquaintance is limited (Fehr and Gächter, 2002). Cooperative behavior involves behavior aimed at achieving common goals, regardless of individual consequences (Rand and Nowak, 2013).

☆ There are no interests or activities for myself or my coauthors that might be seen as influencing the research.

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https://doi.org/10.1016/j.jpsychires.2024.06.026
Received 21 February 2024; Received in revised form 14 June 2024; Accepted 17 June 2024
Available online 18 June 2024

The interplay between these elements is dynamic: high trust reduces the need for altruistic punishment, as it presumes cooperation, while in low-trust environments, altruistic punishment can rebuild trust by penalizing defectors (Gintis et al., 2003). These dynamics are key to understanding the mechanisms that support social cohesion and the evolution of cooperation (Rand and Nowak, 2013). In other words, trust facilitates cooperation, while altruistic punishment ensures its stability. In turn, effective cooperation boosts trust and norm compliance within the community. These dynamic interactions reveal that trust, altruistic punishment, and cooperation are essential for understanding social decision-making and group dynamics.

1.2. Trust and MDD

Trust is commonly defined as a belief about other's benevolent intentions during a social interaction, and is essential to initiate, establish, and maintain social relationships (Balliet and Van Lange, 2013). It is a key concept in understanding multiple levels of social phenomena (Campbell et al., 2010). Recent meta-analyses have explored the relationship between trust and mental disorders, revealing that patients with psychosis exhibit fewer trust-related behaviors compared to healthy controls (Prasannakumar et al., 2023).

The Trust Game (TG) is widely used to investigate individuals' ability to trust and trustworthiness (Berg et al., 1995). The TG involves two roles: the investor and the trustee. Initially, the investor must decide the amount of money to invest with the trustee. Once invested, this amount is multiplied by a certain factor, after which the trustee has the option to return any portion of the multiplied sum to the investor. Generally, the amount invested by the investor is utilized as a metric to measure trust behaviors (Berg et al., 1995). Jin et al. (2023) found that patients with MDD typically made fewer investments than HCs (healthy controls). Numerous studies have observed a tendency for MDD patients to display slightly reduced trust levels than HCs (Kubo et al., 2021; Wehebrink et al., 2018). However, other studies have reported no significant difference in trust behaviors between MDD patients and HCs (Preuss et al., 2016; Unoka et al., 2009). Additionally, Mellick et al. (2019) have shown that adolescent girls reporting depressive symptoms but not meeting the criteria for MDD invested more in the Trust Game than HCs. These mixed findings might partially be attributed to insufficient statistical power due to the small sample size.

1.3. Altruistic punishment and MDD

The human sense of fairness has a substantial impact on decision-making and permeates many aspects of social interaction (Frith and Singer, 2008; Zheng et al., 2017). Unfair behavior frequently results in sanctions. The punishment of social norm violations is always altruistic (Fehr and Gächter, 2002), occurs universally across human societies (Henrich et al., 2006; Oosterbeek et al., 2004), may stem from an evolutionary strategy that promotes cooperation (Brosnan and de Waal, 2014; Ule et al., 2009). To date, there is no meta-analysis to quantify the influence of MDD on such punishment.

The Ultimatum Game (UG) is a well-established paradigm to study behavioral responses to fair and unfair social situations (Guth et al., 1982). The UG involves two roles: the proposer and the responder. The proposer is tasked with making an offer, while the responder has the option to either accept or reject it. Acceptance implements the proposal, while rejection leaves nothing for both players. Studies in healthy populations have indicated that individuals tend to reject low offers to punish unfair behaviors (Bolton and Zwick, 1995; Koenigs and Tranel, 2007; Oosterbeek et al., 2004). Refusing "free money" is costly and is termed "altruistic punishment" (Emanuele et al., 2008). Serotonin depletion in healthy volunteers leads to an increased tendency to punish others who violate social norms (Crockett et al., 2008, 2013), suggesting a possible alteration in altruistic punishment behaviors in MDD patients, as serotonin reduction is a fundamental characteristic of MDD (Surtees et al., 2006). However, current findings regarding the relationship between MDD and altruistic punishment behaviors exhibit inconsistency. Some studies report increased altruistic punishment behaviors in MDD patients (e.g., Wang et al., 2014), while others observe a decrease (e.g., Harlé et al., 2010). Additionally, some studies found no significant difference in altruistic punishment between MDD patients and HCs (e.g., Destoop et al., 2012).

1.4. Cooperation and MDD

Cooperation refers to behavior aimed at achieving common goals, regardless of individual consequences (Rand and Nowak, 2013), and is a crucial aspect of social decision-making. Many game paradigms, such as the Prisoner's Dilemma (PD), Ultimatum Game, and Trust Game, have been used to assess the preferences of cooperation under different conditions (van Dijk and De Dreu, 2021).

Currently, the magnitude and direction of the link between MDD and cooperation remain inconclusive. Several studies have shown that individuals in remission from MDD tend to exhibit a higher propensity for cooperation compared to HCs in both the PD and TG (Ong et al., 2017; Pulcu et al., 2015). While Pulcu et al. (2015) found no significant differences in cooperation between HCs and currently depressed MDD patients in the PD, notable disparities were observed in other paradigms, such as the UG (e.g., Destoop et al., 2012). Several studies focusing on individuals exhibiting depressive symptoms without fulfilling MDD criteria reveal a negative correlation between depressive symptoms and cooperative behavior in PD (Clark et al., 2013; Surbey, 2011). However, Sorgi and Van 't Wout (2016) reported that greater depression severity correlates with steadier and more continuous cooperation in trials with a cooperating partner, while the severity of depression does not affect cooperation with a defecting partner in the PD.

1.5. Interim summary

To sum up, the findings regarding the relationship between MDD and social decision-making are inconclusive, possibly due to the limited statistical power with small sample sizes or the potential influence of moderating variables. For these reasons, this current meta-analysis aims to clarify the associations between MDD and social decision-making. Given that MDD is frequently associated with impaired social functioning, we propose the following hypotheses: MDD impairs social decision-making, leading to MDD patients exhibiting reduced trust, lower levels of altruistic punishment, and decreased cooperative behaviors compared to HCs.

2. Methods

2.1. Registration

This meta-analysis has been preregistered on PROSPERO (CRD42024496609).

2.2. Search strategies

We conducted a comprehensive literature search without date restrictions through the Web of Science, PubMed, PsycINFO, and Embase using a combination of three categories of search terms: (a) depression-related terms; (b) terms related to social decision-making; and (c) terms related to behavioral tasks (see Supplementary Table 1). To ensure comprehensiveness and accuracy in our searches, we customized specific controlled vocabularies for each database. (see Supplementary Search strategy for details). Additionally, the bibliographies of existing reviews and meta-analyses on relevant topics were manually reviewed. To ensure comprehensive coverage of the literature, we conducted multiple searches. The most recent search was performed in December 2023.

2.3. Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) Studies with groups diagnosed with MDD as the primary diagnosis; (2) Inclusion of at least one behavioral task, namely the Ultimatum Game, Trust Game , Dictator Game (DG), Prisoner's Dilemma; (3) Inclusion of healthy control groups without psychopathology; (4) Behavioral data should be available for at least one of the target dependent variables: trust, altruistic punishment, and cooperation; (5) Employing case-control or cross-sectional designs; (6) Diagnosis based on validated criteria, specifically the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Classification of Diseases (ICD); (7) Publication in English-language, peer-reviewed empirical journals. The exclusion criteria were as follows: (1) Patients group included bipolar disorders, schizophrenia, major psychosis, dementia, or neurologic diseases (including head injury); (2) Samples overlapping with other included data sets.

The initial screening of articles was independently conducted by two reviewers, Peng (Author 3) and Yin (Author 4). Following this, any disagreements or discrepancies were resolved through a consensus meeting with another reviewer, Wang (Author 1). This process was repeated during the full-text review. We have shown the selection process in a PRISMA flow diagram (Fig. 1).

2.4. Quality assessment

The Newcastle-Ottawa Scale (NOS) for case-control studies was employed to assess the quality of the included articles. The NOS comprises eight items categorized into three dimensions: selection, comparability, and exposure. Each item is associated with multiple response options. A star system enables a semi-quantitative assessment of study quality, where each item can receive up to one star, except for the comparability item, which can receive up to two stars. The NOS scoring ranges from zero to nine stars. For the current meta-analysis, the quality of the articles was independently assessed by two reviewers: Wang (Author 1) and Peng (Author 3). Any discrepancies were resolved through consensus between these two authors. The assessment revealed that all studies scored six stars or above, indicating high research quality (see Supplementary Table 2 for details).

2.5. Variable conceptualization

This study investigates examines three key outcome variables: trust, altruistic punishment, and cooperation. Trust behavior is evaluated by the investor's transfers in the TG. Altruistic punishment is measured by the respondent's acceptance rate in the UG. Cooperation is quantified through the proposer's offers in the UG and DG, the trustee's back-transfers in the TG, and the tendency to cooperate in the PD. The conceptualization of cooperation is based on previous studies (Gunschera et al., 2022; van Dijk and De Dreu, 2021).

2.6. Data extraction

The following data were independently extracted by two authors: (1) Article characteristics. Namely first author, and publication year; (2) Sample characteristics, which were extracted in a two-step process. Initially, common information for both MDD and HCs was extracted, including sample size, age, gender ratio, education years, country, and task score. Subsequently, specific information for MDD was extracted, including diagnostic criteria, depression scale, and treatment coverage; (3) Task characteristics, which varied across different outcome variables, leading to the extraction of specific task-related information (see Supplementary Table 5 for detailed information). Any inter-rater discrepancies were discussed and resolved by consensus.

2.7. Statistical analysis

All statistical analyses were conducted with *Metafor* package in the R environment. To avoid overestimation of the effect size related to small sample sizes, effect sizes were calculated as standardized mean differences (Hedge's) between patients with MDD and HCs on measures for social decision-making on an online website (https://www.campbellcollaboration.org/research-resources/effect-size-calculator.html). A positive effect size indicated elevated social functioning (e.g., willingness to cooperate) by MDD patients, whereas negative values indicated the opposite performance. The effect sizes were calculated based on means and standard deviations or standard errors when possible; occasionally, *F*, *t*, or *p* values were used with sample size to estimate the effect size. When these types of statistics were not reported, we contacted the author requesting the raw data of the behavioral tasks.

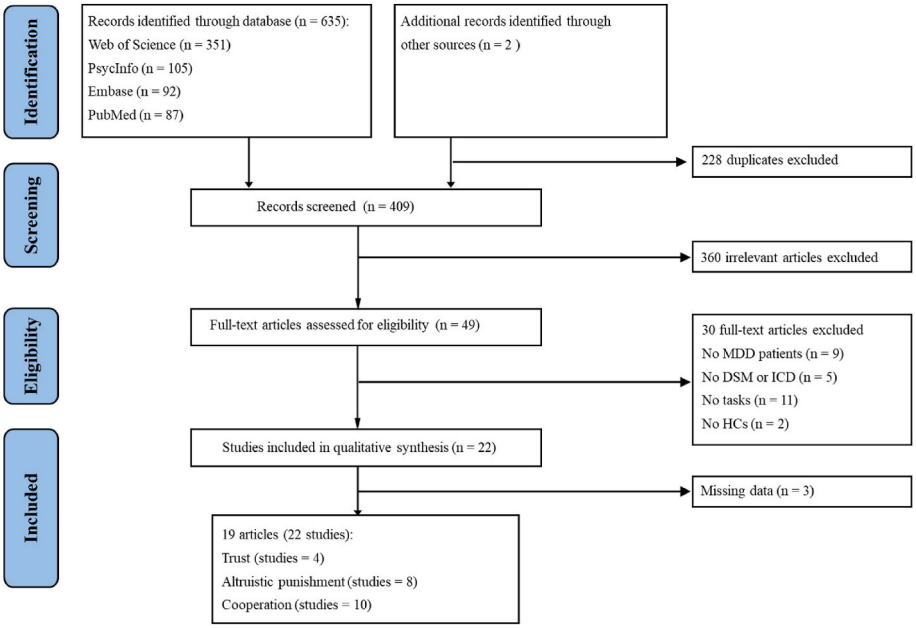

Fig. 1. PRISMA flow diagram depicting the search strategy and selection of studies.

However, if the request was not successful or sufficient information could not be extracted from the given graphs, we had to exclude those studies from the meta-analysis.

Multiple effect sizes were reported in several studies due to the administration of various behavioral tasks or the investigation of different groups, leading to dependency between effect sizes. Ignoring this dependency may bias the results. To account for this dependency, a three-level random-effects model with restricted maximum likelihood was adopted. This model considered the dependence among effect sizes, enhancing information accuracy and increasing statistical power (Cheung, 2014). In this study, the model examined three distinct sources of variance: sampling variance of effect sizes (level 1), variance among effect sizes within a study (level 2), and variance across different studies (level 3).

2.8. Heterogeneity analysis

Heterogeneity in effect sizes was assessed using Cochran's Q test and the I^2 statistic. These measures estimate the proportion of variation in observed effects attributable to true heterogeneity across studies rather than random error. Cochran's Q test serves to detect the presence of heterogeneity in meta-analyses (Cochran, 1954), whereas the I^2 statistic quantifies its extent (Higgins and Thompson, 2002). A significant result in Cochran's Q test indicates heterogeneity. An I^2 value of 0% suggests no observed heterogeneity, with higher values indicating greater heterogeneity. Typically, I^2 values of 25%, 50%, and 75% represent low, moderate, and high heterogeneity respectively, and I^2 score <25% was considered acceptable (Higgins et al., 2003).

2.9. Moderation analysis

Given the heterogeneity between effect sizes, we conducted moderation analysis for sample and task characteristics. Additionally, to avoid multicollinearity issues arising from interrelated moderators, we conducted a multiple-moderator analysis including all significant moderators.

Sample characteristics. (a) Demographic Variables. Due to demographic variables between MDD patients and HCs being matched in most studies, the demographics of MDD patients in this article were used as moderators, including average age, gender ratio, years of education, and region (0 = Asian, 1 = America, 2 = Europe). (b) Depression Symptoms. Moderators included depression severity and treatment Coverage. Due to variations in depression scales, we standardized depression scale scores (see Supplementary Table 3).

Task characteristics. (a) Cooperation: Moderators comprised task type (0 = UG, 1 = DG, 2 = TG, 3 = PD). (b) Altruistic Punishment. Moderators included stake size (conversion of various currencies to chinses yuan).

2.10. Publication bias

Publication bias assessment utilized funnel plots and Egger's test. Funnel plots visualize the absence of small studies with insignificant effect sizes, while Egger's test quantitatively assesses funnel plot asymmetry (Egger et al., 1997). When publication bias is absent, funnel plots exhibit symmetry, and Egger's test yields a non-significant value.

3. Results

The system search identified a total of 637 articles, of which 635 were retrieved from databases, and the other two (i.e., Agay et al., 2008; Mukherjee et al., 2020) were obtained through manual searches of existing reviews and meta-analyses. After removing 228 duplicate articles, 409 articles were retained. Following primary and secondary screening, 22 articles were selected for qualitative analysis. After excluding three articles due to incomplete data (i.e., Preuss et al., 2016; Szanto et al., 2014; Zhang et al., 2019), 19 articles were used for quantitative analysis. Among them, 4 articles discuss trust (i.e., Jin et al., 2023; Kubo et al., 2021; Unoka et al., 2009; Wehebrink et al., 2018), 8 discuss altruistic punishment (i.e., Destoop et al., 2012; Gradin et al., 2015; Harlé et al., 2010; Jin et al., 2022; Pulcu et al., 2015; Radke et al., 2013; Scheele et al., 2013; Wang et al., 2014), and 10 discuss cooperation (i.e., Cáceda et al., 2014; Destoop et al., 2012; Gradin et al., 2016; Mukherjee et al., 2020; Ong et al., 2017; Pulcu et al., 2015; Scheele et al., 2013; Shao et al., 2015; Wu et al., 2020; Zhang et al., 2012).

3.1. Trust

Thirteen effect sizes from four eligible articles were included to compare trust behaviors between MDD patients ($N = 173$; $M_{age} = 31.70$; 56.65% female) and HCs ($N = 155$; $M_{age} = 31.61$; 52.26% female). Regarding the depression scales used, three articles used the Hamilton Depression Rating Scale (HDRS), and one article used Symptom Checklist 90 (SCL-90). Data collection for the included studies was conducted in Asia (n = 2) and Europe (n = 2). Refer to Table 1 for more detailed information.

The pooled effect size was Hedge's $g = -0.347$ (95% *CI*: [−0.509, −0.185]; $p < 00.001$), suggesting that MDD patients exhibit less trust behaviors compared to HCs (see Fig. 2). Overall heterogeneity was nonsignificant, $Q_E(12) = 5.916$, $p = 0.920$, and $I^2 = 0\%$, indicating no necessity to explore potential moderators.

3.2. altruistic punishment

Fourteen effect sizes from eight eligible studies were included to compare altruistic punishment behaviors between MDD patients (N = 255; Mage = 33.62; 65.88% female) and HCs (N = 212; Mage = 31.94; 45.88% female). The majority of the included studies used the Beck Depression Inventory (BDI) and HDRS, accounting for 87.5% (n = 7). Data collection for the included studies was conducted in Asia (n = 2), America (n = 2), and Europe (n = 4). For more detailed information, refer to Table 2.

The overall effect size was nonsignificant, with Hedge's $g = 0.232$ (95% CI: [−0.095, 0.559], $p = 0.149$) (refer to Fig. 3). Overall heterogeneity was classified as moderate to high, with $Q_E(13) = 24.635$, $p = 0.026$, and $I^2 = 63.97\%$. Notably, $I^2_{\text{Level 3}}$ contributed 63.97% and $I^2_{\text{Level 1}}$ contributed 36.03% to the total variation.

Regarding sampling characteristics, both moderator age ($\beta = 0.035$; $Q_E(12) = 18.919$, $p = 0.090$; $F(1,12) = 5.354$, $p = 0.039$) and region ($Q_E(11) = 8.625$, $p = 0.656$; $F(2,11) = 8.005$, $p = 0.007$) showed significant effects. Other sample characteristics, including gender ratio, years of education, treatment coverage, and depression severity, did not exhibit significant moderating effects. As for the task characteristic, the stake size was found to be nonsignificant. A follow-up comparison was conducted based on the moderator region. Significant effect sizes were observed in Asian ($k = 4$; Hedge's $g = 0.427$, 95% CI [0.175, 0.679]; $t = 3.734$; $p = 0.003$), America ($k = 2$; Hedge's $g = -0.526$, 95% CI [−1.001, −0.052]; $t = -2.444$; $p = 0.033$), and European ($k = 8$; Hedge's $g = 0.338$, 95% CI [0.120, 0.557]; $t = 3.406$; $p = 0.006$). The effect size in American studies was significantly smaller compared to those in Asian and European studies, with no significant differences observed between Asia and Europe (See Supplementary Table 6 for details).

The multiple-moderators analysis, which included significant moderators, yielded a notable result, $F(3, 10) = 6.386$, $p = 0.011$, indicating that at least one regression coefficient of the moderators significantly differed from zero. Specifically, the region (Asia vs. America) was identified as exerting unique moderating effects on the relationship between MDD and Altruistic Punishment (refer to Table 3).

3.3. Cooperation

Sixteen effect sizes from ten eligible articles were included to

Table 1
Sample characteristics of the included studies for trust behavior.

Source	Country	Depression Scale	Task	N (MDD)	N (HCs)	N (Female)		Mean age	
						MDD	HCs	MDD	HCs
Trust									
Jin et al. (2023)	China	HDRS; PHQ-9	TG	68	52	43	28	27.88	26.10
Kubo et al. (2021)	Japan	HDRS; BDI-II	TG	38	38	16	16	30.33	30.50
Unoka et al. (2009)	Hungary	SCL-90	TG	25	25	20	20	29.30	30.10
Wehebrink et al. (2018)	Netherlands	HDRS	TG	42	40	19	17	39.28	39.73

Abbreviations: BDI, BDI: Beck Depression Inventory; BDI–II, Beck Depression Inventory-II; MADRS, Montgomery–Asberg Depression Rating Scale; IDS, Inventory of Depressive Symptomatology; PHQ, Patient Health Questionnaire.

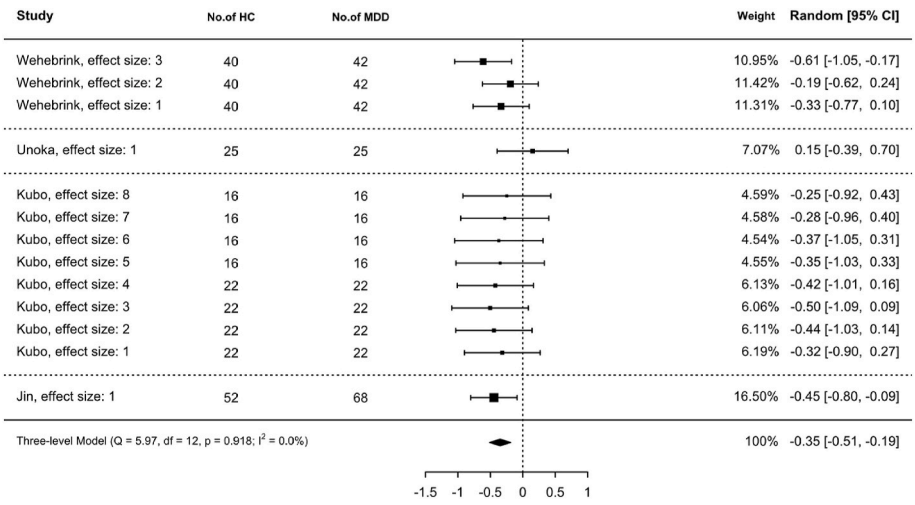

Fig. 2. Differences in trust behaviors between MDD patients and HCs.

Table 2
Sample characteristics of the included studies for altruistic punishment.

Source	Country	Depression Scale	Task	N (MDD)	N (HCs)	N (Female)		Mean age	
						MDD	HCs	MDD	HCs
Altruistic Punishment									
Destoop et al. (2012)	Belgium	HDRS; BDI-II	UG	39	22	26	11	39.46	34.68
Gradin et al. (2015)	Uruguay	HDRS; BDI-II	UG	25	25	17	17	25.48	25.44
Harlé et al. (2010)	USA	BDI-II	UG	15	23	12	12	19.00	19.00
Jin et al. (2022)	China	HDRS	UG	68	55	43	29	27.88	26.04
Pulcu et al. (2015)	UK	MADRS	UG	59	33	37	20	38.25	38.03
Radke et al. (2013)	Netherlands	BDI-II	UG	15	15	9	6	38.50	38.30
Scheele et al. (2013)	Germany	HDRS; BDI-II	UG	20	20	16	12	47.75	41.10
Wang et al. (2014)	China	HDRS	UG	14	19	8	10	32.60	32.9

compare the cooperative behaviors between MDD patients (N = 360; M_{age} = 40.16; 71.94% female) and HCs (N = 325; M_{age} = 39.43; 67.38% female). Among the included studies, 5 studies used the UG, 2 used the DG, 3 used the TG, and 2 used the PD (see Table 4 for details). The most included studies used the Beck Depression Inventory (BDI) and HDRS, accounting for 80% (n = 8). Data for the included studies was collected in Asia (n = 3), America (n = 4), and Europe (n = 3). For more detailed information, refer to Table 4.

The pooled effect size based on the three-level meta-analytic model was Hedge's g = 0.361 (95% CI [0.152, 0.570]; p = 0.002), indicating that MDD patients exhibit a greater willingness to cooperate compared to HCs (see Fig. 4). Overall heterogeneity was statistically significant, Q_E (15) = 30.013, p = 0.012, and I^2 = 50.54%, suggesting a necessity to explore potential moderators. The distribution of variance at the sampling, within-study and between-study levels were 49.46%, 42.42%, and 8.12%, respectively.

For sample characteristics, the moderation analysis revealed that age (β = 0.021; Q_E (14) = 21.402, p = 0.092; F (1,14) = 5.986, p = 0.028), and treatment coverage (β = 0.551; Q_E (13) = 22.228, p = 0.052; F (1,13) = 5.088, p = 0.042) demonstrated significance, while education year showed marginal significance (β = −0.061; Q_E (12) = 18.231, p = 0.109; F (1,12) = 4.540, p = 0.054). None of the other sample characteristics or task characteristics had significant moderating effects (see Supplementary Table 6).

Multiple-moderators analysis, including both significant and marginally significant moderators, produced a nonsignificant result, F (3,9) = 2.053 p = 0.177.

3.4. Publication bias

The contour-enhanced funnel plot and Egger's regression test were employed to test publication bias for each dependent variable. The funnel plot is illustrated in Fig. 5. The results of Egger's regression test revealed no significant asymmetry in the funnel plot for the variables Trust (z = 0.475, p = 0.635), Altruistic Punishment (z = 0.256, p = 0.798), and Cooperation (z = 1.245, p = 0.213), suggesting a lack of

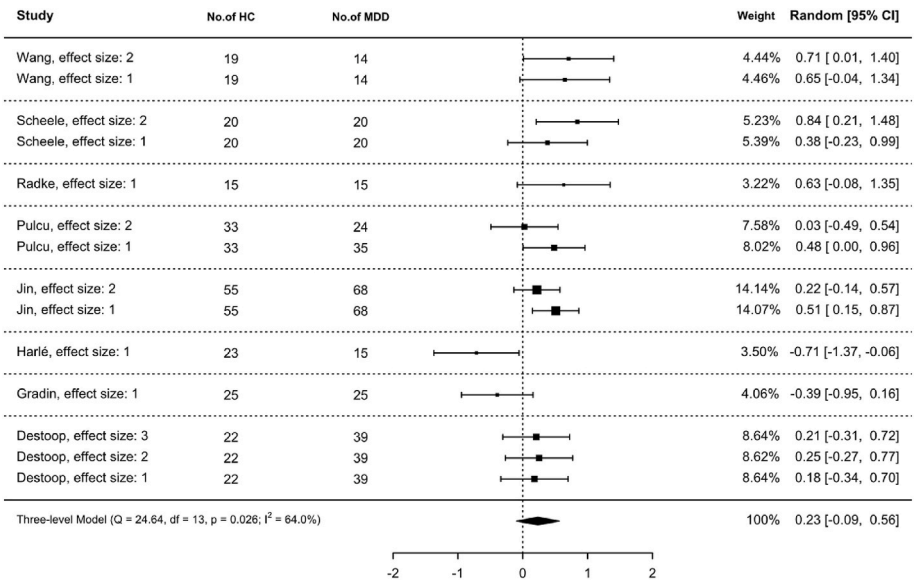

Fig. 3. Differences in altruistic punishment between MDD patients and HCs.

Table 3
Moderation analysis: Results from the multiple-moderator model.

Moderators	β (SE)	95% CI	t	p
Intercept	0.701 (0.192)	[0.273, 1.129]	3.646	0.004
Age	0.042 (0.024)	[-0.011, 0.096]	1.772	0.107
Region				
Asian vs. America	−0.700 (0.284)	[-1.332, −0.067]	−2.465	0.033
Asian vs. Europe	−0.590 (0.320)	[-1.304, 0.124]	−1.840	0.096

significant publication bias in these findings.

4. Discussion

This meta-analysis aims to investigate the impact of MDD on social decision-making. By three-level meta-analysis, we quantified differences in social decision-making—specifically, trust, altruistic punishment, and cooperative behaviors—between patients with MDD and HCs. The results indicated that compared to healthy controls, MDD patients demonstrated distinct social behaviors across several dimensions. Specifically, there was a noticeable reduction in trust behaviors. However, no significant differences were found in altruistic punishment. In contrast, an increase in cooperative behaviors was observed. Moderation analysis revealed that age and region significantly moderated the impacts of MDD on altruistic punishment, while age, years of education, and treatment coverage influenced the effects on cooperative behaviors associated with MDD. In the following sections, we will discuss these findings in more detail.

4.1. Trust

MDD patients exhibited significantly reduced trust behavior than HCs in the Trust Game, aligning with previous findings on the trust levels of MDD patients assessed via questionnaires (Flasinski et al., 2020; Yao et al., 2022). MDD patients are commonly associated with repeated negative thinking, low self-esteem, and a pessimistic outlook toward the future (Carneiro et al., 2023; Korn et al., 2014), which may lead to reduced trust toward others in interpersonal interactions. Additionally, this reduced trust might be caused by a suspicion of others' motives, as MDD patients have a negative other-schema (Yao et al., 2022). Meta-analysis has revealed consistent activations in the anterior insula during the trust stage of the Trust Game (Bellucci et al., 2017). Furthermore, alteration of structure and function of the anterior insula has been extensively observed (He et al., 2022; Schnellbaecher et al., 2022; Sliz and Hayley, 2012), suggesting a potential role in the neuropathology of MDD episodes (Pang et al., 2018).

This discovery can enable doctors and psychologists to better comprehend and address the challenges that patients with MDD encounter in interpersonal relationships and social interactions, facilitating the implementation of more effective interventions.

4.2. Altruistic punishment

No statistically significant differences were observed in the impact of

Table 4
Sample characteristics of the included studies for cooperation.

Source	Country	Depression Scale	Task	N (MDD)	N (HCs)	N (Female)		Mean age	
						MDD	HCs	MDD	HCs
Cooperation									
Cáceda et al. (2014)	USA	BDI-II	TG	56	33	36	16	31.85	37.6
Destoop et al. (2012)	Belgium	HDRS; BDI-II	UG	39	22	26	11	39.46	34.68
Gradin et al. (2016)	Uruguay	HDRS; BDI-II; MADRS	PD	25	25	17	17	25.48	25.44
Mukherjee et al. (2020)	USA	BDI-II	UG	64	64	37	31	40.45	38.53
Ong et al. (2017)	USA	IDS-C	TG	30	27	22	17	27.9	28.4
Pulcu et al. (2015)	UK	MADRS	PD; DG	24	33	14	20	38.25	38.03
Scheele et al. (2013)	Germany	HDRS; BDI-II	UG	20	20	16	12	47.75	41.10
Shao et al. (2015)	China	BDI-II	TG	18	16	18	16	39.97	41.00
Wu et al. (2020)	China	HDRS	DG	34	36	23	30	65.00	65.83
Zhang et al. (2012)	China	BDI-II	TG	50	49	50	49	45.50	43.74

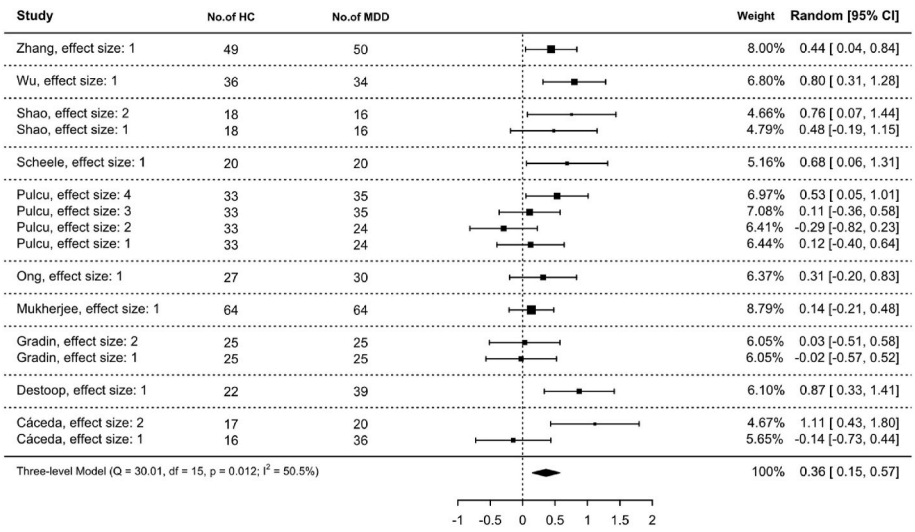

Fig. 4. Differences in cooperative behavior between MDD patients and HCs.

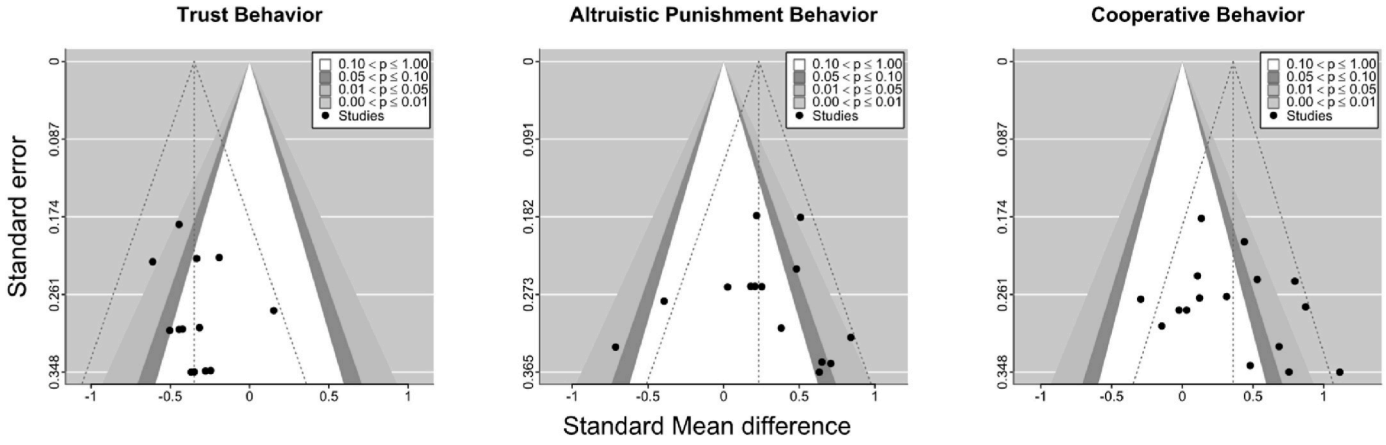

Fig. 5. Contour-enhanced funnel plot for each dependent variable.

MDD on altruistic punishment, which could be attributed to heterogeneity. The research findings revealed that the heterogeneity in altruistic punishment was classified as moderate to high, indicated by an I^2 value of 63.97%. Approximately two-thirds of this heterogeneity stems from variance among different studies, while over one-third originates from sampling variance. Although no significant overall effect was found, the presence of significant heterogeneity necessitates moderation analysis.

Moderation analysis revealed that age and region significantly influenced the overall effects. Regarding age, MDD patients more frequently reject unfair offers as age increases. This finding aligns with previous studies conducted on healthy populations (Harlé and Sanfey, 2012). Compared to healthy young adults, older individuals more frequently reject unfair offers in ultimatum games (Harlé and Sanfey, 2012), and demonstrate higher levels of pro-social behavior (Harlé and Sanfey, 2012; Kettner and Waichman, 2016; Sutter and Kocher, 2007). This inclination may stem from older individuals' stronger focus on social norms of fairness to uphold the stricter norm of equitable sharing (Harlé and Sanfey, 2012; Roalf et al., 2012). Regarding region, MDD patients in Asia and Europe tend to reject unfair offers more frequently, while those in the Americas more frequently accept unfair offers. Several factors could account for this observed discrepancy. Firstly, from the perspective of cultural differences, societies in Asia and Europe may emphasize collectivism and a sense of social responsibility more strongly (Hofstede, 2016; Lacko et al., 2020; Shavitt et al., 2011; Wang and Liu, 2010). This could lead to individuals with MDD in these regions exhibiting higher levels of altruistic punishment to meet social expectations (Jin and Kang, 2010; Kim and Nam, 1998; Wei and Jung, 2017). However, cultures in the Americas typically emphasize individualism, focusing on personal achievements and self-actualization (Hofstede, 2016; Shavitt et al., 2011). Consequently, this cultural orientation may lead to MDD patients being less engaged in altruistic punishment activities that require the sacrifice of personal interests. Research by Jiao and Zhao (2023) demonstrates that participants exhibit more altruistic allocation behavior and are more tolerant of unfair allocation behavior after being primed by the collectivistic (vs. individualistic) texts. Moreover, individuals from South America and the United States West exhibit lower rejection rates in the Ultimatum Game task compared to individuals elsewhere, such as in Asia (Oosterbeek et al., 2004). Age differences may also account for the observed discrepancy, as the studies from the Americas included in this paper had the youngest average age among all examined.

These findings indicate that the impact of MDD on altruistic punishment behavior may be influenced by factors such as culture. This insight enables the provision of more precise and customized support and interventions for MDD patients across diverse cultural and economic backgrounds.

4.3. Cooperation

This meta-analysis revealed that individuals with MDD displayed

more cooperative behavior compared to the HCs, a finding that challenges the commonly held belief of social dysfunction in MDD patients (Fombonne et al., 2001; Knight and Baune, 2019; Saris et al., 2020). Traditionally, MDD has been associated with negative social outcomes, such as social withdrawal and a decline in social skills (Jia et al., 2024; Porcelli et al., 2019; Teo et al., 2020). Our research findings suggest that in specific social contexts, MDD patients may demonstrate increased cooperative behaviors. This phenomenon is likely linked to the sense of guilt that MDD patients experience. O'Connor and colleagues proposed a "pathological hyper-altruism hypothesis" based on elevated levels of altruistic forms of guilt in MDD patients relative to HCs and predicting that patients will make altruistic decisions more frequently (O' Connor et al., 2012; O'Connor et al., 2007; O'Connor et al., 2000). Additionally, this behavior could be connected to the specific psychological needs of MDD patients. Engaging in cooperative behaviors may help these individuals seek social support and positive interactions, potentially alleviating emotional distress and social isolation (Leary and Jongman-Sereno, 2014; Wang et al., 2018; Wickramaratne et al., 2022). Furthermore, this behavior may also be linked to the negative inferential style characteristic of MDD patients, who often hold negative schemas about others (Yao et al., 2022, 2023). For example, in the UG, MDD patients think the recipients are greedy and will demand a higher allocation ratio, otherwise, they will reject the offer. To accommodate the greed of the other party and protect themselves from harm, MDD patients have to increase their cooperation.

Moderation analysis unveiled the significance of age and treatment coverage, with education year demonstrating marginal significance. Age could influence the cooperative behaviors of MDD patients, with increased age possibly leading to a greater focus on social norms, especially equitable sharing (Beadle et al., 2012; Harlé and Sanfey, 2012; Roalf et al., 2012). Treatment coverage could influence the social and cooperative actions of MDD patients. Effective therapy not only enhances cognitive functions (Pan et al., 2017), aiding patients in better comprehending and adhering to social norms but might also elevate their cooperation in social interactions. Moreover, support and positive feedback in treatment can boost patients' self-efficacy and social identity, thereby further facilitating cooperative behaviors (Milanovic et al., 2018; Wang et al., 2022). The education year might influence the effect of MDD on social decision-making. Higher educational levels might lead to elevated professional and social expectations, placing additional psychological stress on patients (Al-Rouq et al., 2022). Such pressures may lead them to be more conservative and hesitant in social and cooperative contexts, feeling that they fall short of expectations, thereby intensifying anxiety and stress, and impacting their social decisions and actions (Wu et al., 2013).

This finding is crucial for enhancing treatment strategies for MDD. For instance, clinical interventions could more effectively leverage group activities or collaborative team tasks to help patients forge and sustain social connections, thereby improving their overall well-being.

4.4. Trust, altruistic punishment, and cooperation

This study reveals an intriguing finding: MDD patients displayed reduced trust behaviors (measured by investor's transfers in the TG) but increased cooperative behaviors (quantified through proposer's offers in the UG and DG, trustee's back-transfers in the TG, and the tendency to cooperate in the PD) compared to HCs. Typically, trust and cooperative behaviors are positively correlated, as evidenced by previous research (Acedo-Carmona and Gomila, 2014; Balliet and Van Lange, 2013; Ferrin et al., 2008). However, the results of this meta-analysis indicate that MDD patients deviate from this typical correlation, underscoring the complex nature of MDD and its impact on social decision-making. We hypothesize that the social decision-making performance of MDD patients may be linked to their methods of inferring others' intentions. MDD patients frequently hold a negative other-schema (Yao et al., 2022, 2023), potentially leading to their pessimistic inferences about others' intentions. Regarding trust behavior, MDD patients' tendency to make pessimistic inferences about others' intentions leads them to exaggerate investment risks and reduce investments in the TG, thereby showing a decreased trust towards others. Concerning cooperative behaviors, MDD patients might view the other party as greedy and believe that not fulfilling their expectations could result in retaliation, thereby causing themselves harm. In the UG, MDD patients think the recipients are greedy and will demand a higher allocation ratio, otherwise, they will reject the offer. Similarly, in the TG, MDD patients also believe that investors expect a higher back-transfer, otherwise, they would reduce or even cease future investments. To accommodate the greed of the other party and protect themselves from harm, MDD patients have to increase their cooperation. It should be noted that the TG often consists of multiple trials (e.g., Cáceda et al., 2014; Ong et al., 2017; Shao et al., 2015; Zhang et al., 2012). Although some studies specify that each trial involves different investors (e.g., Zhang et al., 2012), participants often overlook this detail as the experiment progresses. We did not observe increased cooperative behavior in MDD patients in the DG, possibly because this task does not involve inferring others' intentions (van Dijk and De Dreu, 2021). In the PD, no significant differences in cooperative tendencies were found between MDD patients and HCs (see Supplementary Table 6 for details). As an overall integration of the cooperativeness of the allocator in UG, the returner in TG, the allocator in DG, and the player in PD, the cooperativeness in this meta-analysis was increased by MDD. Comprehensibly, this result contrasts sharply with the result that MDD decreased trust, as measured by the trustiness of the allocator in TG. This situation also reminds researchers of the following: When talking about MDD's effects on social psychological concepts like trust or cooperation, researchers should bear in mind how these concepts are operatively defined or measured.

Trust, altruistic punishment, and cooperation are fundamental components of social interactions and form the basis of individual social decision-making. The expression of these behaviors among MDD patients may be influenced by difficulties in emotional regulation, cognitive biases, and changes in social cognitive functions (Evans et al., 2014; Quigley et al., 2022; Visted et al., 2018). MDD patients often exhibit negative other-schema (Yao et al., 2022), which may be associated with dysfunctions in the brain's reward system (Ng et al., 2019; Yang et al., 2022; Zhang et al., 2013). Additionally, their trust in others may be diminished due to feelings of insecurity or fear of rejection. This diminished trust not only affects an individual's interpersonal relationships but also their willingness to engage in cooperation and perform altruistic punishment. Altruistic punishment, viewed as a social behavior that upholds fairness and justice (Emanuele et al., 2008), requires an individual's endorsement of and support for collective norms. If trust is diminished in patients with MDD, skepticism towards others' intentions and actions may influence their decisions regarding altruistic punishment. However, as previously discussed, even in cultures with eroded trust, altruistic punishment may still be reinforced to emphasize social norms and collective values, as noted by Gächter and Herrmann (2009). Despite reduced trust, patients with MDD may still exhibit increased cooperative behaviors in specific social context, which can be attributed to factors such as guilt, psychological needs, and pessimistic interpretations of others' intentions. Cooperation may provide a mechanism through which, even in the presence of impaired trust, MDD patients can experience positive social interactions through shared goals and a sense of team accomplishment. Moreover, cooperation might also be used as a strategy to rebuild trust by enhancing social connections (Spagnolo, 1999).

4.5. Limitations and future direction

The present study has several limitations. Due to limited data availability in the original samples, our ability to assess the influence of potential moderators on group differences was restricted. For example, the included literature rarely reported suicidal ideation or behavior

among MDD patients. Furthermore, we were unable to establish causal relationships between social decision-making and MDD. Future studies could focus on the social decision-making characteristics of adolescents and children with MDD, as well as whether there are differences in social decision-making among MDD patients in South America and the southern United States compared to other regions, such as Asia. Additionally, the moderating role of gender on the impact of MDD on trusting behavior warrants further exploration, as previous meta-analyses have indicated gender differences in trust behavior in the healthy population.

5. Conclusion

Through a three-level meta-analysis including 22 studies, we found that MDD patients displayed reduced trust behavior while demonstrating increased cooperative behavior when compared to HCs. Furthermore, the impact of MDD on altruistic punishment varied across different regions. These findings answered whether and how social decision-making in MDD patients changes relative to HCs, providing possible practical significance for clinical management and psychoeducation in depression based on social decision-making.

Data availability

The data and the analysis scripts used for this article can be accessed at the OSF page: https://osf.io/4ebwk/?view_only=5e9a930a82cc41f3a2a290e0d380318a.

Funding

Ministry of Education of China - Humanities and Social Sciences Foundation (23YJA190001); Foundational Research Funds for Central Universities (SWU1609115).

CRediT authorship contribution statement

Tao Wang: Writing – original draft, Software, Methodology, Investigation, Data curation, Conceptualization. **Jianmin Zeng:** Writing – review & editing, Resources, Conceptualization. **Peiru Peng:** Investigation, Data curation. **Qiao Yin:** Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2024.06.026.

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