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## TITLE PAGE

### **Risky decision-making in suicide attempters, and the choice of a violent suicidal means: an updated meta-analysis**

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## **INTRODUCTION**

With more than 800,000 deaths each year in the world and 10 to 20 times more non-lethal acts of self-harm, suicidal behaviors remain a major public health concern worldwide (<https://www.who.int/news-room/fact-sheets/detail/suicide>). Improvement in the understanding of the mechanisms leading to suicidal acts is needed to elaborate more efficient prevention measures. For years, this research has mainly focused on the clinical, psychiatric and psychological correlates of suicidal behavior on one side, and their sociological determinants on the other side. Identified risk factors have shown very limited predictive abilities (Franklin et al., 2017).

Over the last twenty years, a growing number of studies have investigated the neurocognitive characteristics of individuals who attempted suicide using neuropsychological batteries and neuroimaging (Dombrovski et al., 2013; Jollant et al., 2011, 2005; Keilp et al., 2001). More recently, meta-analyses and reviews have confirmed various cognitive deficits in those who attempted suicide in comparison to patients who never attempted suicide but suffered from similar mental disorders and to healthy subjects, notably more risky decision-making, reduced cognitive control/executive functions, and deficient memory (Bredemeier and Miller, 2015; Gifuni et al., 2020; Richard-Devantoy et al., 2015, 2014), among others.

The study of decision-making has particularly provided promising results. Since the seminal article in 2005 (Jollant et al., 2005), several groups aimed at replicating the original observation of impaired and riskier decision-making in suicide attempters. A first meta-analysis in 2014 confirmed this association with a moderate effect size when comparing patients with and without a personal history of suicide attempt (Richard-Devantoy et al., 2014). The same study also showed a lack of significant difference between patient and healthy controls suggesting that risky decision-making was more related to the history of suicidal behavior than to comorbid disorders. However, these findings relied on 9 studies

only. Moreover, several questions could not be addressed, including the possibility that people who used a violent suicidal means may be more impaired as suggested by the first study in 2005 and a subsequent study by Gorlyn et al. (2013); the effect of psychiatric comorbidity; the measure of decision-making using different tasks; or an effect of authors/centers who published the most of the topic.

The current study therefore aims to: 1) examine the association between a personal history of suicidal behavior and decision-making impairment in a larger number of studies than the first meta-analysis six years ago and using different decision-making tasks; 2) test the influence of several moderator variables (comorbid disorder; type of mood disorder, publication time, author, center); 3) test the hypothesis of poorer decision-making performance in suicide attempters who used a violent suicidal means as compared to those who used another means.

## **METHODS**

We conducted this work in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). The study protocol was predefined but not registered.

### ***Search strategy***

PubMed and EMBASE were searched for articles published from 1st January 2000 to 1<sup>st</sup> January 2020. The lower time limit was determined by considering the lack of published studies before 2000 in the previous meta-analysis (Richard-Devantoy et al., 2014). It also gave us the opportunity to check for any missed reference in the 2014 meta-analysis.

The search request for PubMed was: (((((((suicide[MeSH Terms]) AND cognition[MeSH Terms]) OR neuropsychology[MeSH Terms]) OR neuropsychologic tests[MeSH Terms]) OR decision making[MeSH Terms]) OR problem solving[MeSH Terms]) OR executive function[MeSH Terms]) AND suicide[Title/Abstract]. The request for EMBASE was: ('suicide'/exp/mj AND 'cognition'/exp/mj OR 'neuropsychology'/exp/mj OR 'neuropsychological test'/exp/mj OR 'decision making'/exp/mj OR 'problem solving'/exp/mj OR 'executive function'/exp/mj) AND suicide:ab,ti AND [2000-2019]/py

We searched for articles published in English or French. Reference list of articles and existing reviews were further screened to identify additional papers.

### ***Study selection***

Articles were first selected on the basis of abstracts using STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) criteria (Vandenbroucke et al., 2007).

Eligibility criteria accorded with the PICOS (participants, interventions, controls, outcomes, and studies) framework were:

*Participants:* Human studies of in or out-patients suffering from any type of major psychiatric disorder with a personal history of suicide attempt defined as any act carried out with a certain intent to die and different from non-suicidal self-injury (*suicide attempters*).

*Interventions:* A decision-making assessment was conducted using any available neuropsychological task but not questionnaires.

*Controls:* Individuals with similar comorbid disorder and current suicidal ideation but without any personal history of suicide attempt (*suicide ideators*); or individuals with similar comorbid disorder but without any history of suicide attempt (*patient controls*); or individuals with no personal psychiatric disorder and suicidal history (*healthy controls*).

*Outcomes:* Task-related decision-making performance.

*Studies:* Case-control design.

See Figure 1 for flow chart. Of the 3,582 identified records, 33 articles were selected for full-text reading. Two articles were then excluded because of a lack of suicide-related data (Bazanis et al., 2002; Dowson et al., 2004). Moreover, three articles were not retained for analyses because the specified decision-making tool was only used in one study: a probabilistic three-choice decision-making task (Dombrowski et al., 2019), the Balloon Analogue Risk Task (Potvin et al., 2018), and the Adult Decision-Making Competence task (Szanto et al., 2018). We also had to exclude the only study investigating suicidal ideation (Sheftall et al., 2015). As some data were used in several consecutive articles in the Montpellier center with a risk of duplication bias, we excluded two articles for the main analyses (Jollant et al., 2013, 2007). However, regarding the paucity of data for the comparison between suicide attempters who used or not a violent means, these data were used

for this contrast and combined to unpublished Montpellier data. Given the small number of studies considering traumatic brain injuries (Brenner et al., 2015; Homaifar et al., 2012), schizophrenia (Adan et al., 2017) and rehabilitation patients with post-traumatic stress disorder (Pustilnik et al., 2017), we excluded these four studies to limit clinical heterogeneity. Twenty-one articles were finally included in the present meta-analysis (Ackerman et al., 2015; Bridge et al., 2012; Chamberlain et al., 2013; Clark et al., 2011; Deisenhammer et al., 2018; Gilbert et al., 2011; Gorlyn et al., 2013; Hegedűs et al., 2018; Ho et al., 2018; Jollant et al., 2017, 2010, 2005; LeGris et al., 2012; Malloy-Diniz et al., 2009; Martino et al., 2011; Oldershaw et al., 2009; Olié et al., 2015; Richard-Devantoy et al., 2016a, 2016b; Westheide et al., 2008; Wyart et al., 2016), including the nine studies using the IGT and published in the 2014 meta-analysis (Richard-Devantoy et al., 2014).

Some additional data were obtained after contacting the authors due to insufficient information in the article for analytic purposes (Gorlyn et al., 2013; Hegedűs et al., 2018; Ho et al., 2018; Jollant et al., 2017, 2013, 2010, 2007; LeGris et al., 2012; Martino et al., 2011; Olié et al., 2015; Richard-Devantoy et al., 2016b). Thank you to these authors.

The Newcastle-Ottawa scale (Wells et al., 2000) was used to assess the quality of each selected study.

### ***Data extraction***

Two investigators (F.J. and R.P.) extracted data into standardized spreadsheets, which included authors, date of publication, study design, exclusion criteria, study population (gender, age, mental disorders), decision-making test used and task scores (means and standard deviations).

Among the 21 selected studies, two decision-making tasks were used: the Iowa Gambling Task (IGT) (18 studies) and the Cambridge Gambling Task (CGT) (3 studies). We used the

scores most often reported in analyses, namely the IGT total net score and the CGT proportion of rational choices.

The IGT (Bechara et al., 1994) is a test of decision-making under uncertainty where odds are initially unknown and that necessitates learning by trials-and-errors. During the IGT, participants are given \$2000 of virtual money and are told to try to win as much money as possible by choosing one card at the time between 4 decks (named A, B, C and D). They are told that each time they pick a card, they can win some money but sometimes also have to pay a fee back (in the original version, they win or win then lose money when choosing a card from a deck; while in more recent versions, they either win or lose). Subjects are not told that a total of 100 cards will be picked and that in the long run, decks A and B resulted in a net loss (risky decks) whereas decks C and D resulted in an overall net gain (safe decks). The “net score” is calculated as the number of choices from advantageous decks (i.e. from decks C and D) minus the number of choices from disadvantageous decks (i.e. from decks A and B) for the 100 choices. Lower net scores indicate more risky choices.

The CGT (Rogers et al., 1999b, 1999a) is a test of decision-making under risk, i.e. odds are explicit at each trial. Participants are presented with an array of ten colored boxes (red or blue) and are told to indicate whether they believe the yellow token is hidden inside a red or a blue box. Choices are associated with explicit risks of winning or losing dependent upon the ratio of red to blue boxes (e.g., 7 red, 3 blue = 70% chance of winning one’s bet when placed on red). Subjects then place a bet on their decision. For each trial, the amount bet automatically increases or decreases with time until a decision is made. The key outcome measure (also called the quality of decision making) is the overall proportion of times, across all trials, that subjects chose the box color that was statistically more likely to yield a token in the long run. Of note, participants occasionally choose lower-odds because those choices are intermittently rewarded.



### *Statistical analyses*

The meta-analysis was conducted with Comprehensive Meta-Analysis software *version 3* (Borenstein et al., 2013). Pooled Hedges's  $g$  effect sizes for IGT and CGT scores were obtained using a random effect model. Effect sizes are usually considered large when  $>0.8$ , moderate when between 0.4 and 0.8 and low when  $< 0.3$  (Egger, 2009). Heterogeneity of the pooled effect size was measured by calculating the prediction interval and  $I^2$  assessed the relative amount of dispersion across analysis and indirectly the amount of sampling error (Borenstein, 2020). Publication bias was estimated using funnel plots and Fail-safe N.

## RESULTS

### *Studies description*

See **Table 1** for detailed description of the selected studies.

The 21 studies represented 2,311 participants of whom 820 were suicide attempters, 886 patients controls, and 605 healthy controls. Three studies had data about suicide attempters who used a violent means (including combined data from the Montpellier center). Studies were conducted in patients suffering from mood disorders as the main diagnosis in 20 studies (including nine in major depressive disorder, three in bipolar disorders, and three in combined types). One study was conducted in borderline personality disorder but most patients were suffering from comorbid mood disorders. In four studies, patients were normothymic at time of assessment. Two studies assessed decision-making in adolescents and two in elderly. Most studies included patients under medication except for two studies (unknown for four studies). The delay between the last suicidal act and decision-making assessment was short in five studies, variable in four studies, and unknown in twelve. F. Jollant was one of the authors of seven of the 21 publications, and Montpellier was the center of recruitment or affiliation in five studies (with only partial overlap between Jollant and Montpellier). Data about suicide attempters who previously used a violent means was available in three studies, while most studies were conducted in individuals who used non-violent means (mainly medication overdose).

### *Suicide attempters versus patient controls*

Standardized mean difference (Hedges'  $g$ ) was -0.28 showing that on average suicidal attempt was associated with worse IGT performance by 0.28 standard deviation compared to non-attempting control patients (See **Figure 2**). The 95% confidence interval was -0.44 to -0.12 and the  $z$ -value for testing the null hypothesis was -3.37, with a corresponding  $p$ -value of

0.001. Q-value was 28.64 with 16 degrees of freedom and  $p=0.026$ , rejecting the hypothesis that the true effect size is identical in all studies.  $I^2$  was 44.13, which tells us that 44% of the variance in observed effects reflects variance in true effect rather than sampling error. The funnel plot of precision showed a balanced distribution of the studies with no adjustment computed with the Trim and Fill method (See **Supplemental Figure 1**). The prediction interval (95%) ranged from -0.78 to 0.22, showing that the worsening of decision-making will be large in some populations but can be trivial in other populations.

A mixed-effect analysis of regression was then performed showing a significant effect of year of publication ( $Z=2.76$ ;  $df=1$ ;  $p=0.006$ ), but not center (Montpellier vs. others) ( $Z=-0.18$ ;  $df=1$ ;  $p=0.9$ ), or author (Jollant vs. not Jollant) ( $Z=-1.11$ ;  $df=1$ ;  $p=0.3$ ), or type of mood disorder (unipolar or bipolar vs. mixed groups) ( $Z=-1.43$ ;  $df=1$ ;  $p=0.2$  and  $Z=-1.36$ ;  $df=1$ ;  $p=0.2$ , respectively) or age group (young vs. adult).

When the CGT was assessed, standardized mean difference (Hedges'  $g$ ) was -0.57, showing that on average suicidal attempt was associated with worse CGT performance by -0.57 standard deviation compared to non-attempter control patients with a mood disorder (**Figure 3**). The 95% confidence interval was -0.82 to -0.31 and the z-value for testing the null hypothesis was -4.37, with a corresponding value of  $p=0.001$ . Q-value was 0.47 with 2 degrees of freedom and  $p=0.79$ , rejecting the hypothesis that the true effect size is identical in all studies. Results must be considered with caution because of the few studies available ( $N=3$ ).

#### *Suicide attempters using a violent versus non-violent means*

IGT net scores were lower in suicide attempters using a violent suicide means as compared to those using a non-violent means (Hedges's  $g$  -0.44 (-0.88 – -0.01)) representing a moderate effect size (**Figure 4**).

### *Suicide attempters versus healthy controls*

IGT performance was lower in suicide attempters when compared to healthy controls (Hedges's  $g$  -0.54 (-0.83 – -0.25)) representing a moderate effect size (**Figure 5a**).  $I^2$  was 80.11, which tells us that 80% of the variance in observed effects reflects variance in true effect rather than sampling error. Four studies could be responsible for this heterogeneity (Jollant et al., 2010; Malloy-Diniz et al., 2009; Richard-Devantoy et al., 2016a; Wyart et al., 2016).

### *Patient controls versus healthy controls*

No difference was found between patient controls and healthy controls for the IGT net scores. (Hedges's  $g$  -0.13 (-0.27 – 0.01) (**Figure 5b**).  $I^2$  was 67.25, which tells us that 67% of the variance in observed effects reflects variance in true effect rather than sampling error.

## DISCUSSION

This meta-analysis extends and refines results reported in a previous meta-analysis in 2014 (Richard-Devantoy et al., 2014). First, we confirm poorer decision-making performance in suicide attempters than in patient controls in a larger number of studies. Of note, the effect size was lower than the one previously reported with a significant effect of time of publication. In addition, we were able for the first time to show that this difference was found when using the IGT or the CGT. Second, the number of studies allowed us to show that this difference was not related to the author (F. Jollant) or the center (Montpellier, France) that published the initial article in 2005 and the highest number of articles in the domain. Moreover, it was not modified by the patients' age group or the type (bipolar vs. unipolar) of mood disorder. Third, secondary analyses suggest that suicide attempters who used a violent means may make riskier decisions than those who used a non-violent means.

The effect size of this association was lower than previously reported in 2014 ( $g = -0.28$  vs.  $-0.47$ ) with a lower effect size in more recent publications. The interpretation of these findings is not easy. However, it has been previously shown that initial studies tend to show higher effect sizes and that replications in different populations with varied recruitment bias tend to lower differences, the so-called Proteus effect (Button et al., 2013). For instance, several recent studies may have recruited less severe patients with better cognitive performance. The effect size reported in the present study based on more individuals and studies may therefore approach its true value.

A significant difference between suicide attempters and healthy controls but not between non-attempter patient controls with a mood disorder and healthy controls was also found suggesting that risky decision-making is more associated with the history of suicide attempt than with a history of mood disorder. A few previous studies additionally suggest that risky decision-making may represent a heritable trait marker of vulnerability. Indeed, risky

decision-making was found in both euthymic suicide attempters (Jollant et al., 2005, Jollant et al., 2010) and in healthy first-degree biological relatives of suicide victims (Hoehne et al., 2015). Interventions aiming at improving decision-making abilities in people who attempted suicide may therefore be a valuable way to prevent recurrence.

The fact that risky decision-making was also found in suicide attempters when using the CGT (based on the “quality of decision-making” measure) tend to suggest that these results are not specific to the task. Notably, deficits in CGT performance in suicide attempters support the proposed deficits in risk encoding and value computation as a mechanism of suicidal behavior (Dombrovski and Hallquist, 2017) more than a sole deficit in learning in condition of uncertainty, a notable feature of the IGT. Current research, including the use of computational models, aims at identifying the precise mechanisms underlying decision-making deficits in relation to suicidal behavior. Importantly, one should remain cautious in interpreting the higher effect size when using the CGT than IGT as the former result only rely on 3 studies. At this stage, it is not clear what the best tool should be to measure decision-making in suicide attempters.

Overall, these findings therefore confirm a significant but modest association between risky decision-making and a history of suicide attempt among patients with mood disorders. However, secondary analyses suggest that suicide attempters who used a violent means may have more marked impairments in decision-making than those who used a non-violent means (mainly medication overdose) as previously suggested by Jollant et al. (2005) and Gorlyn et al. (2013). This sub-group of suicide attempters is at particularly high risk of future suicide death (Bergen et al., 2012; Vuagnat et al., 2019). Interestingly, while non-lethal suicidal acts are mostly associated with the choice of a non-violent means, a majority of suicide deaths occur in the context of the choice of a violent means (e.g. hanging, firearm, drowning) (Vuagnat et al., 2019). The choice of the suicidal methods therefore appears critical in terms

of mortality risk. Moreover, suicide attempters who chose a violent suicidal means appear to be close to those who died from suicide sharing several risk factors including being males and having a family history of suicide (Giner et al., 2014). This subgroup also biologically differed from attempters who used a non-violent means (Ludwig and Dwivedi, 2018), including more serotonergic deficits (Asberg et al., 1976), differential frequency of genetic variants (Courtet et al., 2001) and possibly neuroanatomical differences in the volume of the striatum (Jollant et al., 2018). These various biological variations may influence the quality of decision-making towards more risky choices. One mechanism in play may be through reduced serotonergic modulation leading to a reduction in motivated behavioral inhibition in an aversive context (Guitart-Masip et al., 2014). Future studies should study decision-making in this particular population at very high risk of suicide.

Several limitations of this study have to be highlighted. First, most studies were conducted in mood disorders. There is a clear shortage of studies in other mental disorders at high risk of suicide notably schizophrenia, alcohol and substance disorders, eating disorders or personality disorders in order to clarify if observed alterations in decision-making are transnosographic. Second, we could not run separate analyses in patients in different phases of disease (notably depression and euthymia) due to a lack of sufficient data. This would enable to confirm that risky decision-making represent traits of vulnerability in suicide attempters. Third, the effect of age group could not be correctly assessed due to a limited number of studies in adolescents and no studies using the IGT in elderly. Furthermore, a gender effect could not be calculated due to the lack of available data. Fourth, some analyses were conducted in a small number of studies, which is notably the case for the comparisons between violent and non-violent suicide attempters (3 studies), and between suicide attempters and patient controls using the CGT (3 studies). Interpretation of these findings therefore needs to be cautious. More studies will be necessary to clarify the true effect size. Finally, studies were largely conducted using the IGT

following the initial publication. The use of novel tasks will allow clarifying the mechanisms in play.

In conclusion, the present meta-analysis confirmed more risky decision-making in suicide attempters although these deficits appear to be modest overall but possibly more marked in the subgroup of those who used a violent means. More studies in these individuals are warranted in addition to the identification of the cognitive and biological mechanisms explaining risky decision-making in suicide attempters, the development of robust tools to measure decision-making in this population, and the investigation of targeted therapies specifically aiming at decision-making.



## **FIGURE TITLES**

Figure 1: Flowchart

Figure 2: Forest plot for the comparison of the Iowa Gambling Task net scores between suicide attempters and patients controls

Figure 3: Forest plot for the comparison of the Cambridge Gambling Task overall proportion of rational decisions made between suicide attempters and patients controls

Figure 4: Forest plot for the comparison of the Iowa Gambling Task net scores between suicide attempters who used or not a violent suicidal means

Figure 5: Forest plots for the comparison of the Iowa Gambling Task net scores a) between suicide attempters and healthy controls and b) between patient controls and healthy controls

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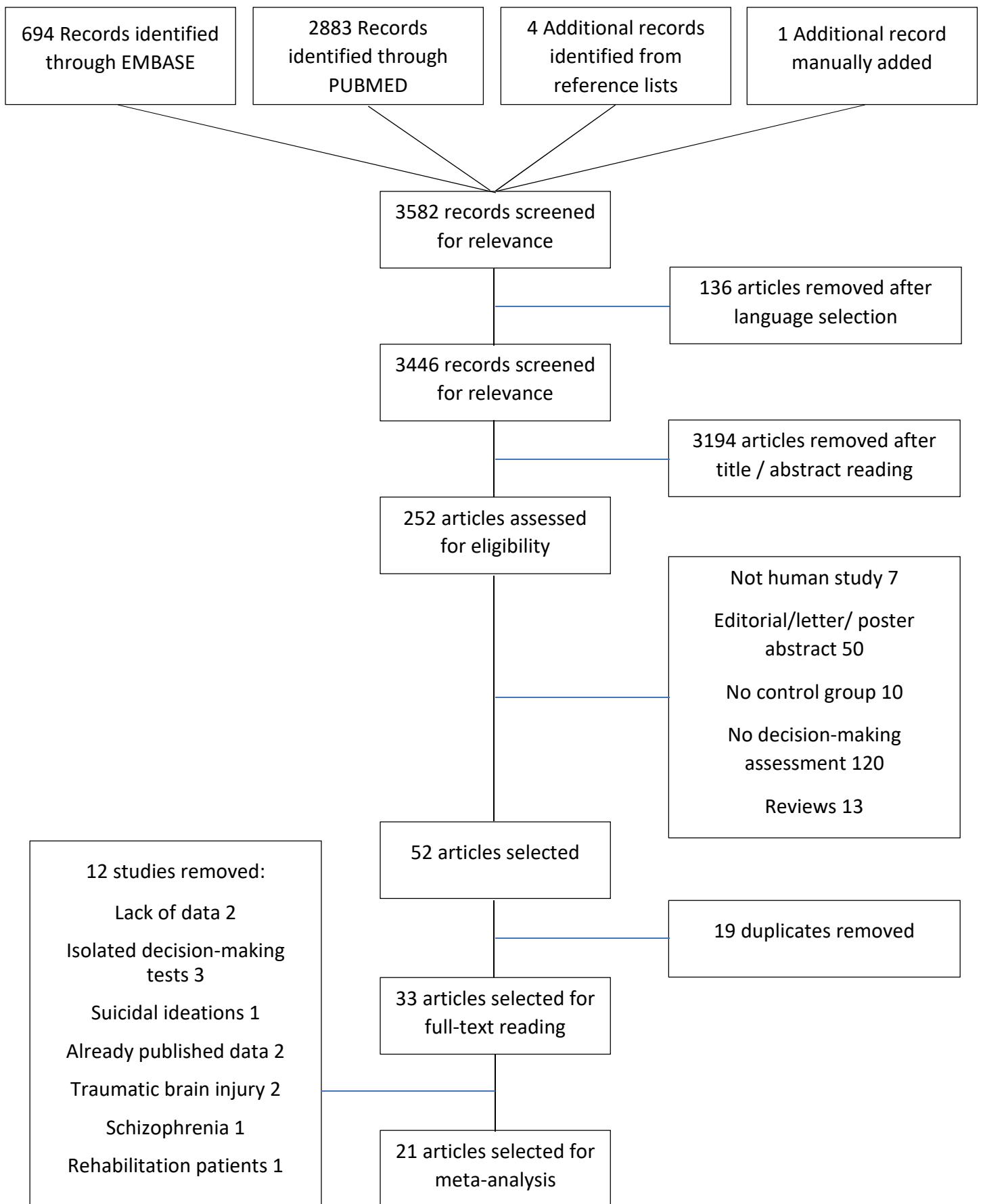
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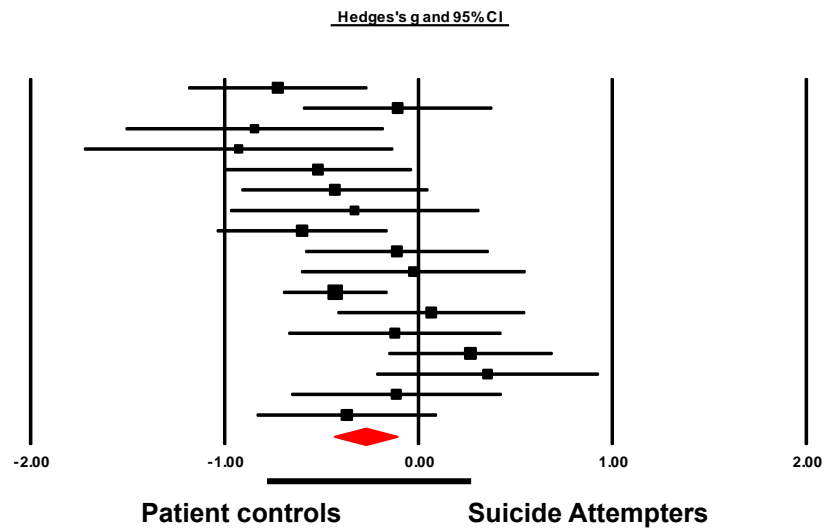
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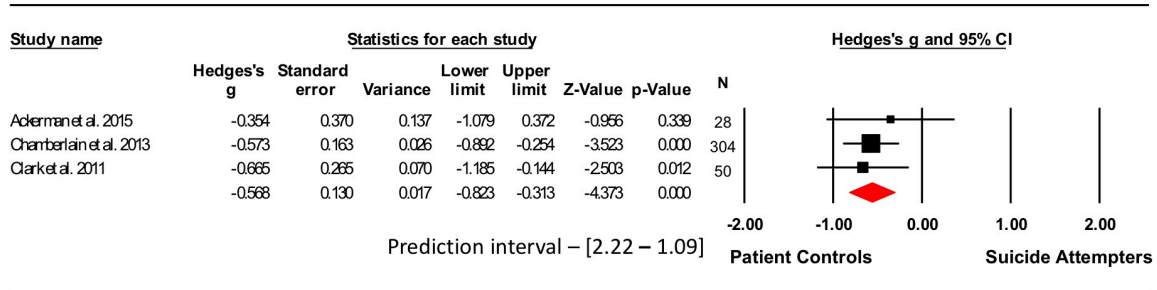
**Figure 1 Flowchart**

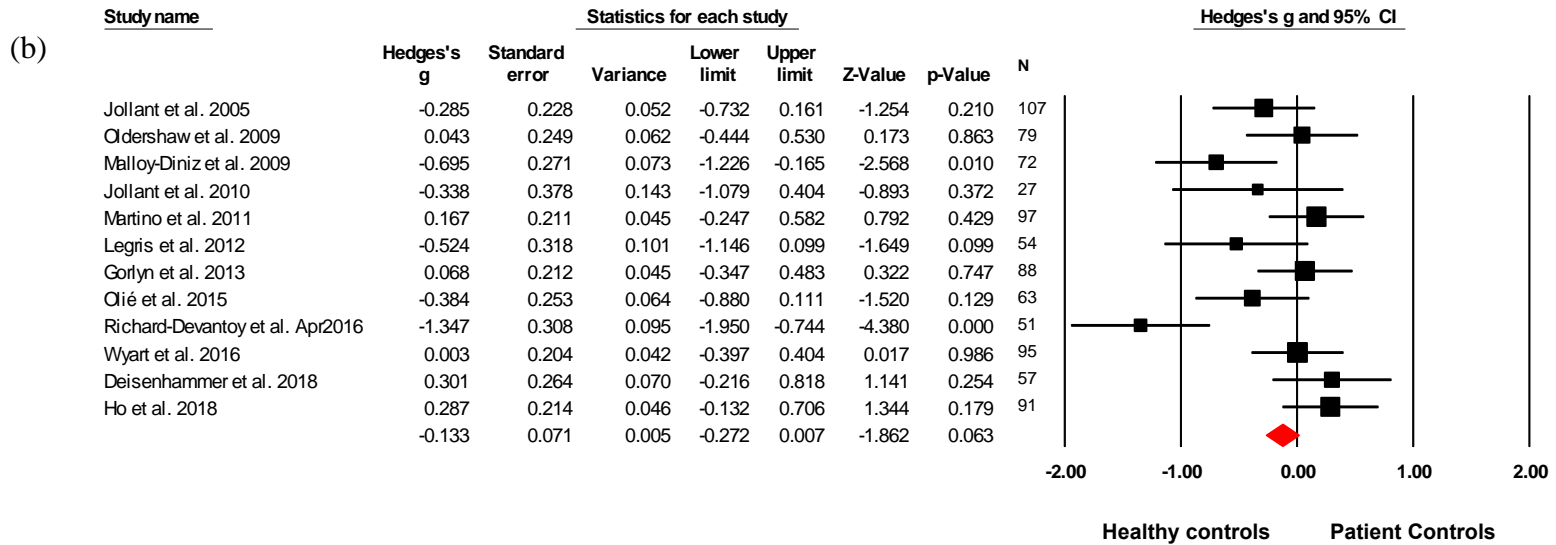
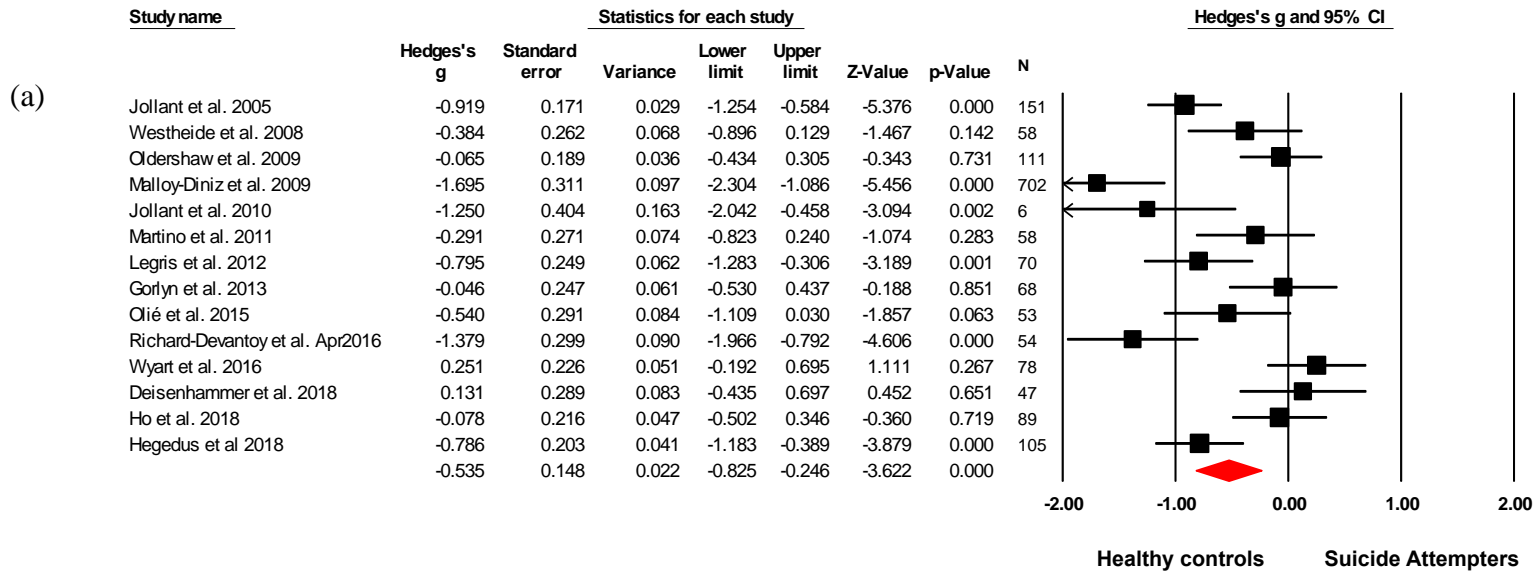
Study name	Statistics for each study							N
	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	
Jollantetal.2005	-0.725	0.237	0.056	-1.191	-0.260	-3.054	0.002	94
Oldershaw etal.2009	-0.107	0.251	0.063	-0.598	0.384	-0.428	0.669	76
Malloy-Diniz etal.2009	-0.845	0.341	0.116	-1.514	-0.176	-2.475	0.013	36
Jollantetal.2010	-0.927	0.409	0.167	-1.729	-0.126	-2.269	0.023	25
Martino etal.2011	-0.518	0.249	0.062	-1.005	-0.031	-2.083	0.037	85
Gilbertetal.2011	-0.431	0.248	0.061	-0.916	0.054	-1.740	0.082	67
Legris etal.2012	-0.329	0.329	0.109	-0.975	0.317	-0.998	0.318	42
Bridge etal.2012	-0.600	0.226	0.051	-1.044	-0.156	-2.650	0.008	80
Gorlyn etal.2013	-0.111	0.243	0.059	-0.587	0.365	-0.457	0.648	72
Olié etal.2015	-0.027	0.297	0.088	-0.609	0.555	-0.090	0.928	46
Richard-Devantoy etal.jan2016 (UP)	-0.429	0.139	0.019	-0.702	-0.156	-3.078	0.002	224
Richard-Devantoy etal.jan2016 (BP)	0.066	0.249	0.062	-0.421	0.553	0.266	0.790	79
Richard-Devantoy etal.Apr2016	-0.122	0.282	0.079	-0.674	0.431	-0.432	0.666	49
Wyartetal.2016	0.268	0.218	0.047	-0.159	0.695	1.231	0.218	87
Jollantetal.2017	0.356	0.295	0.087	-0.221	0.934	1.209	0.227	46
Deisenhammer etal.2018	-0.114	0.279	0.078	-0.660	0.432	-0.410	0.682	52
Ho etal.2018	-0.370	0.239	0.057	-0.837	0.098	-1.549	0.121	70
	-0.278	0.083	0.007	-0.440	-0.116	-3.367	0.001	



Prediction Interval

UP : unipolar mood disorder, BP : Bipolar mood disorder





**Table 1: Characteristics of the 21 studies included in the meta-analysis**

Study	Study location	Newcastle-Ottawa scale rating			Decision-making test	In or out-patients	total N	Suicide attempters				Patient controls				Healthy controls			
		Selection	Comparability	Exposure				Group N	Males (n)	Age	Age SD or range	Group N	Males (n)	Age	Age SD or range	Group N	Males (n)	Age	Age SD or range
Ho et al. 2018	Taiwan	+++	++	++	IGT	out	125	34	3	41.8	1.4	36	16	43.8	1.9	55	9	44.3	1.2
Hegedüs et al. 2018	Hungary	+++	++	++	IGT	in	105	59	18	35.7	12.3	0	–	–	–	46	20	34.2	11.0
Deisenhammer et al. 2018	Austria	+++	+	++	IGT	in	78	21	5	37.2	11.7	31	9	42.5	11.7	26	12	40.1	13
Jollant et al. 2017	Canada	++	++	+	IGT	unknown	47	20	9	45	(24-65)	27	8	47	(29-63)	0	–	–	–
Richard-Devantoy et al. Apr. 2016	Canada	+++	+	+	IGT	unknown	77	26	11	40.3	9.7	23	8	41.3	11.4	28	11	33.8	7.1
Richard-Devantoy et al. Jan. 2016	France	+++	++	+++	IGT	out	303	198	60	UP38.3 BP38.5	12.3 BP	105	26	UP33.2 BP37.5	11.9 BP	0	–	–	–
Wyart et al. 2016	France	+++	++	+++	IGT	unknown	130	35	10	76.6	(65.4-88.5)	52	18	79.1	(69.0-92.2)	43	26	79.3	(73.3-88.1)
Olié et al. 2015	France	++	+	+++	IGT	out	73	15	15	43	(18-60)	23	23	41	(22-58)	35	35	39	(31-39)
Ackerman et al. 2015	USA	++	++	+++	CGT	out	28	14	9	16.9	1.1	14	9	16.9	1.1	0	–	–	–
Gorlyn et al. 2013 *	USA	++	++	+++	IGT	in and out	114	26	17	35.0	12.0	46	15	37.8	10.7	42	26	32.3	10.9
Chamberlain et al. 2013	USA	++	++	+++	CGT	out	304	45	21	23.4	3.5	259	191	21.5	3.3	0	–	–	–
Bridge et al. 2012 *	USA	++	++	+++	IGT	out	80	40	10	15.5	1.4	40	10	15.6	1.4	0	–	–	–
Legris et al. 2012 *	Canada	++	++	++	IGT	out	83	29	–	–	–	13	–	–	–	41	–	31.2	9
Gilbert et al. 2011 *	USA	+++	++	+++	IGT	in and out	67	28	14	43.7	10.7	39	23	41.1	12	0	–	–	–
Martino et al. 2011 *	Argentina	+++	++	+++	IGT	out	119	22	5	42.1	10.6	63	25	39.2	10.8	34	12	40	12.9
Clark et al. 2011	USA	+++	++	+++	CGT	in	82	25	13	67.1	7.5	35	13	70.7	8.4	22	14	67.8	5.1
Jollant et al. 2010 *	UK	++	+	++	IGT	out	40	13	13	38	(28-59)	12	12	43	(25-58)	15	15	30	(22-57)

Oldershaw et al. 2009 *	UK	+++	++	+++	IGT	out	133	54	5	15.8	1.5	22	2	15.7	1.3	57	11	15.8	1.5
Malloy-Diniz et al. 2009 *	Brazil	++	+	+	IGT	out	89	18	10	41	13.8	21	10	40.8	12.6	50	15	36.9	9.8
Westheide et al. 2008 *	Germany	++	+	+++	IGT	in	58	29	17	-	-	0	-	-	-	29	-	39	10.9
Jollant et al. 2005 *	France	+++	++	+++	IGT	in and out	176	69	33	-	-	25	9	40.4	12.2	82	60	38.8	9.1

Footnotes: IGT: Iowa Gambling Task; CGT: Cambridge Gambling Task; SD: Standard Deviation; UP: Unipolar Disorders; BP: Bipolar Disorders  
 \*: studies included in the 2014 meta-analysis (Richard-Devantoy et al. 2014)