

1 **The association of non-obscene socially inappropriate behavior with ADHD symptoms,**  
2 **conduct problems, and risky decision making in a large sample of adolescents**

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14 Running title: non-obscene socially inappropriate behavior in adolescents

1 *Abstract*

2 Non-obscene, socially inappropriate behavior (NOSI) is recognized as part of the tic disorder  
3 spectrum but has received little attention from researchers to date. A study in 87 patients with  
4 Tourette Syndrome showed that comorbid ADHD and conduct disorder were also associated  
5 with an increase in socially inappropriate behavior. This study used data from the Millennium  
6 Cohort Study to investigate the relationship between NOSI and emotional symptoms, conduct  
7 problems and hyperactivity /inattention as assessed by the Strengths and Difficulties  
8 Questionnaire (SDQ) in 1280 youths, aged 14 years. Furthermore, the relationship  
9 between NOSI and decision making processes as assessed by the Cambridge Gambling Task  
10 (CGT) was investigated. Hyperactivity /inattention and conduct problems were significantly  
11 associated with NOSI, emotional problems were not. Risk taking was significantly associated  
12 with misbehaving in lessons but not with being rude or noisy in public. The results replicate and  
13 confirm the association of NOSI with ADHD and conduct problems in a large sample, although  
14 it should be stressed that the size of the association was small. The results also suggest that some  
15 inappropriate behaviors are related to risk taking behavior, while others are not.

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1 *Introduction*

2 Non-Obscene Socially Inappropriate Behavior (NOSI), such as making inappropriate comments  
3 about a person’s appearance (e.g. weight, height) or performing inappropriate actions (e.g. pulling  
4 the fire alarm; (Kurlan et al., 1996) currently has no generally agreed upon operational definition  
5 (Houghton, Alexander, & Woods, 2016). Very little research has been conducted into this  
6 phenomenon and this has been limited to the field of tic disorders (Kurlan et al., 1996;Eddy and  
7 Cavanna, 2013c).

8 Tic disorders are childhood onset neuropsychiatric disorders (TD); ~~characterized by motor and~~  
9 ~~phonic tics~~ (American Psychiatric Association, 2013), tics are repetitive but not stereotyped  
10 movements (e.g. eye blinking, jumping) or vocalizations (e.g. coughing, barking) that occur out of  
11 context However, beyond the diagnostic criteria, TDs are multifaceted disorders that can  
12 encompass a range of different phenomena, such as echopraxia and echolalia, i.e. repeating other  
13 people’s movements or sounds (Finis et al., 2012;Ganos et al., 2012), premonitory urges, i.e.  
14 uncomfortable sensory phenomena accompanying tics (Leckman et al., 1993;Kwak et al.,  
15 2003;Woods et al., 2005;Reese et al., 2014;Brandt et al., 2016), copropraxia and coprolalia, i.e.  
16 involuntary obscene gestures or obscene sounds, words or sentences (Eddy and Cavanna, 2013b).  
17 While coprolalia is very salient and frequently portrayed by the media as characteristic for TDs,  
18 the prevalence in Tourette syndrome (TS) is currently estimated at 10-33% (Shapiro et al.,  
19 1988;Cavanna et al., 2009;Freeman et al., 2009;Cavanna et al., 2011;Eddy and Cavanna, 2013b)  
20 and depends on the sample (Singer, 1997).

21 But not all inappropriate behavior can be classified as “coprophilia” (coprolalia or copropraxia)  
22 (Kurlan et al., 1996;Martino et al., 2017). Kurlan et al., (1996) investigated NOSI in 87 patients  
23 with TS. A significant number of patients reported insulting others as a habit (22%), more typically  
24 family members than strangers, 5% reported making socially inappropriate comments, and 14%  
25 reported having performed socially inappropriate actions (Kurlan et al., 1996). The incidence of  
26 NOSI in TDs in studies with sample sizes < 100 was estimated at approximately 25-50% (Kurlan  
27 et al., 1996;Eddy and Cavanna, 2013c). It has been speculated that NOSI might be related to  
28 increased or decreased sensitivity to social cues (Eddy, 2016;Drury et al., 2018;Eddy, 2018) and  
29 poor decision making (Eddy and Cavanna, 2013a). It was also found that NOSI is significantly  
30 related with attentional problems/ADHD and conduct problems (Kurlan et al., 1996;Eddy and  
31 Cavanna, 2013c) as well as with obsessions (Eddy and Cavanna, 2013c). Moreover, socially

1 disinhibited behavior is highly heritable in patients with Tourette syndrome (Hirschtritt et al.,  
2 2016).

3 Attention-deficit/hyperactivity disorder (ADHD) is characterized by age-inappropriate and  
4 impairing levels of inattention, impulsivity and hyperactivity (American Psychiatric Association,  
5 2013). Socially inappropriate behavior is not a core symptom of ADHD (American Psychiatric  
6 Association, 2013), however it often co-occurs with ADHD symptoms. Children and adolescents  
7 with ADHD tend to demonstrate inappropriate social behaviors, such as intrusive, commanding,  
8 and hostile behavior with peers (Wehmeier et al., 2010). High rates of aggressive behavior and  
9 rule-breaking, relative to typically developing peers have been reported (Gardener & Gerdes,  
10 2015). Moreover, socially inappropriate behaviors appear to be related to low impulse control in  
11 children with ADHD (Bunford et al., 2018). This suggests that NOSI may be part of a more general  
12 impairment of impulse control or decision making, although it is unclear whether NOSI may have  
13 different underlying mechanisms in different disorders.

14 Conduct disorder (CD) is characterized by socially inappropriate behavior, such as aggressive  
15 behavior, damage to property and rule-breaking (Tackett et al., 2005; American Psychiatric  
16 Association, 2013). Children with conduct problems tend to make riskier decisions than control  
17 participants (Fairchild et al., 2009; Crowley et al., 2010) and are more likely to be impulsive and  
18 display sensation seeking and antisocial behavior as youths (Mann et al., 2018). Having both  
19 ADHD and conduct problems appears to exacerbate risky decision making in children further  
20 (Humphreys and Lee, 2011) (for review on decision making in ADHD and CD see (Sonuga-Barke  
21 et al., 2016).

22 The current study investigates the relationship between indicators of NOSI, e.g. complaints about  
23 being rude or noisy in public and symptoms of hyperactivity /inattention as well as conduct  
24 problems, as assessed by the Strengths and Difficulties Questionnaire (SDQ). Furthermore, the  
25 relationship between NOSI and risky decision making, as assessed by the Cambridge Gambling  
26 Task (CGT), are explored.

27

## 28 *Methods*

### 29 *Participants*

30 The data from the 2015 Millennium Cohort Study sweep were used (University of London, 2019).

31 SDQ data was available for [10896–11323](#) participants ([5502–5696](#) males), aged 14 years.

1 Information about complaints for being rude or noisy in public was available for  $n = 11192$  youths.  
2 Out of the sample, 1467 youths (13.1%) had been complained about for being rude or noisy in  
3 public and number of complaints was given for  $n = 1280$  participants (683 males). Information  
4 about misbehaving in class was available for  $n = 11192$  youths. Available data for individual  
5 analyses can vary slightly due to missing data; therefore, each N is reported in Tables 1 and 2.

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### 7 *Measures*

8 **Socially inappropriate behaviors.** NOSI were assessed as the self-reported frequency with which  
9 the cohort member had been complained about for being rude or noisy in public (number of  
10 complaints) and misbehaving in lessons (1-4; 1 = All the time and 4 = never. For this study, the  
11 scale was recoded so that higher numbers represent higher incidents of misbehavior).

12 **SDQ Hyperactivity / inattention problems.** The parent-rated subscale inattention/hyperactivity  
13 of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997), an internationally used  
14 and validated screening questionnaire to assess mental and behavioral strengths and difficulties in  
15 3- to 16-year olds, was used at all measurement occasions to assess ADHD symptoms. The SDQ  
16 is widely used for measuring ADHD symptoms (Cuffe et al., 2005) and shows high correlations  
17 with other scales assessing ADHD symptoms as for instance the Conners Scale (Woerner et al.,  
18 2004) or the Child Behaviour Checklist (CBCL;(Arbeitsgruppe Deutsche Child Behaviour  
19 Checklist, 1998). The SDQ is better able to distinguish between children with and without ADHD  
20 than the CBCL with 118 items (11 for attention problems; (Klasen et al., 2000). The five-item  
21 inattention/hyperactivity subscale sums up ratings of ADHD-related behaviour and has good  
22 internal consistency (average Cronbach's  $\alpha = .87$ , maximum = 10 points). The items for the  
23 subscale are "restless, overactive, cannot stay still for long," "constantly fidgeting or squirming,"  
24 "easily distracted, concentration wanders," "thinks things out before acting," "sees tasks through  
25 to the end, good attention span."

26 **SDQ Conduct problems.** The parent-rated five-item Conduct problem subscale sums up ratings  
27 of conduct related behavior, and has lower internal consistency than other sub-scales (average  
28 Chronbach's  $\alpha = 0.67$ , maximum = 10 points). The items for this subscale are "Often has temper  
29 tantrums or hot tempers", "Generally obedient", "Often fights with other children", "Often lies or  
30 cheats", "Steals from home, school or elsewhere".

1 Every item of the SDQ is rated on a 3-point Likert scale: ‘not true’ (0), ‘somewhat true’ (1) and  
2 ‘certainly true’ (2). Positively worded items are reverse-scored. The possible range is 0 – 10 ( $M =$   
3 3.2 in the norm sample; (Becker et al., 2004),. Teachers carried out the assessment. According to  
4 Woerner and colleagues (2002), the critical cut-off for clinical significance is greater or equal to  
5 seven raw score points (Woerner et al., 2002).

6

7 **SDQ Emotional problems.** The subscale “emotional problems” of the SDQ was used as a control  
8 variable in the current study to ensure the associations found with NOSI and the CGT were specific  
9 to conduct problems and hyperactivity/inattention. The subscale also consist of 5 items, assessing  
10 emotional problems, such as the tendency to worry or be fearful.

11 **Cambridge Gambling Task.** The Cambridge Gambling Task (CGT; (Rogers et al., 1999) is a  
12 computerized assessment of risk-taking and decision making and behavior, where no learning is  
13 involved (see Figure 1).

14 In each trial there are 10 boxes presented at the top of the screen, where the ratio of Red to Blue  
15 boxes varies across trials. Participants are told that there is a token hidden in one of the boxes, and  
16 the task involves selecting which color box the token is hidden in. Box color is chosen using the  
17 selection boxes at the bottom of the screen. The task takes up to 18 minutes to complete.

18 Participants start the task with 100 points, and in each trial must ‘bet’ points on their decision about  
19 which box will contain the token. If they are correct, the number of points bet are added to their  
20 score. If they are wrong, the number of points bet are removed from their score. Participants choose  
21 the number of points to bet by pressing the ‘Bet’ circle in the center of the screen when it shows  
22 the value they wish to bet; this value incrementally changes. Once a selection and bet are made the  
23 token is revealed, and points are altered according to the selection and bet made.

24 In line with the original task design, points won by the end of the task were not associated with  
25 any financial value (Rogers et al., 1999). Evidence demonstrates that financial rewards are not the  
26 only factor to influence risk-taking, where impulsive processing can guide decision making with  
27 the expectation of any objective or subjective reward (Schiebener & Brand, 2015). The CGT  
28 employs a point reward system and provides performance feedback, both of which have been  
29 linked to reward processes in the brain (Yazid et al, 2019). Individuals diagnosed with disordered  
30 gambling make riskier decisions than healthy controls when completing the CGT (Zois et al,  
31 2014), demonstrating the task is sensitive to differences in risky decision making in the absence

1 of financial reward. Research has also demonstrated that pathological gamblers show behavioural  
2 shifts towards risk-taking (Ligneul et al, 2013), as do individuals with attentional disorders  
3 (Dekkers et al, 2016).

4 Scores calculated from this task and reported in the MCS data include: risk taking, quality of  
5 decision-making, decision time, risk adjustment, delay aversion and the overall proportional bet.  
6 For the purpose of this study, we were interested in risk taking, the quality of decision making and  
7 the proportional size of the bet participants placed. Quality of decision making is calculated using  
8 participants judgements about which colour box the token is hidden in, where a higher proportion  
9 of trials in which the more likely outcome is chosen indicates better decision making. Risk taking  
10 is calculated using the mean proportion of current points that the participant ‘bets’ on each trial,  
11 when the more likely outcome is selected.

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### 13 *Statistical Analysis*

14 The incidence of having been complained about for being rude or noisy in public or not (yes/no)  
15 and its relationship with the SDQ subscales was assessed with a rare events logistic regression in  
16 R 3.6.1 (Choirat et al., 2019), due to its low base rate in the sample (13%). Rare events logistic  
17 regression takes the whole sample into account.

18 Normal distributions were tested using Shapiro-Wilk tests. Neither frequency of being rude or  
19 noisy in public ( $0.18, p < .001$ ), nor misbehaving in class ( $.79, p < .001$ ) were normally distributed.  
20 Furthermore, the SDQ conduct problems ( $.85, p < .001$ ), SDQ hyperactivity / inattention ( $.94, p <$   
21  $.001$ ) and emotional symptoms ( $.85, p < .001$ ) were also non-normally distributed. While CGT risk  
22 taking ( $1.0, p = .19$ ) and overall proportional bet ( $1.0, p = .19$ ) were normally distributed, CGT  
23 quality of decision making was not ( $.84, p < .001$ ). CGT risk taking values ranged from .05 - .95,  
24 indicating a wide range of risk taking decisions. Therefore, Spearman's rank correlation coefficient  
25 *rho* was used to assess the association between the indicators of NOSI and the three SDQ subscales  
26 as well as the CGT subscales. Partial, non-parametric correlations were used to control for the  
27 effects of sex. Correlation coefficients were Fisher-transformed to calculate confidence intervals.  
28 All tests of significance were two-tailed. Analyses were run in SPSS 24 (IBM Corp, 2016).

29

### 30 *Results*

1 Both hyperactivity / inattention ( $\beta = .08$ ,  $SE = .01$ ,  $z = 6.02$ ,  $p < .001$ ) and conduct problems ( $\beta =$   
2  $.16$ ,  $SE = .02$ ,  $z = 8.13$ ,  $p < .001$ ; intercept  $\beta = -2.25$ ,  $SE = .05$ ,  $z = -44.65$ ,  $p < .001$ ) were  
3 significantly associated with having been complained about for being rude or noisy in public, while  
4 emotional problems were negatively associated with having been complained about ( $\beta = -.08$ ,  $SE$   
5  $= .02$ ,  $z = -5.37$ ,  $p < .001$ ).

6 Mean number of complaints was 5.5 ( $SD = 19.16$ ; range = 1-300). Mean misbehavior in class was  
7 1.6 ( $SD = .64$ ). Associations between frequency of complaints about being rude or noisy in public,  
8 as well as misbehavior in lessons, and the SDQ are reported in Table 1.

9 Risk taking, quality of decision making, and the size of the overall proportional bet as assessed by  
10 the CGT were significantly associated with misbehaving in lessons but not with frequency of being  
11 rude or noisy in public (Table 2). Exploratory analyses showed that the difference between the  
12 correlations was significant for CGT risk taking ( $z = -2.67$ ,  $p = .008$ ) and overall proportional bet  
13 ( $z = -2.37$ ,  $p = .018$ ) but not for quality of decision making ( $z = 1.18$ ,  $p = .24$ ). With Bonferroni  
14 correction for 3 post-hoc  $t$ -tests, the only difference that remained significant was for the CGT risk  
15 taking subscale.

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### 17 *Discussion*

18 The results of this study showed that there was a significant relationship of both hyperactivity /  
19 inattention and conduct problems with indicators of non-obscene socially inappropriate behavior  
20 (NOSI). The results are in line with previous findings (Kurlan et al., 1996; Eddy and Cavanna,  
21 2013c), confirming an association of attentional and conduct problems with NOSI, ~~independent of~~  
22 ~~tic disorders,~~ in a large non-clinical sample of adolescents. The results are presumably  
23 independent of tic disorders, although data on the latter were not available from this cohort.  
24 However, the results also show that the relationship is small. The results indicate that NOSI could  
25 be considered a cross-disorder phenomenon and is likely not a form of complex motor or vocal tic  
26 (Kurlan et al., 1996). This is also in line with findings from a heritability study, showing that  
27 socially disinhibited tics were associated with comorbid OCD and ADHD (Hirschtritt et al., 2016).  
28 Even though coprophenomena have been shown to be associated with NOSI in tic disorders  
29 (Kurlan et al., 1996; Eddy and Cavanna, 2013c), they might be different phenomena. It is more  
30 likely that there is a common underlying mechanism that facilitates both coprophenomena and  
31 NOSI that could be related to impulse control, decision making processes, sensitivity to social cues



1 (Eddy and Cavanna, 2013a;Eddy, 2016;2018) or compulsive tendencies (Kurlan et al., 1996;Eddy  
2 and Cavanna, 2013c). It has been suggested that difficulties in distinguishing between the mental  
3 states of self and others may be associated with socially inappropriate behaviors in TDs (Eddy,  
4 2016;Eddy et al., 2017;Eddy, 2018). However, experimental data will be needed to confirm this  
5 association directly and whether the same mechanism is applicable to ADHD and conduct  
6 problems. Which mechanisms are found to play into NOSI may also depend on how NOSI is  
7 operationalized. In this study, the frequency of being rude or noisy in public and the frequency of  
8 misbehaving in lessons were taken as indicators of NOSI.

9 Interestingly, the association between attentional problems and conduct problems was larger with  
10 misbehavior in class than with being rude or noisy in public. Two explanations are possible. First,  
11 it is possible that misbehavior in class is a milder indicator for NOSI than rudeness in public.  
12 Rudeness in public may tap into a different construct that may be closer to insulting others or even  
13 to coprophenomena. Second, it is possible that misbehaving in class is taken as an indicator for  
14 hyperactivity and conduct problems when they are assessed. School records are often used to aid  
15 diagnosis of ADHD for instance. Thus, a more formal definition of NOSI is necessary to avoid  
16 circularity between assessing inattention / conduct problems and assessing NOSI as an  
17 independent construct. In this study, circularity is unlikely because parent-reported SDQ scores  
18 were used, rather than diagnoses. Classroom behavior is unlikely to play an important role in the  
19 parent's assessment of their child's ADHD and conduct problem symptoms because the  
20 questionnaire does not assess them. The NOSI indicators were self-reported by the adolescents  
21 and therefore independent from the SDQ scores. Furthermore, the experimental data on decision  
22 making is independent of both of them. Interestingly, the data show that parent-rated problems and  
23 risky decisions in the CGT only predicted risky behavior in public and school to a small extent.

24 Decision making processes were explored in this study as a possible underlying mechanism for  
25 NOSI. Risk taking ~~and the proportional size of the bet~~ in the CGT ~~were was~~ significantly associated  
26 with misbehaving in class, even when attentional and conduct problems were controlled for. In  
27 contrast, lower quality of decision making was mainly explained by higher attentional and conduct  
28 problems. Interestingly, being rude or noisy in public was not related to risky decision making  
29 processes. Again, the results highlight the necessity for a more formal operationalization of NOSI.  
30 The tendency to make risky decisions could impact NOSI actions, such as damaging objects,  
31 pulling a fire alarm or acting out in class, while NOSI verbalizations, such as insulting others or

1 being rude, may be influenced by other underlying processes, such as sensitivity to social cues  
2 (Eddy and Cavanna, 2013a). Alternatively, there could be a difference in the processes affecting  
3 NOSI in a familiar setting and NOSI in a public setting. It has been shown that NOSI occurs more  
4 commonly in familiar settings than in public settings in tic disorders (Kurlan et al., 1996). To  
5 facilitate future research, it would be useful to formally operationalize NOSI, independent of  
6 disorders, and perhaps to define a clinically relevant cut-off that would allow research in clinical  
7 and subclinical populations.

8 In conclusion, indicators of NOSI were found to be significantly associated with both attention  
9 and conduct problems in adolescents, suggesting a cross-diagnostic phenomenon. Risky decision  
10 making processes were weakly associated with NOSI in a familiar setting but not in a public  
11 setting.

12 A strength of this study is the large sample size and that the indicators of hyperactivity / inattention  
13 and conduct problems were continuous rather than categorical (yes/no). The main limitation of  
14 this study is that only certain indicators of NOSI could be used, i.e. being rude or noisy in public  
15 and misbehaving in lessons. Overall, in order to research NOSI more widely, it would be helpful  
16 to define NOSI more clearly and to define at what point it becomes clinically relevant. For instance,  
17 misbehaving in lessons could be considered a normal, that is, sub-clinical expression of NOSI as  
18 long as it does not lead to serious consequences, such as expulsion from school.

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#### 20 *Author contribution statement*

21 VB and EPC conceptualized the study. VB analyzed the data, VB and JK drafted the manuscript.  
22 EPC drafted the CGT methods section and critically revised the manuscript. Each author  
23 contributed different aspects of expertise: VB on TDs and NOSI, JK on ADHD, EPC on the CGT  
24 and CD.

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Table 1. Association between NOSI indicators and indicators of hyperactivity, conduct and emotional problems

<b>Rude / noisy in public</b>	<b>SDQ hyperactivity / inattention</b>	<b>SDQ conduct problems</b>	<b>SDQ emotional problems</b>	<b>Sex</b>
N	<del>1211</del> 1244	<del>1211</del> 1244	<del>1211</del> 1244	<del>1211</del> 1280
<i>rho</i> ( <i>p</i> )	.176 (< .001) <sub>2</sub>	.16-17 (< .001)	.06-07 (.05402)	-.007 (.82)
95% CI	.11-.22	.11-.22	.01 - .13	-.06 - .05
Partial <i>rho</i> controlled for sex	.17 (< .001)	.17 (< .001)	.07 (.016)	
<b>Misbehavior in lessons</b>				
N	<del>10586</del> 11021	<del>11029</del> 10586	<del>11026</del> 10586	<del>10586</del> 11358
<i>rho</i> ( <i>p</i> )	.28 ( <i>p</i> < .001)	.24 ( <i>p</i> < .001)	.01 ( <i>p</i> = .2935)	<del>-.15-16</del> (< .001)
95% CI	.27 - .31	.23 - .27	-.01 - .03	-.18 – (-.14)
Partial <i>rho</i> controlled for sex	.26 ( <i>p</i> < .001)	.24 ( <i>p</i> < .001)	-.03 ( <i>p</i> < .001)	
95% CI	.25 - .29	.23 - .27	-.05 – (- .01)	

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The table displays correlation coefficients for the association between indicators of non-obscene socially inappropriate behavior (NOSI) and SDQ subscales hyperactivity / inattention, conduct problems and emotional problems. Partial correlations are controlled for sex. CI = confidence interval.

Table 2. Association between NOSI indicators and CGT subscales

<b>Rude / noisy in public</b>	<b>CGT risk taking</b>	<b>CGT Quality of decision making</b>	<b>CGT overall proportional bet</b>
N	1217	1217	1217
<i>rho (p)</i>	.05 (.10)	-.05 (.096)	.05 (.063)
95% CI	-.01 - .11	-.11 - .01	-.01 - .11
<b>Misbehavior in lessons</b>			
N	10653	10654	10654
<i>rho (p)</i>	.14 (< .001)	-.09 (< .001)	.13 (< .001)
95% CI	.12 - .16	-.11 – (-.07)	.11 - .15
Partial <i>rho</i> controlled for sex, SDQ hyperactivity / inattention and SDQ conduct disorder	.10 ( .001)	-.03 ( .274)	.10 ( .001)
95% CI	.08 - .12	-.05 – (-.01)	.08 - .12
<b>Sex</b>			
N	10718	10719	10719
<i>rho (p)</i>	-.25 (< .001)	.02 (.019)	-.22 (< .001)
95% CI	-.27 – (-.23)	.001 - .04	-.23 – (-.20)

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2 The table displays correlation coefficients for the association between indicators of non-obscene  
 3 socially inappropriate behavior (NOSI) and three subscales of the Cambridge gambling task  
 4 (CGT). CI = confidence interval.

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1 *Figure legends*

2 Figure 1

3 The Cambridge Gambling Task. Participants have to place a bet whether a token is hidden in the  
4 red or the blue boxes at the top. Box colour is chosen using the selection boxes at the bottom of  
5 the screen. If the bet is correct, the number of points bet are added to their score.

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