

Supplemental Information for

“Impulsivity Is a Stable, Measurable, and Predictive Psychological Trait”

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Measure Descriptions

1. Self-Report Impulsivity Measures

We administered 10 self-report impulsivity scales with a total of 28 independent variables (Table 1). In each scale, we added three to five lie items from the lie subscale of either the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) or the Revised Eysenck Personality Questionnaire Short Scale for Chinese (Qian et al., 2000). This resulted in a total of 34 lie items, of which 21 were unique. To identify and filter out inattentive responses, we inserted one check item in the middle of each scale, instructing participants to select a specific option. All items in each scale were translated into Chinese with cross-checking and discussions involving at least three researchers. A brief description of each of the 10 scales is given below.

Barratt Impulsiveness Scale 11 (BIS-11; Patton et al., 1995). The BIS-11 is composed of three second-order factors: attentional, motor, and nonplanning impulsiveness. Each consists of two first-order factors: Attentional impulsiveness is composed of attention (e.g., “I am restless at the theater or lectures”) and cognitive instability (e.g., “I often have extraneous thoughts when thinking”); motor impulsiveness is composed of motor impulsiveness (e.g., “I often act on impulses”) and perseverance (e.g., “I change residences”); and nonplanning impulsiveness is composed of self-control (e.g., “I plan tasks carefully”) and cognitive complexity (e.g., “I like puzzles”). The Chinese version of the scale (Li et al., 2011) contains 30 items and uses a five-point response scale.

Behavioral Inhibition System/Behavioral Activation System Scale (BIS/BAS).

Carver and White (1994) developed the BIS/BAS scale to measure Gray's two motivational systems: the behavioral approach system (BAS) and the behavioral inhibition system (BIS), which were argued to represent impulsivity and anxiety, respectively (Gray, 1981). This scale consists of 20 items rated on a four-point scale and has four subscales: BAS drive (e.g., "I go out of my way to get things I want"), BAS fun seeking (e.g., "I am always willing to try something new if I think it will be fun"), BAS reward responsiveness (e.g., "When I am doing well at something, I love to keep at it"), and BIS (e.g., "Even if something bad is about to happen to me, I rarely experience fear or nervousness").

Dickman Impulsivity Inventory (DII; Dickman, 1990). DII distinguishes between two types of impulsivity based on their consequences: functional impulsivity and dysfunctional impulsivity. The functional impulsivity subscale consists of 11 true/false items (e.g., "I dislike doing things slowly, even if they are not very difficult"), and the dysfunctional impulsivity subscale consists of 12 true/false items (e.g., "I often act without thinking through a situation").

Eysenck's I-7 (I-7; Eysenck & Eysenck, 1978). The I-7 scale comprises three components: impulsivity, venturesomeness, and empathy. For the purpose of our study, we administered the 19 items for the impulsivity component (e.g., "Do you tend to act on the spur of the moment?") and the 16 items for the venturesomeness component (e.g., "Would you like to travel alone in a foreign country?") only. All items were answered with a true/false format.

Impulsive Sensation Seeking Scale (IMPSS; Zuckerman et al., 1993). The IMPSS is a subscale of the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ) and measures the combination of impulsivity and sensation seeking. It includes 11 true/false items for sensation seeking and eight true/false items for impulsiveness.

Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). Torrubia et al. (2001) developed SPSRQ to measure Gray's anxiety and impulsivity personality dimensions (Gray, 1981). This 48-item scale uses a yes–no response format and includes two subscales: a 24-item Sensitivity to Punishment scale (e.g., “Do you often refrain from doing something because you are afraid of it being illegal?”) and a 24-item Sensitivity to Reward scale (e.g., “Does the good prospect of obtaining money motivate you strongly to do some things?”).

UPPS-P Impulsive Behavior Scale. The UPPS-P is a widely used scale to measure five factors of impulsivity: (negative) urgency (e.g., “I have trouble controlling my impulses”), (lack of) premeditation (e.g., “I have a reserved and cautious attitude toward life”), (lack of) perseverance (e.g., “I generally like to see things through to the end”), sensation seeking (e.g., “I generally seek new and exciting experiences and sensations”), and positive urgency (e.g., “When I am very happy, I can't seem to stop myself from doing things that can have bad consequences”). The scale consists of 59 items with a four-point response format. Whiteside and Lynam (2001) initially developed the first four factors of UPPS; Cyders et al. (2007) later added positive urgency as the fifth factor.

Multidimensional Personality Questionnaire–Control (MPQ-C; Patrick et al., 2002). The MPQ is a comprehensive inventory that measures various personality traits. For the purposes of our study, we used only the 24 true/false items from the control subscale (e.g., “I keep close track of where my money goes”).

The Revised NEO Personality Inventory (NEO PI-R). Developed by Costa and McCrae (1992), the NEO PI-R is a scale measuring the Big Five personality traits. All items are answered on a five-point scale. We only used the eight items measuring impulsivity (e.g., “Sometimes I do things on impulse that I later regret”), the eight items measuring self-discipline (e.g., “I am pretty good about pacing myself so as to get things done on time”), the eight items measuring deliberation (e.g., “Occasionally I act first and think later”), and the eight items measuring excitement seeking (e.g., “I often crave excitement”).

Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987). The TPQ measures three personality factors: novelty seeking, harm avoidance, and reward dependence, with a true/false response format. We used only the eight items from the novelty seeking subscale (e.g., “I often react so strongly to unexpected news that I say or do things that I regret”).

2. Behavioral Tasks

We administered 10 impulsivity behavioral tasks with a total of 20 dependent variables (Table 1). For each behavioral task, we selected the most commonly applied settings in previous research. Because the tasks were carried out online, we made efforts to reduce potential confoundings because of participants’ lack of effort or attention. In

three tasks (Balloon Analogue Risk Task, passive avoidance with loss of reward, and decision from experience), participants were incentivized to gain extra rewards for their performance. In four tasks (go/no-go, stop signal task, immediate and delayed memory tasks, and synthetic face identification task), we implemented control criteria to determine whether participants paid sufficient attention to the tasks. Participants who did not meet the criteria on the first try were asked to redo the task for a maximum of three tries; after that, they were allowed to proceed to the next task regardless of whether their performance met the criteria. For participants trying a task multiple times, their best performance was recorded as their performance in the task. In the delay discounting task, we set a data-inclusion criterion to exclude questionable data. A brief description of each of the 10 tasks is given below.

Balloon Analogue Risk Task (BART; Lejuez et al., 2002). In this task, participants were presented with a series of 30 simulated balloons, one at a time. Each balloon could be inflated by clicking a “pump” button. If the balloon did not explode after a pump, a 0.02 RMB reward would be added to a temporary bank. However, if it did explode, all money in the temporary bank would be lost. Participants could stop pumping the balloon at any point by clicking a “collect money” button, which transferred the accumulated money from the temporary bank to a permanent bank.

As the number of pumps increased, so did the probability of the balloon exploding, ranging from 1/128 to 1. Specifically, the probability of explosion was 1/128 on the first pump, 1/127 the second, 1/126 the third, and so on, until it reached 1 on the 128th pump. The average explosion point was 64 pumps. The dependent measure in this task is the

average number of pumps excluding balloons that exploded (i.e., the average number of pumps prior to money collection). Higher average pumps indicate higher levels of impulsivity.

Decision From Experience (DFE; Hertwig et al., 2004). In this task, participants were presented with 10 two-alternative risky choice problems, where the payoff distributions of the alternatives were hidden from the participants. Participants could learn each alternative's payoff distribution by clicking on the respective button as often as they wished, finding out the payoff outcomes with no real consequences. Once they stopped sampling, participants could press a "decision button" to indicate the alternative they wanted to gamble on. The gamble was then played out, and the payoff was added to an experimental account.

All problems were in the gain domain and were presented in random orders. In five problems, the alternatives differed in both the probability and the amount of the payoff; in the other five problems, the alternatives had the same probabilities but different payoffs. The dependent measure in this task is the average number of sampling times, with fewer sampling times indicating higher impulsivity.

Delay Discounting (DD; Richards et al., 1999). In this task, participants were asked to choose between a fixed amount of delayed payoff and an immediate variable amount. We used the double-limit procedure that includes two top limits (i.e., a maximum top limit and a minimum top limit) and two bottom limits (i.e., a maximum bottom limit and a minimum bottom limit) that were set to zero on the first trial. These limits changed according to the participants' choices as the session progressed until the

difference between the maximum bottom limit and the maximum top limit reached 5% of the fixed amount, and the corresponding variable amount was then taken as the estimate of the indifference point (see details in Richards et al., 1999).

We used three amounts (50 RMB, 500 RMB, and 5,000 RMB) and five delays (after one week, one month, three months, six months, and one year) in the fixed-amount option. To detect careless participants, we inserted one question that had a dominant option (i.e., get 50 RMB today vs. get 5 RMB in 1 week) after every 50 questions. Participants who chose the dominated option in over half of these questions were excluded. The dependent measures are the discounting rates in the three fixed-amount conditions. Higher discounting rates indicate higher impulsivity.

Go/No-Go (GNG; Dong et al., 2010). In this task, participants were instructed to make quick responses by pressing a button in go trials when presented with the letter “O,” and to withhold their response in no-go trials when presented with the letter “S.” The task consisted of 30 practice trials and 300 test trials, of which 80% were go trials and 20% were no-go trials. Each stimulus was shown for a maximum of 1,000 ms. To mitigate potential confounding due to carelessness, participants who had an omission error rate of 75% or higher on go trials or a commission error rate of 25% or higher on no-go trials were retested for a maximum of three times until they achieved lower error rates that met the criteria. The dependent measure is the commission error rate in no-go trials, with a higher rate indicating higher impulsivity.

Passive Avoidance With Loss of Reward (PALR; Newman et al., 1985). In this task, participants saw eight unique two-digit numbers, which were randomly repeated

eight times for a total of 64 trials. Of the eight numbers, four were designated as positive stimuli (S+) and the remaining four negative (S-). The goal for participants was to learn through trial and error when to respond and when to withhold their response. Correct responses were rewarded with 0.50 RMB; incorrect responses resulted in a loss of 0.50 RMB. To avoid punishment, participants had to learn to withhold their response to stimuli that frequently resulted in a loss. No rewards or losses were incurred when participants did not respond. The dependent measure in this task is the commission error rate for negative stimuli, with a higher rate indicating higher levels of impulsivity.

Stop Signal Task (SST; Verbruggen et al., 2019). In this task, participants were instructed to quickly identify the direction of green arrows while maintaining accuracy. However, in 25% of the trials, the arrow was replaced by “XX” after a variable stop-signal delay, indicating a stop trial where participants were required to withhold their response. The stop-signal delay was initially set to 300 ms and was adjusted using a one-up, one-down staircase procedure in increments of 50 ms based on participants’ success in withholding their response on the previous stop trial. Participants completed 32 practice trials with feedback and four blocks of 64 test trials without feedback, with one-fourth of the trials being stop trials. To ensure data quality, participants who performed poorly on go trials (i.e., omission error rate higher than 75%) were asked to repeat the test a maximum of three times until their performance met the criterion. The dependent measure is the stop signal response time, calculated using the integration method with replacement of go omissions (see details in Verbruggen et al., 2019), where a longer stop signal response time indicates higher impulsivity.

Information Sampling (IS; Clark et al., 2006). In this task, participants were presented with a grid of gray boxes arranged in a 10×10 pattern. Each box contained one of two colors, and participants had to guess which color was in the majority after opening as many boxes as they wanted. The task included two conditions: the fixed-win condition and the decreasing-win condition. In the fixed-win condition, participants could win or lose 100 points depending on their response, regardless of how many boxes they opened. In the decreasing-win condition, each round began with 500 points, and opening each box costed 10 points. An incorrect choice in this condition led to a fixed loss of 100 points.

Participants completed 10 rounds in each condition. The proportion of the majority-colored boxes ranged from 51% to 60%. In each condition, participants started with 1,000 points, and the points they earned over the two conditions were added together and then converted to money at a ratio of 500 points to 1 RMB. The dependent measures are the average number of boxes opened and the mean estimated probability of being correct at the point of decision in each condition. A lower average number of boxes opened or a lower mean estimated probability of being correct indicates higher impulsivity.

Time Estimation (TIME; Dougherty et al., 2005). The time estimation task includes two subtasks: the time interval estimation task and the time production task. In the time interval estimation task, participants were presented with a duration of time and asked to estimate how long it lasted. Four time intervals (5 ± 2 s, 10 ± 2 s, 30 ± 2 s, and 60 ± 2 s) were presented twice in random orders. In the time production task,

participants were presented with the same time intervals as in the time estimation task and asked to produce the exact duration by pressing a button to start a timer, holding it throughout the production, and releasing it to stop the timer. The dependent measure for each time interval is the mean estimation bias over both the time estimation task and the time production task, with a larger bias indicating higher impulsivity.

Immediate and Delayed Memory Tasks (IMT and DMT; Dougherty et al., 2002).

The IMT and DMT are continuous performance tests used to assess impulsive behavior. In the IMT, participants were presented with a sequence of five-digit numbers one at a time with a brief intertrial interval, and were instructed to respond when the current number matched the one immediately preceding it. One third of the stimuli were target stimuli that matched the previous number, one third were catch stimuli that differed from the previous number by only one digit, and one third were filler stimuli that were completely different from the previous number. In the DMT, participants were also presented with sequences of five-digit numbers; however, three distractor stimuli were added between the two stimuli to be compared. Participants were instructed to ignore the distractors and to remember and compare the nondistractor stimuli only.

Each task contained 300 stimuli. The dependent measure for both tasks is the ratio of commission errors to correct detections. A higher ratio indicates higher impulsivity.

Synthetic Face Identification Task (SFIT; Liu et al., 2020). In this task, participants were presented with synthetic faces that were either aligned or misaligned, and were instructed to identify the gender of the top half of the face (Task A) or the bottom half of the face (Task B). The faces used were of two male celebrities and two

female celebrities. Participants completed 16 practice trials and 96 test trials in each task, with half of the trials being aligned faces and the other half misaligned faces. To ensure data quality, participants with an accuracy rate below 90% were asked to retake the test for a maximum of three times until they reached a 90% or higher level of accuracy. The dependent measure is the difference in response time between aligned and misaligned faces in each task. A larger difference indicates higher impulsivity.

3. Frequencies of Impulsivity-Related Behaviors

Participants also reported how frequently they had engaged in seven impulsivity-related behaviors in the previous three months. We divided the reporting into three questionnaires: one including smoking and drinking behaviors, one including impulsive buying and impulsive eating, and one including internet gaming, short video app usage, and social media usage. There was one check item in the middle of each questionnaire.

Drinking and Smoking. Drinking was measured by the Alcohol Use Disorders Identification Test (Allen et al., 2001), a 10-item survey using a five-point response scale. Smoking was measured by the Fagerström test for nicotine dependence (Heatherton et al., 1991), which contains six items with a mixed response format that includes true/false and a four-point scale.

Impulsive Buying and Impulsive Eating. The buying impulsiveness scale (Rook & Fisher, 1995), which consists of nine items rated on a seven-point scale, was used to measure impulsive buying. Impulsive eating was measured by the Three-Factor Eating Questionnaire (Karlsson et al., 2000), which consists of 18 items rated on a four-point

scale and assesses three factors: cognitive restraints (six items), uncontrolled eating (nine items), and emotional eating (three items).

Internet Gaming, Short Video App Usage, and Social Media Usage. Internet gaming was assessed using the Internet Gaming Disorder scale (Lemmens et al., 2015), which consists of nine dichotomous items. Short video app usage was measured using a modified version of the Internet Addiction Test that contains nine items rated on a five-point scale (Widyanto & McMurrin, 2004). Social media usage was measured using a modified version of the Bergen Facebook Addiction Scale (Andreassen et al., 2012), in which we replaced Facebook with popular Chinese social media WeChat, Weibo, and QQ. It has six items rated on a five-point scale.

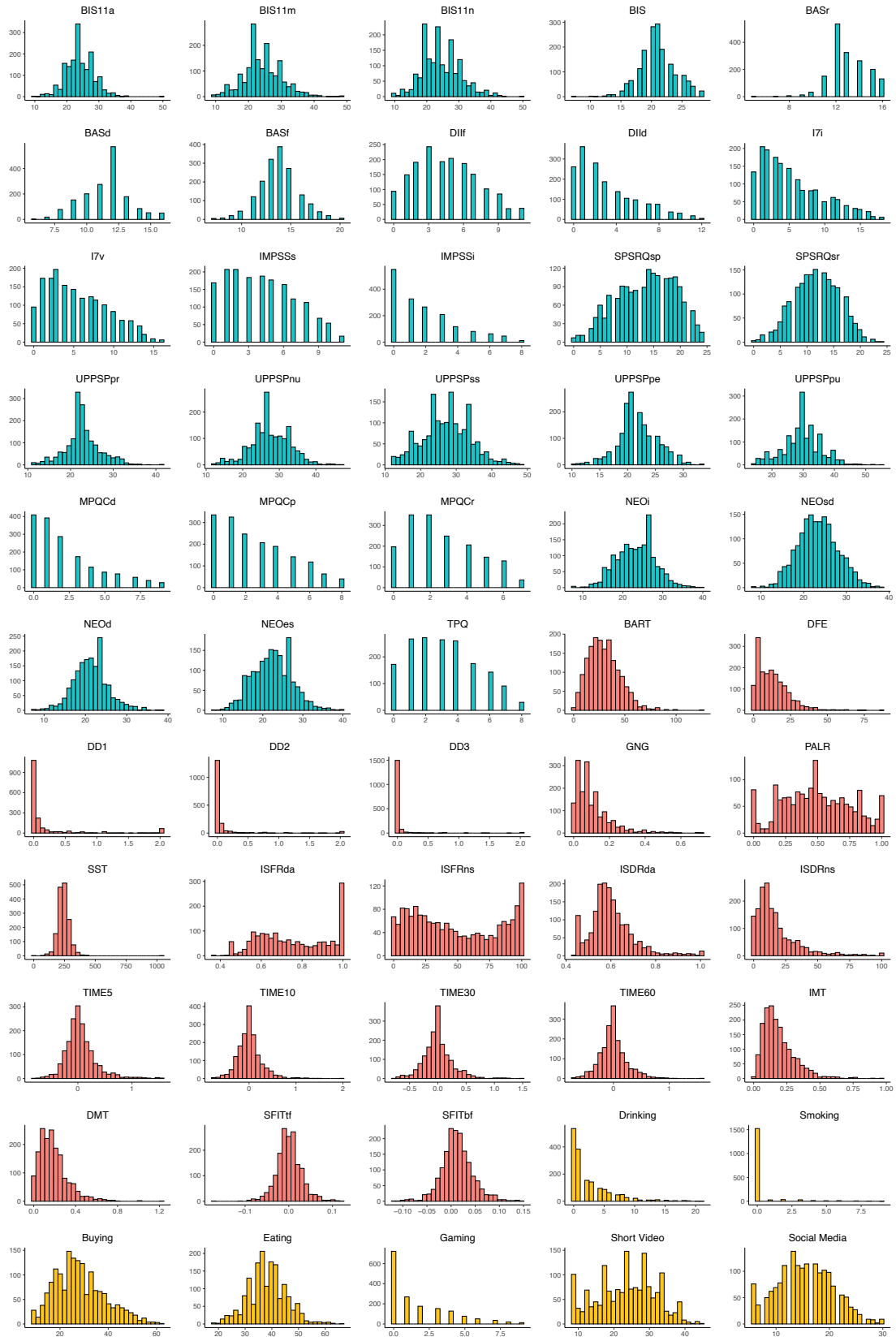


Figure S1. Distributions of all measures of impulsivity and impulsivity-related behaviors. Abbreviations listed in Table 1.

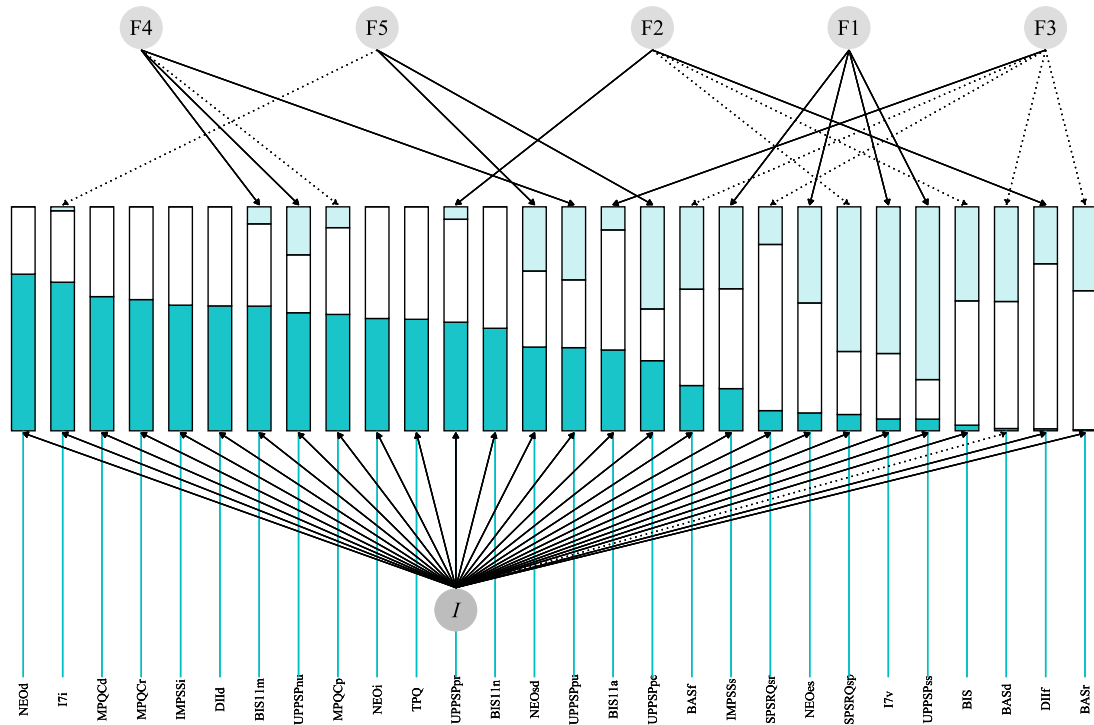


Figure S2. The reduced bifactor model with 28 self-report measures ($N = 1,676$). It contains a general impulsivity factor I and five specific factors.

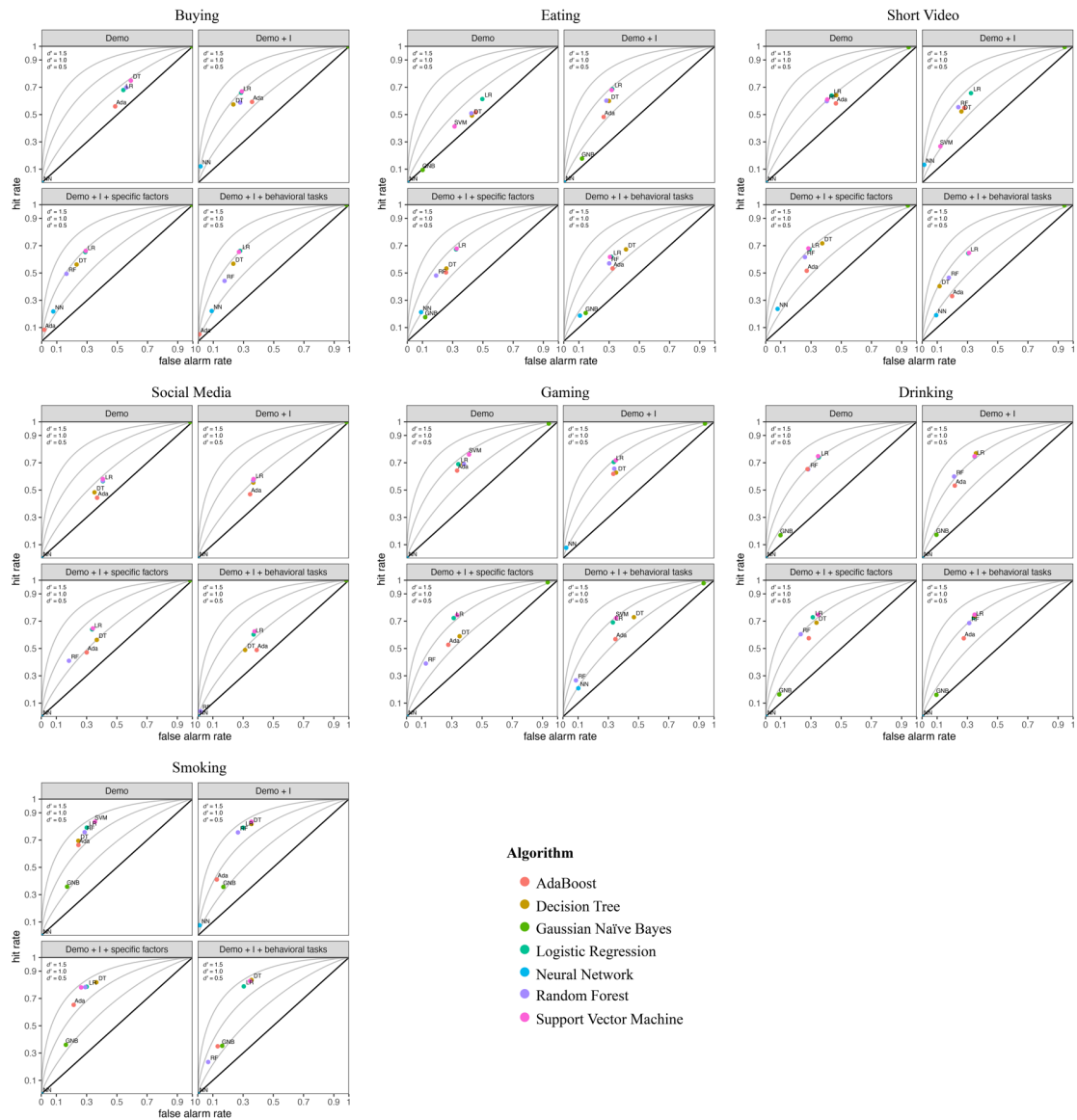


Figure S3. Prediction performances of seven machine-learning algorithms with factor I in the predictor sets. Each algorithm uses four different predictor sets, three of which contain the score of factor I , to predict the seven impulsivity-related behaviors. The title at the top of each small panel indicates the predictor set used for prediction. Each panel shows a model's prediction performance, represented as a point in the graph, with a particular predictor set. In general, the closer the point is to the upper left corner of the graph, the higher its d' (a measure of overall accuracy), and the better its prediction performance.

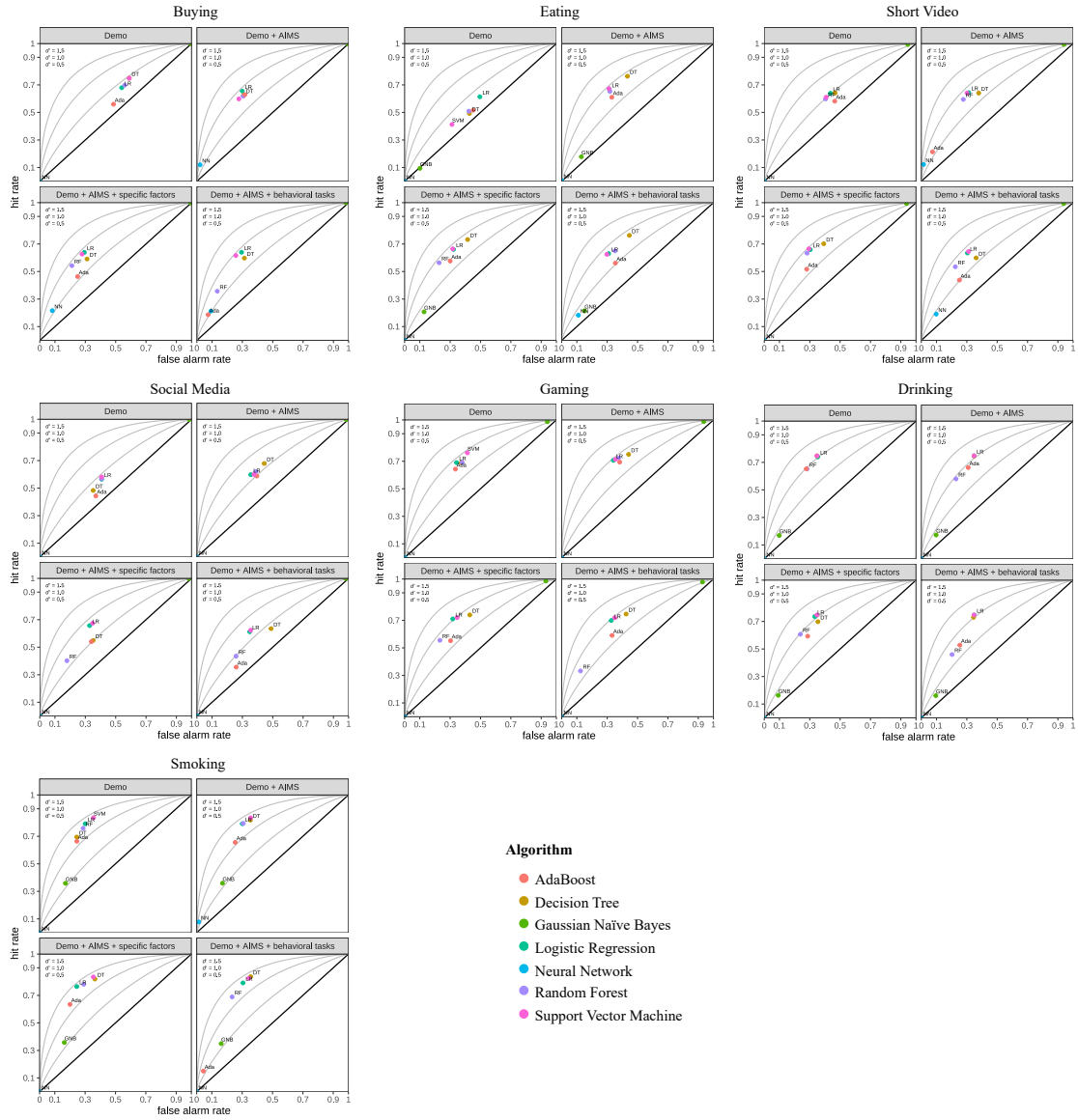


Figure S4. Prediction performances of seven machine-learning algorithms with AIMS-50 in the predictor sets. Each algorithm uses four different predictor sets, three of which contain the score of AIMS-50, to predict the seven impulsivity-related behaviors. The title at the top of each small panel indicates the predictor set used for prediction. Each panel shows a model's prediction performance, represented as a point in the graph, with a particular predictor set. In general, the closer the point is to the upper left corner of the graph, the higher its d' (a measure of overall accuracy), and the better its prediction performance.

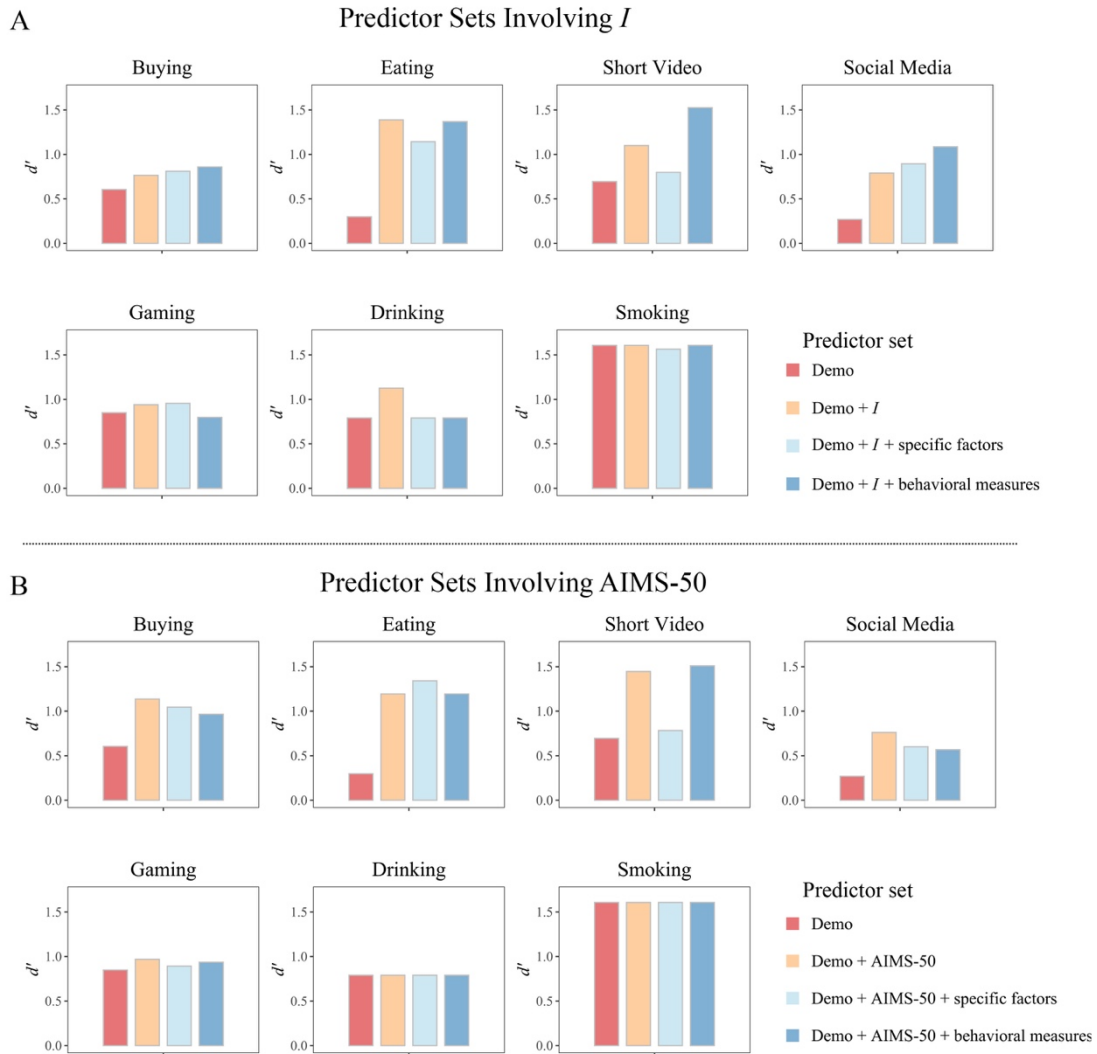


Figure S5. Cross-time prediction performances of the best machine-learning algorithms. We used predictors measured in the first round to predict impulsivity-related behaviors reported in the second round ($N = 196$). The same seven machine-learning algorithms used for the same-time predictions were applied for the cross-time predictions. Panel A shows the performance of the best-performing algorithm among the seven algorithms in predicting each behavior with factor *I* in the predictor sets. Panel B shows similar results with AIMS-50 in the predictor sets.

Table S1. Demographic statistics of study samples

Category	Value	Number of participants	
		Main sample	Retest sample
Sex	Female	1,001	123
	Male	675	73
Age	< 30 years	1,068	124
	30–44 years	540	64
	≥ 45 years	68	8
Occupation	Student	721	85
	Nonstudent	955	111
Education	High school and below	70	6
	Vocational college	134	10
	Bachelor	1,018	117
	Master	421	59
	Doctor	33	4
	Total	1,676	196

Note. All participants in the retest sample were from the main sample.

Table S2. Criteria for judging results as invalid

Measure	Criterion/criteria	Dependent variable	# of invalid cases in 1 st round	# of invalid cases in 2 nd round
Self-report scales				
Barratt Impulsiveness Scale-11	Failed in check item	BIS11a	8	0
		BIS11m	8	0
		BIS11n	8	0
Behavioral inhibition system and behavioral activation system scales	Failed in check item	BIS	13	0
		BASr	13	0
		BASd	13	0
		BASf	13	0
Dickman Impulsivity Inventory	Failed in check item	DIIf	4	0
		DIId	4	0
Eysenck's I-7	Failed in check item	I7i	4	0
		I7v	4	0
Impulsive Sensation Seeking Scale	Failed in check item	IMPSSs	5	0
		IMPSSi	5	0
Sensitivity to Punishment and Sensitivity to Reward Questionnaire	Failed in check item	SPSRQsp	3	0
		SPSRQsr	3	0
UPPS-P Impulsive Behavior scale	Failed in check item	UPPSPpr	14	2
		UPPSPnu	14	2
		UPPSPss	14	2
		UPPSPpe	14	2
		UPPSPpu	14	2
Multidimensional Personality Questionnaire –Control	Failed in check item	MPQCd	9	1
		MPQCp	9	1
		MPQCr	9	1
NEO PI-R	Failed in check item	NEOi	14	1
		NEOsd	14	1
		NEOd	14	1
		NEOes	14	1
Tridimensional Personality Questionnaire	Failed in check item	TPQ	2	0
Behavioral tasks				
Balloon Analogue Risk Task	No unexploded balloons	BART	1	0
Decision from experience	Missing value	DFE	0	0
Delay discounting	1. Failed in probe questions 2. Unable to fit the hyperbolic function 3. Experimental procedure error	DD1	17	3
		DD2	17	3
		DD3	17	3
Go/no-go	Missing value	GNG	0	0
Passive avoidance with loss of reward	Missing value	PALR	0	0
Stop signal task	1. Assumptions not met: (1) $0.25 < P(\text{respond} \text{signal}) < 0.75$ (2) Mean response time of stop trials < mean response time of go trials 2. Experimental procedure error	SST	115	7

Information Sampling task with fixed rewards and decreased rewards (ISFR and ISDR)	Missing value	ISFRda	0	0
		ISFRns	0	0
		ISDRda	0	1
		ISDRns	0	1
Time estimation (TIME)	The average bias is beyond three standard deviations, and more than two trials with a bias greater than 2 or less than 2/3.	TIME5	0	0
		TIME10	3	0
		TIME30	0	0
		TIME60	1	0
Immediate and Delayed Memory Task (IMT and DMT)	1. Correct detection rate ≤ 0.2 2. Correct rate in filler trials ≤ 0.5	IMT	8	1
		DMT	10	1
Synthetic face identification task	1. Correct rate < 0.9 2. Missing value	SFITf	10	1
		SFITbf	10	1
Frequency of impulsivity-related behaviors				
Alcohol Use Disorders Identification Test	Failed in check item	Drinking	11	1
Fagerström test for nicotine dependence	Failed in check item	Smoking	11	1
Buying impulsiveness scale	Failed in check item	Buying	23	0
Three-Factor Eating Questionnaire	Failed in check item	Eating	23	0
Nine-item Internet Gaming Disorder Scale	Failed in check item	Gaming	31	0
Short video app addiction test, adopted from the Internet Addiction Test	Failed in check item	Short Video	31	0
Social media addiction scale, adopted from the Bergen Facebook Addiction Scale	Failed in check item	Social Media	31	0

Table S3. Internal consistency (Cronbach's alpha) of the impulsivity scales

Scale	Subscale	Cronbach's alpha
Barratt Impulsiveness Scale-11	Attentional impulsiveness	0.76
	Motor impulsiveness	0.88
	Nonplanning impulsiveness	0.87
Behavioral inhibition system and behavioral activation system scales (BIS/BAS)	BIS	0.78
	BAS-reward responsiveness	0.66
	BAS-drive	0.76
Dickman Impulsivity Inventory	BAS-fun seeking	0.63
	Functional impulsivity	0.73
	Dysfunctional impulsivity	0.79
Eysenck's I-7	Impulsiveness	0.84
	Venturesomeness	0.82
Impulsive Sensation Seeking Scale	Impulsive sensation seeking	0.83
Sensitivity to Punishment and Sensitivity to Reward Questionnaire	Sensitivity to punishment	0.85
	Sensitivity to reward	0.76
	Premeditation	0.85
UPPS-P Impulsive Behavior Scale	Negative urgency	0.87
	Sensation seeking	0.89
	Perseverance	0.77
Multidimensional Personality Questionnaire – Control	Positive urgency	0.89
	Control	0.89
	Impulsiveness	0.76
NEO PI-R	Self-discipline	0.78
	Deliberation	0.77
	Excitement seeking	0.67
Tridimensional Personality Questionnaire	Novelty seeking	0.66

Table S4. Pairwise Spearman correlations among all impulsivity measures

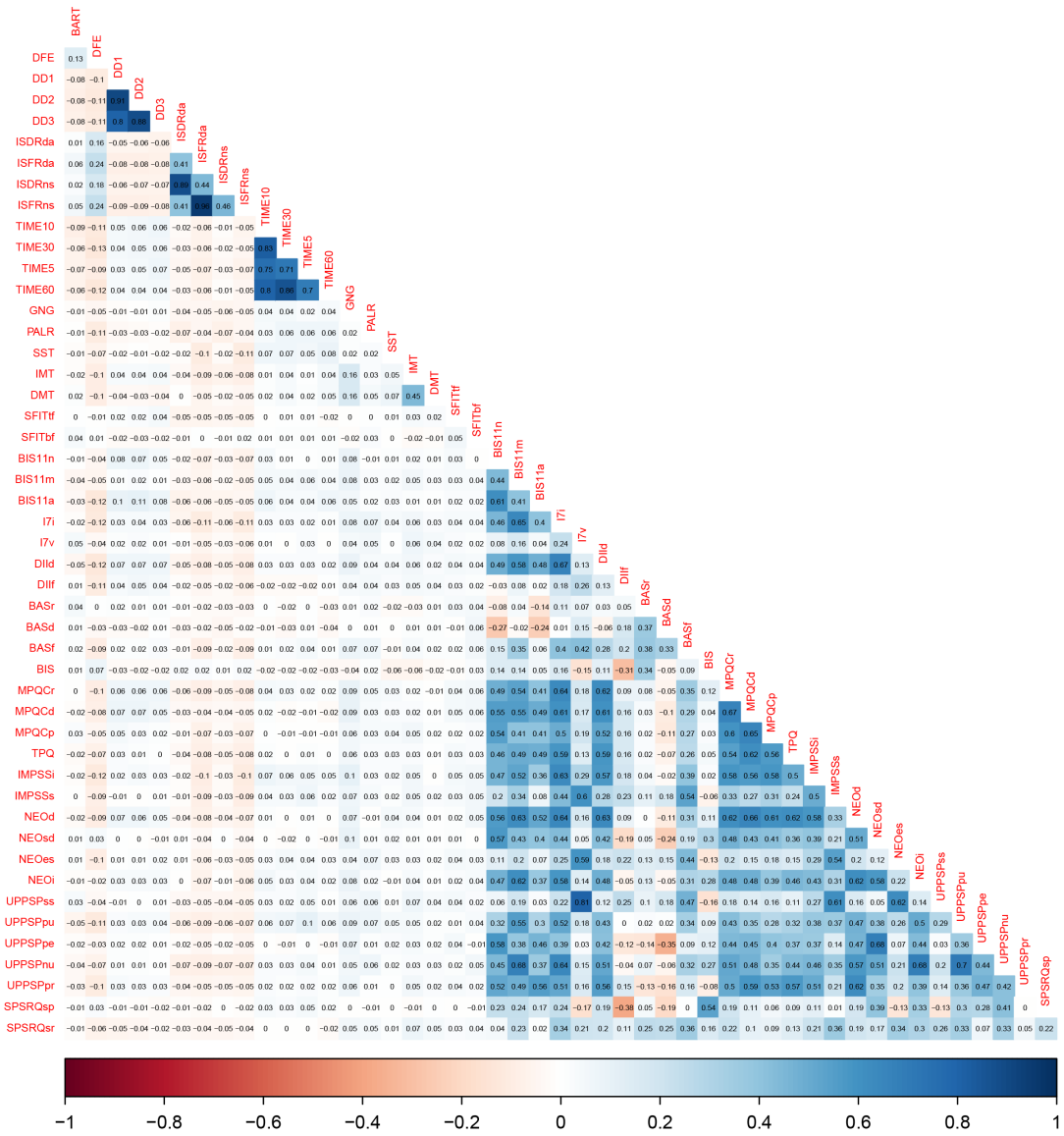


Table S5. Factor loadings in the bifactor model with all 48 impulsivity measures as results of a confirmatory factor analysis

Variable	<i>I</i>	F1	F2	F3	F4	F5	F6	h2
BIS11a	0.57						0.38	0.47
BIS11m	0.76							0.58
BIS11n	0.65						0.42	0.61
BIS	0.19					0.62		0.42
BASr	0.12						-0.46	0.22
BASd	-0.03						-0.73	0.53
BASf	0.41		0.47					0.39
DIIf	0.08					-0.51		0.26
DIId	0.75							0.56
I7i	0.81							0.65
I7v	0.22		0.79					0.67
IMPSSs	0.43		0.63					0.58
IMPSSi	0.75							0.57
SPSRQsp	0.31					0.79		0.72
SPSRQsr	0.34						-0.35	0.24
UPPSPpr	0.68					-0.28		0.55
UPPSPnu	0.74							0.54
UPPSPss	0.22		0.87					0.81
UPPSPpe	0.54						0.52	0.57
UPPSPpu	0.63							0.39
MPQcd	0.77					-0.19		0.63
MPQcp	0.68					-0.21		0.51
MPQcr	0.77							0.59
NEOi	0.71							0.51
NEOsd	0.60						0.31	0.46
NEOd	0.83							0.70
NEOes	0.27		0.67					0.52
TPQ	0.70					-0.17		0.52
BART	-0.04							0.00
DFE	-0.13							0.02
DD1	0.05			0.89				0.79
DD2	0.06			1.00				1.00
DD3	0.05			0.88				0.78
GNG	0.11							0.01
PALR	0.06							0.00
SST	0.05							0.00
ISFRda	-0.12				0.95			0.93
ISFRns	-0.12				0.97			0.95
ISDRda	-0.05				0.46			0.21
ISDRns	-0.05				0.49			0.24
TIME5	0.05	0.75						0.56
TIME10	0.05	0.90						0.81
TIME30	0.04	0.94						0.89
TIME60	0.03	0.91						0.83
IMT	0.06							0.00
DMT	0.03							0.00
SFITtf	0.04							0.00
SFITbf	0.05							0.00
SS loadings	9.40	3.14	2.92	2.63	1.99	1.86	1.76	

Note. “h2” is the amount of variance in the variable explained by the factors, and “SS loadings” are the eigenvalues in exploratory factor analysis.

Table S6. Factor loadings in the reduced bifactor model with 28 self-report impulsivity measures as results of a confirmatory factor analysis

Variable	<i>I</i>	F1	F2	F3	F4	F5	h2
BIS11a	0.60			0.32			0.46
BIS11m	0.75				0.28		0.63
BIS11n	0.68						0.46
BIS	0.16		-0.65				0.45
BASr	0.07			-0.61			0.38
BASd	-0.10			-0.65			0.43
BASf	0.45			-0.61			0.57
DIIf	0.10		0.50				0.26
DIId	0.75						0.56
I7i	0.81					-0.13	0.68
I7v	0.23	0.81					0.71
IMPSSs	0.43	0.60					0.55
IMPSSi	0.75						0.56
SPSRQsp	0.27		-0.80				0.72
SPSRQsr	0.30			-0.41			0.26
UPPSPpr	0.70		0.24				0.54
UPPSPnu	0.73				0.57		0.85
UPPSPss	0.23	0.88					0.82
UPPSPpe	0.56					0.68	0.77
UPPSPpu	0.61				0.46		0.59
MPQcd	0.77						0.60
MPQcp	0.72				-0.30		0.61
MPQcr	0.77						0.59
NEOi	0.71						0.50
NEOsd	0.61					0.54	0.66
NEOd	0.84						0.70
NEOes	0.28	0.66					0.51
TPQ	0.71						0.50
SS loadings	9.48	2.86	1.68	1.62	0.84	0.77	

Note. “h2” is the amount of variance in the variable explained by the factors, and “SS loadings” are the eigenvalues in exploratory factor analysis.

Table S7. Fit indices of different psychometric models as results of confirmatory factor analyses

Model	RMSEA	SRMR	TLI	CFI
Unidimensional model	0.100	0.118	0.753	0.764
Two factors				
Multidimensional model	0.089	0.108	0.807	0.815
Second-order model	0.089	0.108	0.807	0.815
Bifactor model	0.087	0.107	0.813	0.824
Four factors				
Multidimensional model	0.076	0.084	0.859	0.866
Second-order model	0.075	0.084	0.859	0.866
Bifactor model	0.060	0.069	0.911	0.916
Six factors				
Multidimensional model	0.063	0.072	0.903	0.908
Second-order model	0.064	0.073	0.899	0.904
Bifactor model	0.055	0.064	0.925	0.930
Eight factors				
Multidimensional model	0.059	0.068	0.914	0.920
Second-order model	0.064	0.072	0.900	0.905
Bifactor model	0.053	0.061	0.931	0.936

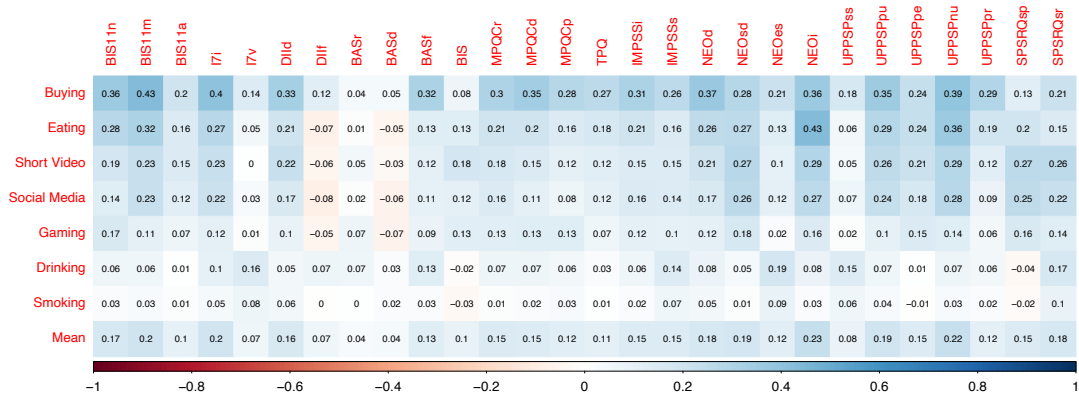
Table S8. Coefficients ω , ω_H , and ω_{HS} for the two bifactor models

The full model	Total score	F1	F2	F3	F4	F5	F6
ω	0.924	0.931	0.876	0.948	0.833	0.851	0.858
ω_H OR ω_{HS}	0.751	0.929	0.729	0.945	0.822	0.337	0.297

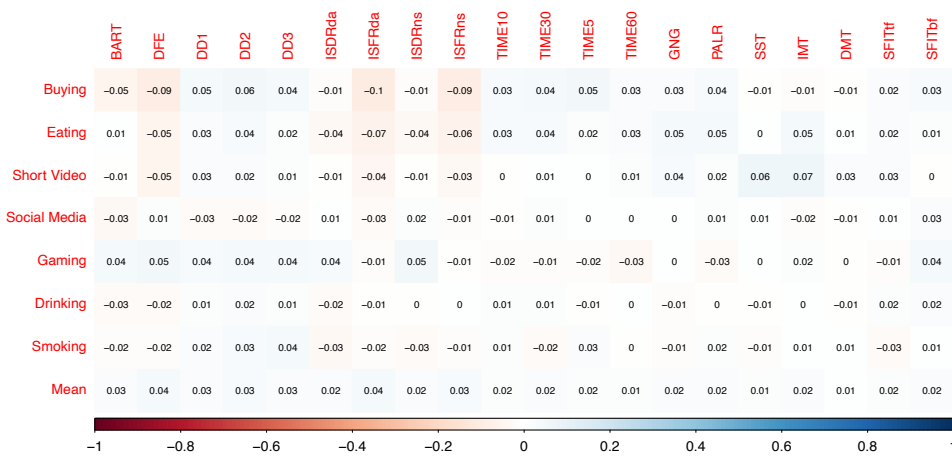
The reduced model	Total score	F1	F2	F3	F4	F5
ω	0.952	0.878	0.756	0.758	0.888	0.866
ω_H OR ω_{HS}	0.854	0.757	0.577	0.565	0.222	0.272

Table S9. Spearman correlations between impulsivity measures and impulsivity-related behaviors

Self-report scales



Behavioral tasks



Extracted factors and Impulsivity scales (AIMS-50, BIS-11)



Note. “Best” means the measure among all existing measures that had the highest correlation with a certain impulsivity-related behavior. “BIS-11” is the total score of the Barrat Impulsiveness Scale-11.

Table S10. The adjustable impulsivity scale (AIMS) with items in their original response formats and the psychometric properties of the scale with varied length

	Item	Correlation with factor <i>I</i>	Cronbach's alpha	Test-retest reliability
1	Sometimes I do things on impulse that I later regret.	0.57	—	0.43
2	I often do things on the spur of the moment.	0.73	0.62	0.60
3	I am always able to keep my feelings under control. (R)	0.75	0.66	0.66
4	I often make matters worse because I act without thinking when I am upset.	0.78	0.71	0.70
5	I say things without thinking.	0.80	0.75	0.73
6	When I am upset, I often act without thinking.	0.82	0.78	0.73
7	I often get involved in things I later wish I could get out of.	0.83	0.79	0.76
8	Over the years, I have done some pretty stupid things.	0.83	0.81	0.77
9	I always consider the consequences before I take action. (R)	0.85	0.82	0.76
10	When a project gets too difficult, I am inclined to start a new one.	0.86	0.82	0.76
11	I have trouble controlling my impulses.	0.87	0.84	0.77
12	When I feel rejected, I will often say things that I later regret.	0.87	0.85	0.78
13	I sometimes eat myself sick.	0.87	0.84	0.79
14	I waste a lot of time before settling down to work.	0.86	0.85	0.80
15	In the heat of an argument, I will often say things that I later regret.	0.86	0.86	0.81
16	There are so many little jobs that need to be done that I sometimes just ignore them all.	0.87	0.86	0.81
17	I think things through before coming to a decision. (R)	0.88	0.87	0.80
18	I have trouble resisting my cravings.	0.88	0.87	0.80
19	I am often not as cautious as I should be.	0.89	0.88	0.80
20	I am a productive person who always gets the job done. (R)	0.89	0.88	0.81
21	When excited, I cannot control myself.	0.89	0.89	0.81
22	Are you an impulsive person?	0.89	0.89	0.82
23	I tend to give up easily.	0.90	0.89	0.82
24	I often get into trouble because I don't think before I act.	0.90	0.90	0.82
25	I have trouble making myself do what I should.	0.89	0.90	0.82
26	I buy things on impulse.	0.90	0.90	0.83
27	I often react so strongly to unexpected news that I say or do things that I regret.	0.90	0.91	0.83
28	I often follow my instincts, hunches, or intuition without thinking through all the details.	0.90	0.91	0.83
29	I am pretty good about pacing myself so as to gets things done on time. (R)	0.90	0.91	0.84
30	I think twice before I answer a question. (R)	0.91	0.91	0.83
31	I behave rationally. (R)	0.91	0.91	0.83
32	Often, I don't spend enough time thinking over a situation before I act.	0.92	0.92	0.83
33	I am more likely to do things quickly and carelessly rather than slowly and carefully.	0.92	0.92	0.83
34	I often make up my mind without taking the time to consider the situation from all angles.	0.92	0.92	0.84
35	Once I start a project, I almost always finish it. (R)	0.92	0.92	0.84
36	When good things happen to me, it affects me strongly.	0.92	0.92	0.84
37	When I feel bad, I will often do things I later regret in order to make myself feel better now.	0.92	0.92	0.84
38	Do you need to use a lot of self-control to keep out of trouble?	0.92	0.92	0.84
39	I often stop one thing before completing it and start another.	0.92	0.92	0.84
40	I am future oriented. (R)	0.92	0.93	0.84
41	It is hard for me to resist acting on my feelings.	0.93	0.93	0.84
42	Do you get so "carried away" by new and exciting ideas that you never think of possible snags?	0.93	0.93	0.84
43	I plan ahead carefully when I go on a trip. (R)	0.93	0.93	0.84

44	I plan tasks carefully. (R)	0.93	0.93	0.84
45	I have little difficulty resisting temptation. (R)	0.93	0.93	0.85
46	When face a difficult problem, I keep thinking till I find a solution. (R)	0.93	0.93	0.85
47	Many times, the plans I make don't work out because I haven't gone over them carefully enough in advance.	0.93	0.94	0.85
48	I often say and do things without considering the consequences.	0.93	0.94	0.85
49	Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.	0.93	0.94	0.85
50	I am very levelheaded, usually have both feet on the ground. (R)	0.93	0.94	0.85

Note. Reverse scoring for items with (R). The three columns on the right show the psychometric properties for AIMS with items up to a specific row. For example, with 10 items that include Item 1 to Item 10, values of the three properties are 0.86, 0.82, and 0.76, respectively.

Response format

- a. "Strongly disagree / Disagree / Neutral / Agree / Strongly agree" for items 1, 2, 3, 8, 9, 10, 13, 14, 16, 17, 18, 20, 25, 29, 30, 35, 43, 45.
- b. "Strongly disagree / Disagree / Agree / Strongly agree" for items 4, 6, 7, 11, 12, 15, 23, 36, 37, 41, 49.
- c. "Not at all / Seldom / Sometimes / Usually / Always" for items 5, 21, 26, 31, 40, 44, 46.
- d. "True / False" for items 19, 22, 24, 27, 28, 32, 33, 38, 39, 42, 47, 48, 50.

An Independent Study Testing a Reformatted AIMS-50

The items in AIMS were selected from existing scales that differ in response format (see Table S10). This may create inconveniences in the application of AIMS. In a reformatted version of AIMS (see Table S11), we unified responses to all items with a four-point scale, and changed three question items to statements. Specifically, we changed the item “Are you an impulsive person?” to “I am an impulsive person”; the item “Do you need to use a lot of self-control to keep out of trouble?” to “I need to use a lot of self-control to keep out of trouble”; and the item “Do you get so ‘carried away’ by new and exciting ideas that you never think of possible snags?” to “I get so ‘carried away’ by new and exciting ideas that I never think of possible snags.”

To examine the psychometric properties of this reformatted AIMS-50, we recruited an independent sample of 273 participants to complete the scale. After removing 37 participants who failed at attention checks, a sample of 236 participants remained (106 females, $M_{\text{age}} = 23.44$ years).

Figure S6 shows the distribution of participants’ total scores in the reformatted AIMS, and it is close to a normal distribution. With Cronbach’s alpha at 0.96, the internal consistency of the reformatted AIMS was very high. We then conducted a confirmatory factor analysis to check the fit of a single-factor model, and the results show a good fit of this model: SRMR = 0.07, RMSEA = 0.03, CFI = 0.99, and TLI = 0.99. These results indicate that the original AIMS could be replaced with the formatted one in the measurement of factor *I*.

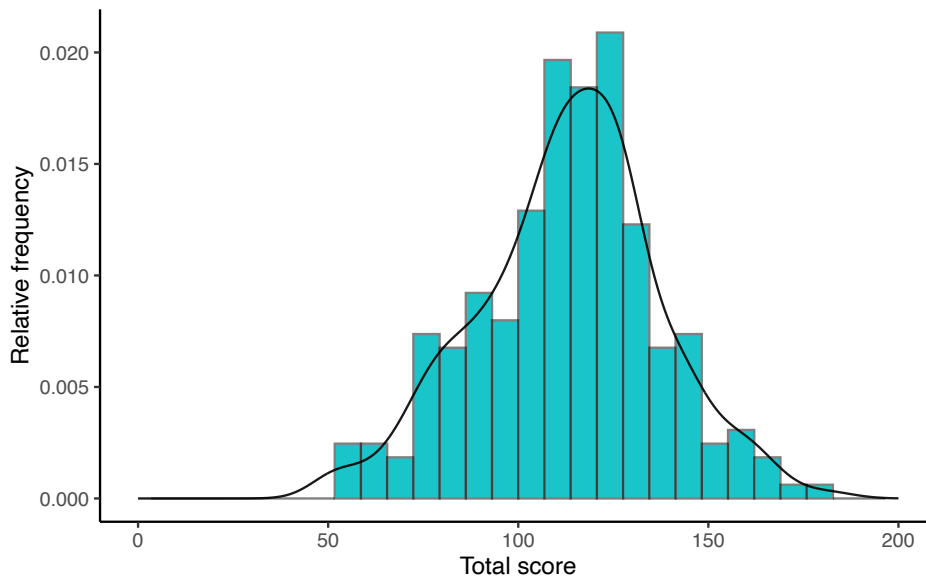


Figure S6. Score distribution of the reformatted AIMS-50 in an independent sample ($N = 236$).

Table S11. AIMS-50 with a unified response format

	Item
1	Sometimes I do things on impulse that I later regret.
2	I often do things on the spur of the moment.
3	I am always able to keep my feelings under control. (R)
4	I often make matters worse because I act without thinking when I am upset.
5	I say things without thinking.
6	When I am upset, I often act without thinking.
7	I often get involved in things I later wish I could get out of.
8	Over the years, I have done some pretty stupid things.
9	I always consider the consequences before I take action. (R)
10	When a project gets too difficult, I am inclined to start a new one.
11	I have trouble controlling my impulses.
12	When I feel rejected, I will often say things that I later regret.
13	I sometimes eat myself sick.
14	I waste a lot of time before settling down to work.
15	In the heat of an argument, I will often say things that I later regret.
16	There are so many little jobs that need to be done that I sometimes just ignore them all.
17	I think things through before coming to a decision. (R)
18	I have trouble resisting my cravings.
19	I am often not as cautious as I should be.
20	I am a productive person who always gets the job done. (R)
21	When excited, I cannot control myself.
22	I am an impulsive person.
23	I tend to give up easily.
24	I often get into trouble because I don't think before I act.
25	I have trouble making myself do what I should.
26	I buy things on impulse.
27	I often react so strongly to unexpected news that I say or do things that I regret.
28	I often follow my instincts, hunches, or intuition without thinking through all the details.
29	I am pretty good about pacing myself so as to get things done on time. (R)
30	I think twice before I answer a question. (R)
31	I behave rationally. (R)
32	Often, I don't spend enough time thinking over a situation before I act.
33	I am more likely to do things quickly and carelessly rather than slowly and carefully.
34	I often make up my mind without taking the time to consider the situation from all angles.
35	Once I start a project, I almost always finish it. (R)
36	When good things happen to me, it affects me strongly.
37	When I feel bad, I will often do things I later regret in order to make myself feel better now.
38	I need to use a lot of self-control to keep out of trouble.
39	I often stop one thing before completing it and start another.
40	I am future oriented. (R)
41	It is hard for me to resist acting on my feelings.
42	I get so 'carried away' by new and exciting ideas that I never think of possible snags.
43	I plan ahead carefully when I go on a trip. (R)
44	I plan tasks carefully. (R)
45	I have little difficulty resisting temptation. (R)
46	When face a difficult problem, I keep thinking till I find a solution. (R)
47	Many times, the plans I make don't work out because I haven't gone over them carefully enough in advance.
48	I often say and do things without considering the consequences.
49	Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.
50	I am very levelheaded, usually have both feet on the ground. (R)

Note. Reverse scoring for items with (R). Response format: 1 = "Strongly disagree," 2 = "Disagree," 3 = "Agree," and 4 = "Strongly agree."

Notes on the Administration of the Self-report Questionnaires and Scales

Participants first completed three questionnaires that inquired their frequencies of engagement in seven impulsivity-related behaviors in the past three months before completing 10 self-report scales and 10 behavioral tasks of impulsivity. The frequency measures were divided into three questionnaires: one on smoking and drinking, one on impulsive buying and impulsive eating, and one on internet gaming, short video app usage, and social media usage. The orders of these three questionnaires were fixed for each participant, so were the orders of the items in each questionnaire. Tables S12, S13, and S14 show the specific items and the item orders in each questionnaire.

For the 10 self-report scales, the orders of their presentations were randomized for each participant, so were the orders of the items in each scale. Tables S15 to S24 show the items in each scale. In addition, as a means of attention check, we inserted three or five lie items in each scale, depending on the length of the scale. The lie items were drawn randomly from a pool of 21 items that were from the lie subscale of either the Eysenck Personality Questionnaire or the Revised Eysenck Personality Questionnaire Short Scale for Chinese; Table S25 lists these items.

Table S12. Items in the questionnaire that inquired frequencies of drinking and smoking behaviors

Drinking (from the Alcohol Use Disorders Identification Test)	
1	How often do you have a drink containing alcohol?
2	How many drinks containing alcohol do you have on a typical when you are drinking?
3	How often do you have six or more drinks on one occasion?
4	How often during the last three months have you found that you were not able to stop drinking once you had started?
5	How often during the last three months have you failed to do what was normally expected from you because of drinking?
6	How often during the last three months have you needed a first drink in the morning to get yourself going after a heavy drinking session
7	How often during the last three months have you had a feeling of guilt or remorse after drinking?
8	How often during the last three months have you been unable to remember what happened the night before because you had been drinking?
9	Have you or someone else been injured as a result of your drinking?
10	Has a relative, friend, doctor, or other health worker been concerned about your drinking or suggested that you should cut down?
Smoking (from the Fagerström test for nicotine dependence)	
1	How soon after you wake up do you smoke your first cigarette
2	Do you find it difficult to refrain from smoking in places where it is forbidden eg in church, at the library, in cinema, etc?
3	Which cigarette would you hate most to give up?
4	How many cigarettes/day do you smoke?
5	Do you smoke more frequently during the first hours after waking than during the rest of the day?
6	Do you smoke if you are so ill that you are in bed most of the day?

Note. Each item was presented in the order listed in the table for all participants.

Table S13. Items in the questionnaire that inquired frequencies of impulsive buying and impulsive eating

Buying (from the Buying impulsiveness scale)	
1	I often buy things spontaneously
2	“Just do it” describes the way I buy things
3	I often buy things without thinking
4	“I see it, I buy it” describes me
5	“Buy now, think about it later” describes me
6	Sometimes I feel like buying things on the spur-of-the-moment
7	I buy things according to how I feel at the moment
8	I carefully plan most of my purchases (R)
9	Sometimes I am a bit reckless about what I buy
Eating (from the Three-Factor Eating Questionnaire)	
1	I deliberately take small helpings as a means of controlling my weight
2	I consciously hold back at meals in order not to gain weight
3	I do not eat some foods because they make me fat
4	How frequently do you avoid “stocking up” on tempting foods?
5	How likely are you to consciously eat less than you want?
6	On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never giving in), what number would you give yourself?
7	When I smell a sizzling steak or a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal
8	Sometimes when I start eating, I just can’t seem to stop
9	Being with someone who is eating often makes me hungry enough to eat also
10	When I see a real delicacy, I often get so hungry that I have to eat right away
11	I get so hungry that my stomach often seems like a bottomless pit
12	I am always hungry, so it is hard for me to stop eating before I finish the food on my plate
13	I am always hungry enough to eat at any time
14	How often do you feel hungry?
15	Do you go on eating binges though you are not hungry?
16	When I feel anxious, I find myself eating
17	When I feel blue, I often overeat
18	When I feel lonely, I console myself by eating

Note. Each item was presented in the order listed in the table for all participants, and reverse scoring was used for the item with (R).

Table S14. Items in the questionnaire that inquired frequencies of internet gaming, short video app usage, and social media usage

Internet Gaming (from the Nine-item Internet Gaming Disorder Scale)	
1	During the last three months, have there been periods when all you could think of was the moment that you could play a game?
2	During the last three months, have you felt unsatisfied because you wanted to play more?
3	During the last three months, have you been feeling miserable when you were unable to play a game?
4	During the last three months, were you unable to reduce your time playing games, after others had repeatedly told you to play less?
5	During the last three months, have you played games so that you would not have to think about annoying things?
6	During the last three months, have you had arguments with others about the consequences of your gaming behavior?
7	During the last three months, have you hidden the time you spend on games from others?
8	During the last three months, have you lost interest in hobbies or other activities because gaming is all you wanted to do?
9	During the last three months, have you experienced serious conflicts with family, friends or partner because of gaming?
Short Video App Usage (adopted from the Internet Addiction Test)	
1	Do you fear that life without the short video APP would be boring, empty and joyless?
2	Do you feel preoccupied with the short video APP when off-line or fantasies about being on-line?
3	Do you lose sleep due to late night short video APP using?
4	Do you find that you stay on short video APP longer than you intended?
5	Do you try to hide how long you've been on short video APP?
6	Does your job performance or productivity suffer because of the short video APP?
7	Do you check your short video APP before something else that you need to do?
8	Do you try to cut down the amount of time you spend on short video APP and fail?
9	Do you find yourself saying "Just a few more minutes" when on short video APP?
Social Media Usage (adopted from the Bergen Facebook Addiction Scale)	
1	How often during the last three months have you spent a lot of time thinking about social media or planned use of social media?
2	How often during the last three months have you felt an urge to use social media more and more?
3	How often during the last three months have you used social media to forget about personal problems?
4	How often during the last three months have you tried to cut down on the use of social media without success?
5	How often during the last three months have you become restless or troubled if you have been prohibited from using social media?
6	How often during the last three months have you used social media that it has had a negative impact on your job/studies?

Note. Each item was presented in the order listed in the table for all participants.

Table S15. Items in the Barratt Impulsiveness Scale 11 (BIS-11)

Attentional impulsiveness	
1	When having a problem, I can come up with a good solution (R)
2	When necessary, I can think about a problem for a long time (R)
3	I can view a problem from different perspectives (R)
4	When I have a problem, I like to think slowly (R)
5	When facing a difficult problem, I can be patient in coming up with a solution (R)
6	I think a lot about pros and cons before I make a decision (R)
7	I can think calmly (R)
8	I cannot make up my mind quickly (R)
9	I can concentrate when I'm thinking (R)
10	I can easily come up with innovative solutions to the problems I encounter (R)
Motor impulsiveness	
11	I do things without thinking
12	I cannot control my behavior well
13	I have trouble controlling my temper.
14	I say things without thinking
15	When I'm excited, I cannot control my behavior
16	I often act on impulses
17	I act on the spur of the moment
18	I tend to buy things on an impulse
19	I do things recklessly.
20	I do whatever coming to my mind immediately.
Nonplanning impulsiveness	
21	I plan tasks carefully (R)
22	I plan for the future (R)
23	I save regularly (R)
24	I have plans for working and earning (R)
25	I do things rationally (R)
26	I eat and sleep regularly (R)
27	I get things organized before I leave home (R)
28	I can complete tasks on schedule (R)
29	I have a plan for spending money (R)
30	Making plans for the future is very important to me (R)

Note. Reverse scoring for items with (R). The items were adopted from the revised Chinese version of BIS-11 (Li et al, 2011) and were translated from Chinese. The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S16. Items in the Behavioral inhibition system/Behavioral activation system (BIS/BAS)

BIS	
1	If I think something unpleasant is going to happen, I usually get pretty “worked up” (R)
2	I worry about making mistakes (R)
3	Criticism or scolding hurts me quite a lot (R)
4	I feel pretty worried or upset when I think or know somebody is angry at me (R)
5	Even if something bad is about to happen to me, I rarely experience fear or nervousness
6	I feel worried when I think I have done poorly at something (R)
7	I have very few fears compared to my friends
BAS-Reward responsiveness	
8	When I get something I want, I feel excited and energized
9	When I’m doing well at something, I love to keep at it
10	When good things happen to me, it affects me strongly
11	It would excite me to win a contest
12	When I see an opportunity for something I like, I get excited right away
BAS Drive	
13	When I want something, I usually go all-out to get it
14	I go out of my way to get things I want
15	If I see a chance to get something I want, I move on it right away
16	When I go after something I use a “no holds barred” approach
BAS Fun seeking	
17	I will often do things for no reason than that they might be fun
18	I crave excitement and new sensations
19	I’m always willing to try something new if I think it will be fun
20	I often act on the spur of the moment

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S17. Items in the Dickman Impulsivity Inventory (DII)

Functional impulsivity	
1	I don't like to make decisions quickly, even simple decisions, such as choosing what to wear, or what to have for dinner (R)
2	I am good at taking advantage of unexpected opportunities, where you have to do something immediately or lose your chance
3	Most of the time, I can put my thoughts into words very rapidly
4	I am uncomfortable when I have to make up my mind rapidly (R)
5	I like to take part in really fast-paced conversations, where you don't have much time to think before you speak
6	I don't like to do things quickly, even when I am doing something that is not very difficult (R)
7	I would enjoy working at a job that required me to make a lot of split-second decisions
8	I like sports and games in which you have to choose your next move very quickly
9	I have often missed out on opportunities because I couldn't make up my mind fast enough (R)
10	People have admired me because I can think quickly
11	I try to avoid activities where you have to act without much time to think first
Dysfunctional impulsivity	
1	I will often say whatever comes into my head without thinking first
2	I enjoy working out problems slowly and carefully (R)
3	I frequently make appointments without thinking about whether I will be able to keep them
4	I frequently buy things without thinking about whether or not I can really afford them
5	I often make up my mind without taking the time to consider the situation from all angles
6	Often, I don't spend enough time thinking over a situation before I act
7	I often get into trouble because I don't think before I act
8	Many times the plans I make don't work out because I haven't gone over them carefully enough in advance
9	I rarely get involved in projects without first considering the potential problems (R)
10	Before making any important decision, I carefully weigh the pros and cons (R)
11	I am good at careful reasoning (R)
12	I often say and do things without considering the consequences

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S18. Items in the I-7 scale

Impulsiveness	
1	Do you often buy things on impulse?
2	Do you generally do and say things without stopping to think?
3	Do you often get into a jam because you do things without thinking?
4	Are you an impulsive person?
5	Do you often do things on the spur of the moment?
6	Do you mostly speak without thinking things out?
7	Do you often get involved in things you later wish you could get out of?
8	Do you get so 'carried away' by new and exciting ideas, that you never think of possible snags?
9	Do you need to use a lot of self-control to keep out of trouble?
10	Would you agree that almost everything enjoyable is illegal or immoral?
11	Are you often surprised at people's reactions to what you do or say?
12	Do you think an evening out is more successful if it is unplanned or arranged at the last moment?
13	Do you usually work quickly, without bothering to check?
14	Do you often change your interests?
15	When people shout at you, do you shout back?
16	Do you usually make up your mind quickly?
17	Do you usually think carefully before doing anything? (R)
18	Before making up your mind, do you consider all the advantages and disadvantages? (R)
19	Do you prefer to 'sleep on it' before making decisions? (R)
Venturesomeness	
1	Would you enjoy water skiing?
2	Do you quite enjoy taking risks?
3	Would you enjoy parachute jumping?
4	Do you like diving off the high board?
5	Do you welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional?
6	Would you like to learn to fly an aero plane?
7	Do you sometimes like doing things that are a bit frightening?
8	Would you enjoy the sensation of skiing very fast down a high mountain slope?
9	Would you like to go scuba diving?
10	Would you enjoy fast driving?
11	Would you like to go pot-holing?
12	Usually do you prefer to stick to brands you know are reliable, to trying new ones on the chance of finding something better? (R)
13	Do you think hitch-hiking is too dangerous a way to travel? (R)
14	Do you find it hard to understand people who risk their necks climbing mountains? (R)
15	Generally, do you prefer to enter cold sea water gradually, to diving or jumping straight in? (R)
16	Would you be put off a job involving quite a bit of danger? (R)

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S19. Items in the Impulsive Sensation Seeking Scale

Impulsivity	
1	I tend to begin a new job without much advance planning on how I will do it
2	I usually think about what I am going to do before doing it (R)
3	I often do things on impulse
4	I very seldom spend much time on the details of planning ahead
5	Before I begin a complicated job, I make careful plans (R)
6	I enjoy getting into new situations where you can't predict how things will turn out
7	I often get so carried away by new and exciting things and ideas that I never think of possible complications
8	I am an impulsive person
Sensation seeking	
9	I like to have new and exciting experiences and sensations even if they are a little frightening
10	I would like to take off on a trip with no preplanned or definite routes or timetable
11	I like doing things just for the thrill of it
12	I tend to change interests frequently
13	I sometimes like to do things that are a little frightening
14	I'll try anything once
15	I would like the kind of life where one is on the move and traveling a lot, with lots of change and excitement
16	I sometimes do "crazy" things just for fun
17	I like to explore a strange city or section of town by myself, even if it means getting lost
18	I prefer friends who are excitingly unpredictable
19	I like "wild" uninhibited parties

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S20. Items in the Sensitivity to Punishment and Sensitivity to Reward Questionnaire

Sensitivity to punishment	
1	Do you often refrain from doing something because you are afraid of it being illegal? (R)
2	Do you prefer not to ask for something when you are not sure you will obtain it? (R)
3	Are you often afraid of new or unexpected situations? (R)
4	Is it difficult for you to telephone someone you do not know? (R)
5	Do you often renounce your rights when you can avoid a quarrel with a person or an organization? (R)
6	As a child, were you troubled by punishments at home or in school? (R)
7	In tasks that you are not prepared for, do you attach great importance to the possibility of failure? (R)
8	Are you easily discouraged in difficult situations? (R)
9	Are you a shy person? (R)
10	Whenever possible, do you avoid demonstrating your skills for fear of being embarrassed? (R)
11	When you are with a group, do you have difficulties selecting a good topic to talk about? (R)
12	Is it often difficult for you to fall asleep when you think about thing you have done or must do? (R)
13	Do you think a lot before complaining in a restaurant if your meal is not well prepared? (R)
14	Would you be bothered if you had to return to a store when you noticed you were giving the wrong change? (R)
15	Whenever you can, do you avoid going to unknown places? (R)
16	Are you often worried by things that you said or did? (R)
17	Would it be difficult for you to ask your boss for a raise (salary increase)? (R)
18	Do you generally try to avoid speaking in public? (R)
19	Do you, on a regular basis, think that you could do more things if it was not for your insecurity or fear? (R)
20	Comparing yourself to people you know, are you afraid of many things? (R)
21	Do you often find yourself worrying about things to the extent that performance in intellectual abilities is impaired? (R)
22	Do you often refrain from doing something you like in order not to be rejected or disapproved of by others? (R)
23	Generally, do you pay more attention to threats than to pleasant events? (R)
24	Do you often refrain from doing something because of your fear of being embarrassed? (R)
Sensitivity to reward	
25	Does the good prospect of obtaining money motivate you strongly to do some things?
26	Are you frequently encouraged to act by the possibility of being valued in your work, in your studies, with your friends or with your family?
27	Do you often meet people that you find physically attractive?
28	Do you like to take some drugs because of the pleasure you get from them?
29	Do you often do things to be praised?
30	Do you like being the Centre of attention at a party or a social meeting?
31	Do you spend a lot of your time on obtaining a good image?
32	Do you need people to show their affection for you all the time?
33	When you are in a group, do you try to make your opinions the most intelligent or the funniest?
34	Do you often take the opportunity to pick up people you find attractive?

35	As a child, did you do a lot of things to get people's approval?
36	Does the possibility of social advancement move you to action, even if this involves not playing fair?
37	Do you generally give preference to those activities that imply an immediate gain?
38	Do you often have trouble resisting the temptation of doing forbidden things?
39	Do you like to compete and do everything you can to win?
40	Is it easy for you to associate tastes and smells to very pleasant events?
41	Are there a large number of objects or sensations that remind you of pleasant events?
42	When you start to play with a slot machine, is it often difficult for you to stop?
43	Do you sometimes do things for quick gains?
44	Does your attention easily stray from your work in the presence of an attractive stranger?
45	Are you interested in money to the point of being able to do risky jobs?
46	Do you like to put competitive ingredients in all of your activities?
47	Would you like to be a socially powerful person?
48	Do you like displaying your physical abilities even though this may involve danger?

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added five random lie items to this scale.

Table S21. Items in the UPPS-P Impulsive Behavior Scale

Premeditation	
1	I have a reserved and cautious attitude toward life (R)
2	My thinking is usually careful and purposeful (R)
3	I am not one of those people who blurt out things without thinking (R)
4	I like to stop and think things over before I do them (R)
5	I don't like to start a project until I know exactly how to proceed (R)
6	I tend to value and follow a rational, "sensible" approach to things (R)
7	I usually make up my mind through careful reasoning (R)
8	I am a cautious person (R)
9	Before I get into a new situation, I like to find out what to expect from it (R)
10	I usually think carefully before doing anything (R)
11	Before making up my mind, I consider all the advantages and disadvantages (R)
Negative urgency	
12	I have trouble controlling my impulses
13	I have trouble resisting my cravings (for food, cigarettes, etc)
14	I often get involved in things I later wish I could get out of
15	When I feel bad, I will often do things I later regret in order to make myself feel better now
16	Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse
17	When I am upset, I often act without thinking
18	When I feel rejected, I will often say things that I later regret
19	It is hard for me to resist acting on my feelings
20	I often make matters worse because I act without thinking when I am upset
21	In the heat of an argument, I will often say things that I later regret
22	I am always able to keep my feelings under control
23	Sometimes I do things on impulse that I later regret
Sensation seeking	
24	I generally seek new and exciting experiences and sensations
25	I'll try anything once
26	I like sports and games in which you have to choose your next move very quickly
27	I would enjoy water skiing
28	I quite enjoy taking risks
29	I would enjoy parachute jumping
30	I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional
31	I would like to learn to fly an airplane
32	I sometimes like doing things that are a bit frightening
33	I would enjoy the sensation of skiing very fast down a high mountain slope
34	I would like to go scuba diving
35	I would enjoy fast driving
Perseverance	
36	I generally like to see things through to the end

37	I tend to give up easily
38	Unfinished tasks really bother me
39	Once I get going on something I hate to stop
40	I concentrate easily
41	I finish what I start
42	I'm pretty good about pacing myself so as to get things done on time
43	I am a productive person who always gets the job done
44	Once I start a project, I almost always finish it
45	There are so many little jobs that need to be done that I sometimes just ignore them all
Positive urgency	
46	When I am very happy, I can't seem to stop myself from doing things that can have bad consequences
47	When I am in great mood, I tend to get into situations that could cause me problems
48	When I am very happy, I tend to do things that may cause problems in my life
49	I tend to lose control when I am in a great mood
50	When I am really ecstatic, I tend to get out of control
51	Others would say I make bad choices when I am extremely happy about something
52	Others are shocked or worried about the things I do when I am feeling very excited
53	When I get really happy about something, I tend to do things that can have bad consequences
54	When overjoyed, I feel like I can't stop myself from going overboard
55	When I am really excited, I tend not to think of the consequences of my actions
56	I tend to act without thinking when I am really excited
57	When I am really happy, I often find myself in situations that I normally wouldn't be comfortable with
58	When I am very happy, I feel like it is OK to give in to cravings or overindulge
59	I am surprised at the things I do while in a great mood

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added five random lie items to this scale.

Table S22. Items in the Multidimensional Personality Questionnaire–Control

Deliberation	
1	I keep close track of where my money goes (R)
2	When I have to make a decision, I usually take time to consider and weigh all possibilities (R)
3	I often act without thinking
4	I like to stop and think things over before I do them (R)
5	I am very levelheaded, usually have both feet on the ground (R)
6	I am more likely to do things quickly and carelessly rather than slowly and carefully
7	I almost never do anything reckless (R)
8	I tend to value and take a rational, “sensible” approach to things (R)
9	I usually think very carefully before I make up my mind (R)
Planning	
10	I often prefer to “play things by ear” rather than to plan ahead
11	I don’t like to start a project until I know exactly how to do it (R)
12	I plan and organize my work in detail (R)
13	I often start projects with little idea of what the end result will be
14	I generally do not like to have detailed plans
15	Whenever I go out to have fun, I like to have a pretty good idea of what I’m going to do (R)
16	People consider me a rather freewheeling and spontaneous person
17	Before I get into a new situation, I like to find out what to expect from it
Remaining items	
18	I often stop one thing before completing it and start another
19	When I need to buy something, I usually go get it without thinking what more I may soon need from the same store
20	I often act on the spur of the moment
21	I am often not as cautious as I should be
22	People say that I am well organized (that I do things in a systematic manner) (R)
23	I am a cautious person (R)
24	I often like to do the first thing that comes to my mind

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S23. Items in the NEO PI-R

Impulsiveness	
1	I rarely overindulge in anything (R)
2	I have trouble resisting my cravings
3	I have little difficulty resisting temptation (R)
4	when I am having my favorite foods, I tend to eat too much
5	I seldom give in to my impulses (R)
6	I sometimes eat myself sick
7	Sometimes I do things on impulse that I later regret
8	I am always able to keep my feelings under control (R)
Self-discipline	
9	I am pretty good about pacing myself so as to gets things done on time (R)
10	I waste a lot of time before settling down to work
11	I am a productive person who always gets the job done (R)
12	I have trouble making myself do what I should
13	Once I start a project, I almost always finish it (R)
14	When a project gets too difficult, I am inclined to start a new one
15	There are so many little jobs that need to be done that I sometimes just ignore them all
16	I have a lot of self-discipline (R)
Deliberation	
17	Over the years, I have done some pretty stupid things
18	I think things through before coming to a decision (R)
19	Occasionally I act first and think later
20	I always consider the consequences before I take action (R)
21	I often do things on the spur of the moment
22	I rarely make hasty decisions (R)
23	I plan ahead carefully when I go on a trip (R)
24	I think twice before I answer a question (R)
Excitement seeking	
25	I often crave excitement
26	I wouldn't enjoy vocationing in Las Vegas (R)
27	I have sometimes done things just for "kicks" or thrills
28	I tend to avoid movies that are shocking or scary (R)
29	I like to be where the action is
30	I love the excitement of roller coasters
31	I'm attracted to bright colors and flashy styles
32	I like being part of the crowd at sporting events

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S24. Items in the Tridimensional Personality Questionnaire–Novelty seeking

1	I often react so strongly to unexpected news that I say or do things that I regret
2	I like to think about things for a long time before I make a decision (R)
3	I often follow my instincts, hunches, or intuition without thinking through all the details
4	I often have to change my decisions because I had a wrong hunch or mistaken first impression
5	I usually think about all the facts in detail before I make a decision (R)
6	I nearly always think about all the facts in detail before I make a decision, even when other people demand a quick fix (R)
7	I hate to make decisions based only on my first impression (R)
8	I like to pay close attention to details in everything I do (R)

Note. Reverse scoring for items with (R). The order of the items was randomized for each participant, and we added three random lie items to this scale.

Table S25. Lie Items

1	As a child did you do as you were told immediately and without grumbling?
2	If you say you will do something, do you always keep your promise no matter how inconvenient it might be?
3	Are all your habits good and desirable ones?
4	Do you always wash before a meal?
5	Do you always practice what you preach?
6	Are you always willing to admit it when you have made a mistake?
7	Have you ever taken the praise for something you knew someone else had really done? (R)
8	Were you ever greedy by helping yourself to more than your share of anything? (R)
9	Have you ever blamed someone for doing something you knew was really your fault? (R)
10	Have you ever taken anything (even a pin or button) that belonged to someone else? (R)
11	Do you sometimes talk about things you know nothing about? (R)
12	Have you ever broken or lost something belonging to someone else? (R)
13	Do you sometimes boast a little? (R)
14	Have you ever said anything bad or nasty about anyone? (R)
15	As a child were you ever cheeky to your parents? (R)
16	Have you ever cheated at a game? (R)
17	Have you ever taken advantage of someone? (R)
18	Would you dodge paying taxes if you were sure you could never be found out? (R)
19	Have you ever insisted on having your own way? (R)
20	Have you ever been late for an appointment or work? (R)
21	Do you sometimes put off until tomorrow what you ought to do today? (R)

Note. Reverse scoring for items with (R). We added three to five lie items to each scale depending on the length of the scale.

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