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| **TABLE 1 Characteristics of Included Studies** | | | | | |
| Study | Disorder | participants | Clinical measure | Task | results |
| Wiehler | Gambling Disorder | n = 23 frequent gamblers [age mean (SD) =25.91 (6.47), all male], n = 23 healthy control age= 26.52 (5.92) | DSM-V, SCL-90-R, BDI-II, KFG, SOGS, GRCS | Bandit Task | Computational modeling showed gamblers had reduction in direct exploration, but fMRI revealed no considerable difference between groups. Although an explority analysis revealed, gamblers showed a decrease in activity during in direct exploration in the substantia nigra/ventral tegmental area (SN/VTA) |
| Cathomas, F. | Schizophrenia | 45 patients(age=34.00 (10.47)(31 M 14 F) and 19 HC(age=32.53 (9.45) (9 male-10 female) | DSM-V | Bandit Task | Patients with SZ showed reduction performance in the bandit task compared to HC, this reduction was due to a shift from exploitation to random exploration, |
| Addicott, M. A. | ADHD | ADHD[26 (14m/12f)(age=34.2+-8.3& HC[23 (12M/13f) age(27.7+-6.6)] | DSM-IV | Bandit Task | ADHD participants made more exploration, and also found that people with ADHD explore low-value options repeatedly at the cost of maximizing their rewards choices and obtain fewer rewards |
| Kristoffer C. Aberg | Anxiety | 28 participants (eight males; average age ± SEM: 27.571 ± 0.730) | trait-anxiety scores | Bandit Task | Individuals with higher trait-anxiety tendency to made more exploratory decisions. So, they showed no difference in strategy to gain or lose situations. They also found, anxiety via reduction the uncertainty raised exploration. |
| Ryan Smith | Substance use disorders (SUDs) | SUDs (N = 147 age= 34.05 (9.17) & Sex (Male)=0.49 (0.50)) and HCs (N = 54) age=32.27 (11.35) & Sex (Male)=0.44 (0.50) | OASIS, DAST-10 | Bandit Task | Although SUDs won less than HCs in most of time, but both reward sensitivity and insensitivity to data, which had effect on exploration, showed no difference between group, vice versa control group, SUDs showed low action precision, high learning rate for rewards, and low learning rate, In finally, poor performance in explore/exploit decisions in SUDs revealed due to not only to Incompatible selects(especially in the face of positive outcomes) but also showed low optimally learning rates for rewarding vs. non-rewarding outcomes. |
| Lamba, A. | Anxiety | healthy subjects (n = 257) and subjects with anxiety (n = 97) |  | Bandit Task | Healthy individuals were especially good at learning under negative social uncertainty, quickly detected when to stop investing in an exploitative social partner. Vice versa, subjects with anxiety overinvested in exploitative partners, Computational modeling attribute this difference to a selective devaluation in learning from negative social events and a loss to increase learning by increasing uncertainty. |
| Aylward | Anxiety | N = 88 healthy controls (50 female; age = 23 ± 5 yr.) and N = 44 people with unmediated mood and anxiety symptoms  (28 female; age = 28 ± 9 yr.) | STAI, BDI | Bandit Task | individuals with high mood and anxiety symptoms, may change the balance in explore−exploit trade-offs towards exploration in other words they more tendency to explore |
| Martinelli | schizophrenia | 20 patients [Age: mean (SD) 41.50 (6.76) & Gender/male: n (%) 17 (85)] and [24 controls Age: mean (SD) 40.50 (7.58) & Gender/male: n (%) 21 (87.5)] | ICD-10 | Bandit Task | Schizophrenia patients compared with healthy volunteers were attracted to the new image (novel image) and did not pay attention to whether these cases were seen in the previous stage or not. The results showed that patients valued new options extremely, even more than option previously gained high value, they suggested this may interfere with optimal learning in patients through disruption of the exploration-exploitation balancing. |
| Harle | Anhedonia and anxiety | 53 undergraduate students (71% female; mean age = 20.5, age range:18–26) participated in this study | BDI-II | Bandit Task | People with the disorder high-anhedonia to be more stochastic and more exploration. it seems that high-anhedonia people give less weight to instant rewards in addition, they found that depressed people with anhedonia less biased to maximize rewards, whereas, anxiety people, use Win-Stay/Lose-Shift strategy associated with more reliance on an independent learning |
| Harlé | Addiction/methamphetamine-dependent individuals(MDI) | 16 (40% female; mean age =35.4) &16 healthy comparison subjects (HCS; 33% female; mean age = 37.1) | DSM-IV | Bandit Task | They concluded that healthy volunteers (HV) and people with methamphetamine dependence (MDI) have a significant difference in the rate of reward learning and subsequently using that information to make decisions. Results showed (HV) learn from feedback but they overweighed recent data, and their decision strategies is best fit as Softmax. However, MDI presumably pursue ordinary and independence learning policy like, Win-stay/Lose-shift (WSLS), in addition about reward rates they prior notions are so pessimistic and their choosing have low possibility to proportion with optimal option which gives the most reward. |
| Addicott, M. A. | Gambling | A total of 60 participants completed the study and provided useable data (40% male, aged Mean ± SD 34 ± 10 years) | SOGS, QDQ, RAS, GRCS | Bandit Task | Increased the number of gambling correlate with more beliefs related to gambling and they made more exploratory choices on an explore-exploit or foraging task, and acquire fewer scores on a (PHT). Beliefs about gambling unfavorably linked to performance on the Patchy Foraging Task. This demonstrate people with more perceptions to gambling have a tendency to swiftly leave the patch. Their analysis displayed that gamblers who frequently gambling have poor ability to maximization of rewards. Finally they proposed that gambling is a reflection of the inefficient use of a forage search process for financial results. |
| Addicott, M. A. | drug addiction/ cigarette smokers | Participants were 36 ± 11 (M ± SD) years of age and smoked 12 ± 6 cigarettes per day  (range 1-20) |  | Bandit Task | Increased auto-smoking behavior, correlated with Further activation of the brain during exploratory decision making in other words, exploratory decision making need more cognitive effort. |
| Blanco | Depression | 133 | CES-D | Bandit(Leapfrog Task) | depressive people showed more explore, they concluded reduction of sensitivity to rewards caused depressives to underestimate the benefit of obtaining the higher reward, therefore increasing the relative value of exploring |
| Addicott, M. A. | Addiction/Smoking | 37 smokers and non-smokers (21 women), aged 20–55 years (mean ± S.D.: 34 ±10 years) |  | Bandit Task | Smokers in bandit task showed lower exploratory behavior than non-smokers ( made fewer switches between bandit arm) |
| Djamshidian, A. | Parkinson | 27(PD+ICB) [Age (yrs.)= 54.2 ± 9.2 , Gender (male)=22] & 25 PD-ICB [Age (yrs.)=64.2 ± 8.0 ,Gender (male)=21 ]& 24 healthy controls[Age (yrs.)= 57.8 ± 10.7, Gender (male)=14] |  | Bandit Task | PD group with ICBs were Significantly more inclined to choice novel options than either non-impulsive PD patients or controls, without considering of medication status |
| Kristjánsson | Eating disorder | 44 participants were recruited for the foraging task (32 women, 12 men; mean age = 24.8 (SD = 3.5),ranging from 21 to 42 years) |  | foraging task | there are differences in switch costs compared between a symptom group and no symptom group (symptom group have higher switch cost) But this results when extreme group analysis (EGA) were used they were statistically significant |
| Samantha V. Abram | Addiction | 100 students (81% female, average age 20.2 years) | criteria outlined by Johnson and  Bickel | foraging task | Found that interesting rewards in the chasing of high-risk losses predicts reward pursuit (i.e., Next choices), whereas in the lack of such losses, there is no effect on reward value processing or reward chasing. Individuals with high endangered to addiction, showed no decrease in choosing to stay on subsequent risky offers. This suggests that the inability to learn from mistakes is a potential part of risk for addiction. |
| Jennifer K. Lenow | Stress | The control group and stress group were composed of 29 and 36 subjects, respectively. The proportion of females in the stress group was 0.64 and in the control group 0.60 | Perceived Stress Scale (PSS) | foraging task | concluded that both types of stress incline human decision makers towards to more exploiting from options, they results illustrated computational role of stress in decision making, which showed, stress biases environmental quality judgments In other words, stress cause to reduce estimates quality of environment and, consequently, reluctance to seek new source (exploration) |
| Constantino | Parkinson | 23 PD patients [mean age 67.3 years; 12 female] and 21 matched, neurologically intact controls [mean age 61.2 years; 11 female] participated in this study | Hoehn and Yahr scale | foraging task | Lack of DA reduced the mental opportunity cost of time. patients in Oﬀ mode, gathered low reward threshold than controls group, and tonic dopamine DA substitution drug diminish this deficit |
| Robb B. Rutledge | Parkinson | 78 paid volunteers participated in the experiment: 26 patients with Parkinson’s disease (12 females; mean age, 65.7 years), 26  matched healthy elderly control subjects (12 females; mean age, 67.3  years), and 26 healthy young subjects (14 females; mean age, 22.8 years). | Hoehn–Yahr scale, (UPDRS) | foraging task | they concluded that (1) use of dopaminergic medicine increased learning rates in Parkinson’s disease, besides learning rates in Parkinson’s patients off dopamine drugs and aged control people were alike (2)compered learning rates in Parkinson's patients with patients with low effect of disease or aged people showed that patients with Parkinson's disease had low learning rates and the drug choose to act in order to increase the learning rate for positive outcome but not negative outcomes (3) persistence in choice, independent of reward history, increased with normal elderly and Parkinson’s patients and decreased with dopamine drugs. |
| Perandrés-Gómez, A | Gambling Disorder | 84 treatment-seeking patients with gambling disorder [ Mean(SD)=36.26 (11.32),2F/82M ] and 65 controls[ Mean (SD)=33.78 (8.74), 2F/63M | DSM5 criteria and severity assessed using the SOGS questionnaire | PRL task | PGD seemed to behave more stochastically than controls, with a stronger tendency to change their decisions after being rewarded or punished just once, and also to maintain the same decision after 2 or 3 consecutive punishments in their words, more bias to maintain their decisions despite accumulated negative feedback. |
| Marzuki, A. A. | OCD | 50 patients (29 female patients [58%]; median age, 16.6 years [IQR, 15.3-18.0 years]) and 53 controls (30 female participants [57%]; median age, 16.4 years [IQR, 14.8-18.0 years]) |  | PRL task | compared to healthy volunteers, the young patients with OCD, regardless of drug status, had increased both in reward rates and exploration of choice In addition they had decrease punishment rates |
| Kaileigh A. Byrne | Stress | 111 participants (67 females, M age = 19.13, SD age = 1.25) were included in the analysis. Fifty-six participants (34 females, M age = 19.09, SD age = 1.38) were randomly assigned to the stress manipulation condition, and 55 participants (33 females, M age = 19.16, SD age = 1.12) were randomly assigned to the control condition |  | PRL task | Control volunteers had a greater tend to stay with choices rather low uncertainty and switch away from choices that were rather high in uncertainty, unlike stress participants were less affected by uncertainty in addition, moderate acute stress could increase people's tolerance for uncertainty during decision making that require optimizing accumulative outcome over small, immediate rewards |
| Urošević, S. | Bipolar disorders | 47 with BD; 57 healthy controls (HC) | DSM-IV, K-SADS, KDRS,KMRS Scales | PRL task | Compared with healthy volunteers, adolescents with BD were less tendency to insist on their selections based on previous positive feedback (i.e., lower win-stay rates) in the PST's phase of acquisition. Between groups, showed, increasing win-stay rate is more efficiently strategy about learning. |
| psychosis Vinckier, F. | psychosis | Twenty-one healthy, right-handed volunteers (11 males), aged 25–37 years (mean 28.7, s.d. 3.2), |  | PRL task | Findings suggested that a primary characteristic of psychosis lies in a continuous uncertainty that caused to Weaken the stability of behavioral policy resulting in a failure to exploitation from regularities in the environment. |
| Lena Felice Reddy | Schizophrenia | [126 individuals with schizophrenia=Sex (% male) 68%, Age 48.8 (11.2)] and [72 healthy controls=Sex (% male) 55%, Age=46.7 (8.1)] | PANSS,CAINS | PRL task | Schizophrenia patients switched more than healthy control to response to not only valid negative but also valid positive feedback, this indicated that patients have more tendency to indiscriminate shifting. |
| Culbreth | Schizophrenia | [ 57 SZ, Age (y) =37.0 ( 8.6), Sex (% male) =66.7] and [36 CN=Age (y) 36.6 (9.2), Sex (% male) 52.8] | DSM-IV | PRL task | schizophrenia(SZ) showed less efficiently winstay-lseshift strategy and their behavior has few reversal, in the other words they less learn from feedbacks |
| Patzelt, E. H. | Addiction/Cocaine | 45 cocaine users [Age 41.0 (6.9) , Gender (% male) 77%] and 41 non-using controls[Age 40.0 (7.4) , Gender (% male)75%] | DSM IV ,SCID-IV | PRL task | Addicts to Cocaine showed more switching behavior as proved by responsively to false feedback and spontaneous shifting on the reversal-learning task. |
| Tobias U. Hauser | ADHD | [20 ADHD, Age, mean (SD)=14.60 (1.67),Sex (male/female)=13/7] and [20 control, Age, mean (SD)=14.80 (1.46), Sex (male/female)= 10/10] | DSM IV | PRL task | youngster with ADHD disorder compared with healthy volunteers have showed more exploratory behavior and displayed more simplistic learning |
| Waltz, J. A. | Schizophrenia | 29 chronic SZ patients [Age 39.6 & Gender 5 F] and 21 matched normal controls (NCs)[Age=39.6 & Gender 15 M] |  | PRL task | Schizophrenia patients showed more shifting rate in addition, have tendency to switch in response regardless to feedback. the results revealed that SZ patients not stable in their behavior and have problem learning especially in the first place |
| Solomon, M. | Autism | 28 adults with ASDs (Mean age 5 23.5;(SD) 5 5.50) and 30 adults with typical development (Mean age 5 24.4 (5.08)) | DSM-IV-TR, ADOS-G | PRL task | People with ASD showed deficiencies in utilize positive feedback to exploit reward choices also ASD group are slower learning rate |
| Dombrovski, A. Y. | Depression | 65 participants age 60 and older: 15 depressed suicide attempters, 12 depressed suicide ideators, 24 non-suicidal depressed elderly, and 14 non-depressed, non-suicidal elderly comparison subjects. | DSM-IV, HAM-D, SCID | PRL task | Learning rate from rewards and exploration did not differ between groups. |
| Nikoletta Bo´ di | Parkinson | [Controls=(Number/male/female)=20 (15/5) ,age=45.3 (8.5)] , [Never medicated Parkinson’s disease=(Number/male/female)=26 (18/8) ,age= 44.8 (5.2)] , [Recently medicated Parkinson’s disease=(Number/male/female)=22 (17/5),age= 45.3 (8.2)] | Hoehn– Yahr Scale | PRL task | young, never-medicated patients with Parkinson’s disease exhibited significantly reduction in novelty seeking and reward processing, which are related to each other. |
| Verharen, J. P. H. | Anorexia Nervosa | First cohort =[AN patients =60 all women , 27.28 (9.93) & Healthy controls =55 all women , 24.47 (8.31)] Second cohort=[216 AN 96% women 22.25 (7.27)] | DSM-IV | Iowa Gambling Task (IGT) | comparison AN patients with controls exploration versus exploitation, reward sensitivity and value-based learning were intact.in addition, most participants were randomly selected as the session progressed |
| Saperia, S. | Schizophrenia- major depressive | 51 patients with schizophrenia[Sex (M:F) 28:23, 34.5 (10.4)] , 43 patients with major depressive disorder[ Sex (M:F)20:23, 32.3 (11.2)], and 51 healthy controls[Sex (M:F)25:26, 31.7 (11.0)] | DSM-IV | Iowa Gambling Task (IGT) | schizophrenia patients displayed intact lose-shift behavior, but compared to healthy controls showed more reduced win-stay rates, this were significantly related to deficits in motivation and cognition. In contrast, no WSLS deficits appeared in the depressed group. |
| Giannunzio, V. | Anorexia nervosa | 310 female patients[Adolescent girls with AN (n = 109) Age (years)=16.8 (1.2), Adult women with AN (n = 201)Age (years)26.2 (6.6)] 301 healthy female individuals[Adolescent girls (n = 32)Age (years)16.5 (1.3), Adult women (n = 269)Age (years)26.8 (5.5) |  | Iowa Gambling Task (IGT) | They analyzed data considering two different models in IGT outcomes: the ambiguity/risk paradigm and the EV model. The first paradigm explorative abilities and sensitivity to rewards/punishment are tested, and the second part, in which the rules have been figured out and individuals can reveal their impulsive drive for gains or, on the contrary, show their ability to learn from feedbacks in order to achieve a long ‐ term gain. Adult patients with AN on average exhibit significantly poorer decision-making performance (both poor exploration abilities and reversal learning abilities) with tendency to disadvantaged decks, whereas no difference emerged between affected and non-affected adolescents. In both adolescents and adults, patient’s comparison with healthy volunteers exhibited higher levels of fear of losing. In other words, AN is characterized by excessive punishment sensitivity. |
| Christina O. Carlisi | Autism and OCD | 64 right-handed boys (20 typically developing control boys, 24 boys with ASD, 20 boys with OCD), 11–17 years old, IQ ≥ 70 | ICD-10, ADOS, ADOS, ADI-R, ADOS | Iowa Gambling Task (IGT) | Both ASD and OCD patients compared to controls showed reduction in choice consistency and lower reinforcement learning. ASD people compared to OCD group had abnormalities in disorder-specific choice perseverance. Also ASD adolescents' increased switching behavior. Moreover, suggested, OCD patients similar to ASD increased exploration (independent of outcome sensitivity). |
| Mussey, J. L. | Autism | 33 participants completed this study: 15 individuals with high-functioning ASD[Age (Years-Months)=18-9 (3-3) ] and 18[Age (Years-Months)=19-0 (2-1)] individuals with typical development | ADI-R | Iowa Gambling Task (IGT) | Results revealed that patients with ASD, compared with the control group, made more switched between decks, which caused poorer decisions. Moreover, showed that patients learned slowly of which decks are advantaged. |
| Matsuzawa, D. | Schizophrenia | Normal controls (n = 50)[Sex, male/female=33/17 & Age (years)=31.9 ± 7.8] Schizophrenia(n = 61)[Sex, male/female=33/28 &Age (years)=34.3 ± 8.3 ] | DSM-IV | Iowa Gambling Task (IGT) | Controls group after a large penalty, with or without uncertainty about the strategy, showed a slight switch from undesirable decks to beneficial ones. However, patients with schizophrenia under the same conditions, even after big penalties, failed to show shifting from disadvantageous to advantageous decks. |
| Eldad Yechiam | Autism | 15 high functioning children (age =14 out of the 15) were male. The mean group age was 15.6 (SD = 2.8). | ICD-10 | Iowa Gambling Task (IGT) | patients with ASC have a shape of adaptation that characterized by being less sensitivity to the immediate motivation structure and by an intensive exploratory search of the accessible alternatives in the other words, ASC patients have a unique adaptive learning style, which probably is useful in some learning environment but abnormal in others, particularly in social contexts. |
| de Visser, L. | Anxiety | Men (n = 65, mean age ± SEM = 22.4 ± 0.6 years) and women (n = 43, mean age ± SEM = 20.8 ± 0.7 years) |  | Iowa Gambling Task (IGT) | Anxiety affected decision-making in men early in the task, i.e. the exploration phase, in contrast affected women performance in during the second part of the test, i.e. the exploitation phase. |
| Cordovil De Sousa Uva, M. | Alcohol-Dependent | Alcoholic group AT1/AT2 n = 35 [Mean age, ± SD= 48.40 ± 8.2, Male= 17 (48.5%)] Control group n = 22 [Mean age, ± SD =44.36 ± 9.64, Male= 14 (63.63%)] | DSM-IV | Iowa Gambling Task (IGT) | Comparison of Alcohol-dependent patients with controls showed that their abilities to focus on relevant information and switching performance, to make advantageous choices, were low. |
| Cella, Matteo | Depression | 19 outpatients with MDD and 20 healthy controls were recruited | SCID | Iowa Gambling Task (IGT) | Patients with MDD showed have deficits (poor performance) compared to control group during not only the standard but also the contingency-shift phases of the IGT.it probably, depressed group being more dependent to the affective outcomes of previous positive contingencies and show less ﬂexibility in switching towards new advantageous behaviors. |
| Goudriaan, A. E. | Pathological gamblers, alcohol dependents/Tourette | he PG group (n = 48), AD group (n = 46), TS group (n = 47), and a normal control (NC) group (n = 49) | DSM IV | Iowa Gambling Task (IGT) | Comparison normal controls (NC) with disorders group showed that pathological gamblers (PG) group and Alcohol Dependents (AD) group have deficits in decision-making processes, duo to deficiencies in feedback processing after losses, however, not in the Tourette syndrome(TS) group. in addition, subgroup analyses revealed larger decision-making deficits in pathological slot machine gamblers than in pathological casino gamblers. Also results indicated that both the PG group and the AD group selected fewer cards from the advantageous decks than the NC group, only the PG group were faster than the NC group. Furthermore, one main difference is the PG group showed less switch after net losses compared to after rewards than the NC group. |
| Irene Cogliati Dezza | Gambling | 21 young healthy adults participated in this study (12 women; aged 19–29 years, mean  age = 23.24) |  | gambling-task | Reward and information acquired during learning influence the balance between exploitation-exploration, and that this effect was dependent on the reward background. |
| Laurel S Morris | compulsivity/ alcohol use disorders (AUD) & binge-eating disorder (BED) | [AUD HV(32–AUD(55)] & [Obese BED (31)-HV(55)] &[Obese control (30)- HV(55)] | DSM-IV | clock arm | AUD patients displayed reduction of exploratory behavior in both gain and loss environments, that caused diminish the efficiency of exploitative choices. Obese subjects with and without BED did not differ from healthy volunteers but when compared with each other or to AUD participants, BED had boosts exploratory behaviors, particularly in the loss domain |
| Strauss, G. P. | schizophrenia | 51 patients & 39 healthy controls (CN) | DSM-IV-TR | temporal utility integration task | Schizophrenia patients, particularly those with high negative symptoms, showed less tendency to explore when alternative choices could lead to better outcomes compared with controls. |