Not Your Typical Card Reading: An Individualized Model of Decision-Making in the Iowa Gambling Task

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Introduction

- Decision-making happens when a person is presented with a dilemma or choice
- When they do not know the outcomes of potential choices prior to deciding, decisions are thought to contain risk
- **What psychological factors play a role in risky decision-making?**

Psychological Factors and the Iowa Gambling Task (IGT)

- Negative Emotionality and ADHD = **riskier**[1,2,6,9,10,14,17,18,19]
- Older Ages = **less risky**[9,10,23]
- Positive and Negative Mood = **riskier**[20, 23] or **less risky**[20,23]
- Men compared to Women = **riskier**[2] or **no difference**[4,6,12,26]
- Agreeableness and Conscientiousness = **less risky**[2] or **no difference**[4,6]
- Anxiety = **no clear relationship**[5,7,8,13,15,16,26]
- Extraversion and Openness = **no difference**[2,4,6,9,10]

Method

Participants

- 91 undergraduate students at the College of Wooster
- **Age**: *M* = 20.08 (*SD* = 1.42)
- **Gender**: 36 men, 11 non-traditional genders, 44 women
- **Race and Ethnicity**: 1% Middle Eastern, 3% Ashkenazi Jewish, 19% Asian, 12% Black, 7% Hispanic, 2% Native American, 1% Pacific Islander, 65% White

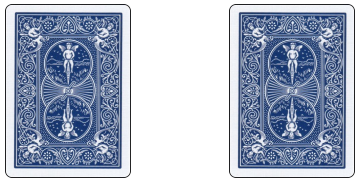
Design

Predictors:

- ***Personality:*** Extraversion, Negative Emotionality, Agreeableness, Conscientiousness, and Openness (BFI-2)[21]
- ***Trait Anxiety*** (STAI-T)[22]
- ***ADHD:*** Hyperactivity and Inattentiveness (ASRS)[11]
- ***Mood:*** Positive Affect and Negative Affect (PANAS)[24]

Dependent Variable:

- IGT Decision-Making[3]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Hypotheses

Forgetting	Sensitivity to Gain	Sensitivity to Loss	Exploring
Negative Emotionality ↑ Conscientiousness ↓ Trait Anxiety ↑ Inattentiveness ↑	Negative Emotionality ↑ Trait Anxiety ↑ ADHD ↑ Negative Mood ↑	Agreeableness ↑ Conscientiousness ↑ Trait Anxiety ↑ Negative Mood ↑	Openness ↑ Hyperactivity ↑

Results

The Final Modified EEF Model was able to predict deck choices at around 50% accuracy, which is significantly better than a model that randomly selects cards (25%).

Variance Accounted for by Psychological Factors:

- Forgetting = 62%
- Sensitivity to Gain = 39%
- Sensitivity to Loss = 98% (AIC = 65.68)
- Exploring = 10%
- Consistency = 42%

Summary of Parameter Relationships with Demographic and Psychological Factors

	Forgetting	Sensitivity to Gain	Sensitivity to Loss	Exploring	Consistency
Gender	Non-traditional ↓ Women ↓	Women ↓			Women ↓
Age	↓	↑			
Extraversion		↑			↓
Negative Emotionality					↑
Agreeableness	↑	↑			
Conscientiousness	↓		↓		↑
Openness	↑	↓			↑
Trait Anxiety			↑ / ↓		
ADHD			↓		
Hyperactivity	↓				
Inattentiveness		↑			
Positive Affect		↓	↑		↑
Negative Affect	↓		↓		

Note. ↑ increased, ↓ decreased, ↑ / ↓ mixed findings

The Model

The Modified Exploitation and Exploration with Forgetting (EEF) Model[25]:

Parameters:

- ***Forgetting***: $f \in [0,1]$, represents information forgetting over time
- ***Sensitivity to Gain***: $g \in [0,1]$, represents how much value is placed on the amount of reward received
- ***Sensitivity to Loss***: $l \in [0,1]$, represents how much value is placed on the amount of penalty received
- ***Exploring***: $x \in [-5,5]$, represents the general tendency to "try out" different deck options
- ***Consistency***: $C \in [-1,14]$, represents how consistent choices are

Equations:

Suppose that $d \in \{1,2,3,4\}$ and $t \in \{1, 2, 3, \ldots, 100\}$. If a deck d is selected at trial t, then

$$\boldsymbol{Exploitation_d(t+1) = (1-f)Exploitation_d(t) + Gain(t)^g - Loss(t)^l}$$

$$\boldsymbol{Exploration_d(t+1) = 0.}$$

Otherwise,

$$\boldsymbol{Exploitation_d(t+1) = (1-f)Exploitation_d(t)}$$

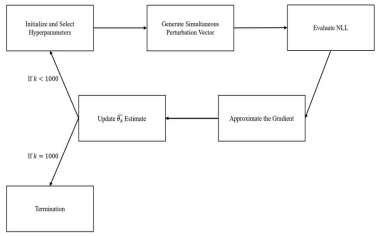
$$\boldsymbol{Exploration_d(t+1) = fExploration_d(t) + (1-f)x.}$$

Producing Probabilities:

- For each deck, values are inserted into the softmax equation (see below) to produce a probability of selecting a particular deck at a particular trial

$$P(Choice = d) = \frac{e^{(Exploitation_d + Exploration_d) * C}}{\sum_{i=1}^{4} e^{(Exploitation_d + Exploration_d) * C}}.$$

Fitting the Modified EEF Model: The SPSA Algorithm:



Discussion

Hypotheses Results

Forgetting	Sensitivity to Gain	Sensitivity to Loss	Exploring
~~Negative Emotionality ↑~~ Conscientiousness ↓ ~~Trait Anxiety ↑~~ ~~Inattentiveness ↑~~ Hyperactivity ↓	~~Negative Emotionality ↑~~ ~~Trait Anxiety ↑~~ ADHD ↑ ~~Negative Mood ↑~~	~~Agreeableness ↑~~ ~~Conscientiousness ↑~~ Conscientiousness ↓ ~~Trait Anxiety ↑~~ ~~Negative Mood ↑~~ Negative Mood ↓	~~Openness ↑~~ ~~Hyperactivity ↑~~

Overall Findings

Riskier

- Older Age
- High Extraversion
- High Agreeableness
- High Conscientiousness
- High ADHD-like Symptomology
- People more consistently in negative moods

Less Risky

- Women
- High Openness
- People more consistently in positive moods

Real-World Implications

- Together, psychological factors come together to influence various pieces of the decision-making process
- Riskier tendencies more susceptibility to gambling and substance use disorders
- Less risky tendencies protective against gambling and substance use disorders.

Conclusion

- Psychological factors influence how people make choices in contexts of risk.
- Using these factors, we can try to build out why different people, when placed in the same situation, make different choices.

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Please use the QR code for References: