RISKY BUSINESS:

The Influence of Psychological Traits on Economic Risk Behavior

by

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ABSTRACT

This thesis investigates the relationship between psychological metrics and economic risk behavior through a laboratory experiment (n=39). A better understanding of the influence of psychological traits on risk preferences could elucidate what drives human decisions under uncertainty and foster a better understanding of ideal portfolio compositions, the real world effects of economic policy, and consumer behavior. The experiment found that the psychological metrics examined, sensation seeking and impulsivity, had little to no predictive ability for economic risk behavior.

INTRODUCTION

We all have preferences in regard to risk. Finding the economically efficient, expected utility maximizing option is one thing, but many times our decisions are shrouded in more mystery. We don't often pull out a pen and paper and calculate our best course of action.

What guides these decisions, and what's going on under the hood? Are more innate traits influencing our decision process? Economic models typically assume that people are rational actors, an assumption we know is not entirely true. It is valuable to examine mechanisms that may be drivers in our decision-making process to better understand how we actually think, and in turn how the predictions of those models may deviate from reality.

Elucidation of factors that may be influencing how humans make economic decisions in the real world is useful to financial professionals in determining the optimal portfolio compositions for their clients, private businesses in providing a better understanding of consumer behavior, as well as to government institutions in understanding the real world effects of economic policy.

EXPERIMENT DESIGN

In order to investigate whether underlying psychological traits are significant drivers in decisions under uncertainty, an experiment was designed to determine if psychological metrics have any predictive ability for economic risk behavior of an individual. The experiment uses two psychological metrics: Arnett's Inventory of Sensation Seeking, and Barratt's

Impulsiveness Scale. The experiment also uses two economic metrics of risk aversion: the Holt-Laury (2002) method, and the Stahl (2016) sequence of framed lottery choices.

Subjects were gathered from respondents to flyers, and were invited to a laboratory session. At these sessions the tasks were administered to subjects through a graphical user interface created using Python. Only one lottery choice, selected at random from either of the lottery choice tasks was resolved. The test was administered to 41 subjects. While there was no time limit for completion of the tasks, the majority of subjects took around 20 minutes to complete the experiment. Upon completion of all four tasks, the program randomly selected the occurring lottery and displayed subject's selection on the lottery choice. Two ten-sided die were brought over, with each dice representing a digit on a scale of 0-99. Subjects then rolled the dice to determine the outcome of their choice on the selected lottery decision and, in turn, their compensation.

PRIOR RESEARCH

The finance industry has a particular interest in the relationship between personality indicators and risk preferences. Many finance professionals give clients questionnaires to attempt to estimate the ideal portfolio composition for a client's personal risk preferences. Past research has utilized performance of traders in prediction markets to simulate real world risk behavior, and assessed the usefulness of personality questionnaires at predicting the influence of emotional regulation, risk, and cognition on trader's behavior and outcome. This research found risk aversion to be positively correlated with the number of trade orders a subject submitted. It also found that the predictive ability of risk aversion was diminished when

metrics for emotional regulation were accounted for (Teschner, Kranz, and Weinhardt 2014). This still, however, suggests a possible connection between risk preferences and behavior that may be conventionally perceived as impulsive.

There has also been research into the relationship between Myers Briggs Type Indicator (MBTI) personality assessments and the accuracy of one's perception of probabilities (Yang, Coble, and Hudson 2009). This research doesn't examine the relationship between risk behavior and Myers Briggs personality type directly, and instead includes a risk metric from the Holt Laury method as another potential predictor of the accuracy of probability perception.

Some research has examined personality measures as metrics of risk behavior directly and has examined the usefulness of the Big Five personality test, the NEO PI-R, and biographical self-reporting as metrics for risk behavior. These measures contain a number of similar questions to that of the AISS and BIS. This research found patterns within the Big Five personality test that are significantly correlated with high overall risk propensity (Nicholson et al. 2005).

Other research has looked at the relationship between personality and risk behavior in more unconventional ways. One experiment utilizes uses a board game task as a method of evaluating both personality and risk behavior, and found risk taking to be positively correlated with impulsivity (Young et al. 2012).

This study examines more specific psychological traits that could be involved in risk related decision processes. If these traits are significant influencers of risk behavior, and have also

been adequately defined, then isolated measurement of these traits may be a better predictor of risk behavior than more general methods of psychological evaluation, like the Big Five and MBTI personality assessments.

It is difficult for a metric to accurately depict risk preferences in the real world, which are nuanced and influenced by many forms of uncertainty and biases. Kahneman and Tversky posit that prospect theory may be a more accurate model of decision making under uncertainty than expected utility theory, which assumes people have a full understanding of the possible outcomes and the probabilities of their occurrence. They identify a number of cognitive biases that may cause humans to systematically misevaluate risk. Many of these biases are related to the differences in humans' evaluation of gains and losses, and aren't relevant to the decisions in this experiment, where there are only gains. Some, however, like the overestimation of the likelihood of occurrence of very low probability outcomes, are relevant (Tversky and Kahneman, 1974). These effects could potentially be stronger in individuals with higher levels of impulsivity or sensation seeking.

PSYCHOLOGICAL METRICS

The trait of sensation seeking was first identified and defined by psychologist Marvin Zuckerman in 1964. Zuckerman defined sensation seeking as "the need for varied, novel, and complex sensations and experiences, and the willingness to take physical and social risks for the sake of such experiences" (Zuckerman et al. 1964).

Arnett's Inventory of Sensation Seeking, or AISS (Arnett 1994) is a modified form of Zuckerman's Sensation Seeking Scale (SSS). Arnett modified the SSS by removing questions inquiring about sexual behavior and drug use, as well as questions regarding strenuous activities so as not to bias the results by age. Arnett also changed the verbiage to not use dated terms like "queer" and "hippies."

Research has found the trait of sensation seeking relates with individuals' likelihood to select high risk careers, engage in dangerous driving practices, use drugs and alcohol, and engage in certain forms of sexual behavior.

While this trait is not directly connected to risk behavior, it is easy to conceive of their connection. For a sensation seeker, the risk associated with a potential choice may add to the excitement of choosing it, and in turn make it a more appealing choice within their own psyche.

The AISS breaks out into two sub-components: novelty and intensity. These subcomponents are considered as two unique qualities which make up a sensation. A novel The sub-component of intensity would likely relate more directly to economic risk, as these situations are both intense, and likely not novel. Odd numbered items in the AISS relate to the novelty sub-component, and even numbered items relate to the intensity sub-component.

Figure 1. AISS Items

1. I can see how it would be interesting to marry someone from a foreign country.

2. When the water is very cold, I prefer not to swim even if it is a hot day.

3. If I have to wait in a long line, I'm usually patient about it.

4. When I listen to music, I like it to be loud.

5. When taking a trip, I think it is best to make as few plans as possible and just take it as it comes.

6. I stay away from movies that are said to be frightening or highly suspenseful.

7. I think it's fun and exciting to perform or speak before a group.

8. If I were to go to an amusement park, I would prefer to ride the rollercoaster or other fast rides.

9. I would like to travel to places that are strange and far away.

10. I would never like to gamble with money, even if I could afford it.

11. I would have enjoyed being one of the first explorers of an unknown land.

12. I like a movie where there are a lot of explosions and car chases.

13. I don't like extremely hot and spicy foods.

14. In general, I work better when I'm under pressure.

15. I often like to have the radio or TV on while I'm doing something else, such as reading or cleaning up.

16. It would be interesting to see a car accident happen.

17. I think it's best to order something familiar when eating in a restaurant.

18. I like the feeling of standing next to the edge on a high place and looking down.

19. If it were possible to visit another planet or the moon for free, I would be among the first in line to sign up.

20. I can see how it must be exciting to be in a battle during a war.

Barratt's Impulsiveness Scale, or BIS, seeks to measure the trait of impulsivity, or the tendency towards quick unplanned reactions without regard for negative consequences. This scale was modified for brevity, and only ten items of the scale are included (Patton and Barratt 1995).

Impulsivity could quite conceivably be a factor in the process of evaluating lottery choices, high levels of which would lead subjects to select a lottery choice without truly evaluating the decision. This distortion of true risk preference is less likely to show itself in our data, as subjects know their decisions are being evaluated, and are potentially more likely to show care in their selections.

Figure 2. BIS Items

1. **I plan tasks carefully.**
2. **I do things without thinking.**
3. **I make-up my mind quickly.**
4. **I am happy-go-lucky.**
5. **I don't pay attention.**
6. **I have racing thoughts.**
7. **I plan trips well ahead of time.**
8. **I am self-controlled.**
9. **I concentrate easily.**
10. **I save regularly.**

While these aspects of our psyche may be informed by our experience, base genetic levels may exist within an individual. It is important to consider the level to which these traits are mutable

in an individual, as the consistency of these metrics over time determines their usefulness as predictors in economic and business applications.

Sensation seeking is possibly a genetic trait, and it has been suggested that our level of sensation seeking may come from our innate balance of neurotransmitters like dopamine, which provide our brains with a reward response when stimulated. No causal effect has been shown between increased dopamine production levels and thrill-seeking behavior, however there is a correlation (Derringer et al. 2010). While sensation seeking may have a genetic basis, metrics like AISS scores decrease with age, and thus do likely change over time. Despite this, a genetic baseline may exist for individuals.

Both questionnaires are scored on Likert scales, meaning subjects choose a response indicating their level of agreement with the statement presented. Their response then indicates their intensity of feeling associated with the statement, or Likert item. The first response option for a Likert item is assigned a value of 1, the second assigned a value of 2, and so forth. Some Likert items are reverse scored, with the first response assigned a value of 4, the second a value of 3, and so forth. The score on each item is then summed to provide a total score.

Data provided by Likert scales is not truly interval data, though it can be and is often interpreted as such. There is no way of knowing if there is a consistent change in intensity of feeling between each answer choice. That is to say changing ones answer from "strongly disagree" to "disagree" may not be the same amount of change in intensity as changing one's answer from "disagree" to "neutral." Despite this the ordinal data provided by Likert scales can be examined as quasi-interval.

We utilized 4 category Likert scales. By limiting the responses to each Likert item to an even number of choices the subject is forced to not select neutral responses, and instead truly evaluate the question they're faced with.

LOTTERY CHOICE TASKS

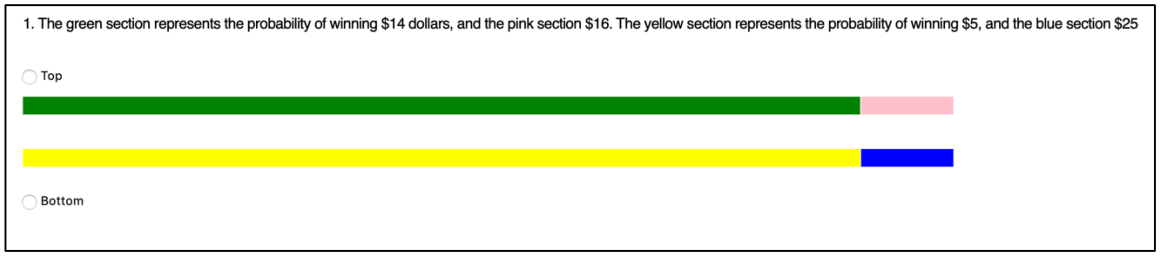
The Holt-Laury task is a sequence of paired lottery choices, put forth by Charles Holt and Susan Laury, which indicates a subject's level of risk tolerance. In these lotteries, the subject is given a choice between two options A and B, where option A always has a smaller spread of pay offs than option B. These payoffs are consistent throughout the questions, with the probability distribution in each task changing together, in 10 percent increments (Holt and Laury 2002).

Figure 3. The Holt-Laury Method

Task	Safe Option (A)	Risky Option (B)
1	10% chance of $14 and 90% chance of $16	10% chance of $5 and 90% chance of $25
2	20% chance of $14 and 80% chance of $16	20% chance of $5 and 80% chance of $25
3	30% chance of $14 and 70% chance of $16	30% chance of $5 and 70% chance of $25
4	40% chance of $14 and 60% chance of $16	40% chance of $5 and 60% chance of $25
5	50% chance of $14 and 50% chance of $16	50% chance of $5 and 50% chance of $25
6	60% chance of $14 and 40% chance of $16	60% chance of $5 and 40% chance of $25
7	70% chance of $14 and 30% chance of $16	70% chance of $5 and 30% chance of $25
8	80% chance of $14 and 20% chance of $16	80% chance of $5 and 20% chance of $25
9	90% chance of $14 and 10% chance of $16	90% chance of $5 and 10% chance of $25

In T5, A and B have the same expected value ($15). We would thus expect a risk neutral individual to choose B for T1-T4, be indifferent for T5, and to choose A for T6-T9. A risk averse individual would switch to choice A before T5, and a risk loving individual after T5.

Figure 4. Representation of a Lottery Choice in the Holt-Laury Task



These choices were presented to my subjects as colored bars, with the size of the colored portion of each bar representing its corresponding payout.

Subject responses are fit to a constant relative risk aversion (CRRA) utility function, providing a comparable risk metric for subjects.

Figure 5. Constant Relative Risk Aversion Utility Function

$$U(Y) = Y^{1-\rho}$$

The risk parameter, ρ, is a score on a risk index where 1 represents total risk aversion, 0 represents risk neutrality, and a negative value represents risk loving preferences.

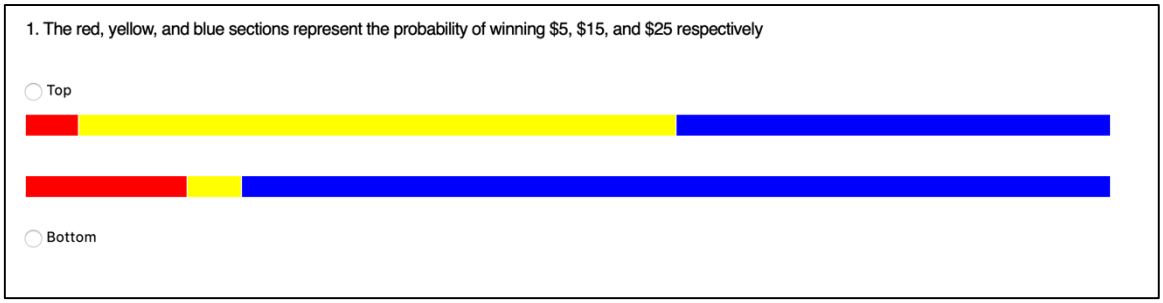
The framed lottery choice task is a sequence of lottery choices that are more uncertain than those of the Holt Laury task. These lottery choices are a sequence set forth in Stahl (2016)

"Framing Lottery Choices", which examines the effect the presentation of lottery choices has on subject behavior.

Figure 6. Probability Distributions of Questions in Framed Lottery Choice Task

Task	Option Top			Option Bottom		
	P($5)	P($15)	P($25)	P($5)	P($15)	P($25)
1	0.05	0.55	0.04	0.15	0.05	0.80
2	0.35	0.65	0.00	0.75	0.10	0.15
3	0.25	0.05	0.70	0.10	0.65	0.25
4	0.65	0.10	0.25	0.15	0.85	0.00
5	0.25	0.65	0.10	0.40	0.05	0.55
6	0.00	0.60	0.40	0.40	0.00	0.60
7	0.20	0.00	0.80	0.00	0.70	0.30
8	0.50	0.05	0.45	0.05	0.80	0.15
9	0.35	0.60	0.05	0.55	0.00	0.45
10	0.15	0.85	0.00	0.60	0.05	0.35
11	0.30	0.05	0.65	0.10	0.65	0.25
12	0.00	0.70	0.30	0.30	0.00	0.70
13	0.10	0.75	0.15	0.35	0.05	0.60
14	0.45	0.10	0.45	0.50	0.45	0.05
15	0.45	0.05	0.50	0.15	0.80	0.05

Figure 7. Representation of a Lottery Choice in the Framed Lottery Choice Task



Lotteries were presented to subjects as colored bars, as before, with the length of each colored section representing the probability of occurrence for its corresponding payout.

These options, being both more subject to framing effects, and more difficult to mathematically evaluate, will allow for more behavioral biases to be present in the subject's decision process. This task simulates an environment most similar to real life choices, which are varied and have some ambiguity. Risk metrics are again created by fitting subject responses to a CRRA utility function.

RESULTS

Two individuals were removed from the sample as outliers. These individuals switched back and forth repeatedly in their choice between the risky and safe lotteries in the Holt-Laury task. As there were no meaningful metrics of economic risk behavior for these subjects, they were removed from the sample.

Figure 8. Summary of Psychological Metrics

Statistic	N	Mean	St. Dev.	Min	Max
AISS total	39	54.5897	8.4033	38	74
Novelty subscore	39	25.7692	5.5415	15	38
Intensity subscore	39	28.8205	4.0708	22	38
BIS total	39	70.2307	13.9141	45	105

AISS and BIS scores have a roughly normal distribution. This would likely be more apparent with a larger sample size. Within the AISS, the mean novelty subscore is higher than the mean intensity subscore. BIS scores were, as expected, strongly correlated with AISS scores (.5075).

Figure 9. Summary of Risk Metric ρ by Treatment.

Treatment	N	Mean	St. Dev.	Min	Max
framed lottery choice task	39	.2049	.4174	-.9117	1
Holt-Laury task	39	.3816	.3232	-.3006	1

Only 5 of 38 subjects (13.2%) demonstrated risk loving behavior ($\rho < 0$) in the framed lottery choice task, and there is essentially no correlation between the total AISS score and subject risk behavior in the framed lottery choice task. Note that the mean risk metric is not statistically significantly different from 0 in either task (mean=.2049 sd=.4174; mean=.3816 sd=.3232), and that as anticipated the standard deviation is greater for the framed lottery choice task.

Figure 10. Correlations of the Risk Metrics with the Psychological Metrics

	AISS total score	Novelty subscore	Intensity subscore	Difference of novelty and intensity subscores	BIS score
Risk metric in framed lottery choice task	-.0176	-.1661	.0954	-.2463	-.2345
Risk metric in Holt-Laury task	-.0683	-.0684	.0533	-.0034	-.0357

There is essentially no correlation at the 5% significance level between the total AISS score and subject risk metric in the framed lottery choices. There is a non-statistically significant positive correlation between the AISS intensity subscore and risk behavior in the framed lottery choices. There is also a non-statistically significant negative correlation between the AISS novelty subscore and risk behavior in the framed lottery choices. Though it is not statistically significant it is signed as we expect; as an individual's novelty subscore increases, they demonstrate less risk averse behavior in the framed lottery tasks.

There is also a non-statistically significant negative correlation between BIS scores and subject risk metric in the framed lottery choices, though this was larger than either of the AISS subscores. Though it is not statistically significant, it is signed as we'd expect, and shows that as an individual's intensity subscore increases, they demonstrate more risk averse behavior in the framed lottery tasks.

The sub traits of sensation seeking have opposite effects on the risk behavior of individuals. This is not in line with expectations. We hypothesized both higher novelty and higher intensity subscores to lead to more risk loving behavior. Behavior in the Holt-Laury task is, as expected, correlated with behavior in the lottery choice task with a correlation of .5053 ($\alpha = .01$).

We estimate a multiple linear regression to determine if some combination of psychological metrics is an effective predictor of risk behavior in either the framed lottery choice task or the Holt-Laury task.

Figure 11. Multiple Linear Regression

$$\boldsymbol{risk\ metric = \beta_0 + \beta_1 novelty + \beta_2 intensity + \beta_3 impulsivity + \varepsilon}$$

In both regressions subject risk metric is the dependent variable, with AISS score, BIS score, and novelty and intensity subscores as the independent variables.

Figure 12. Regression Estimates for the Framed Lottery Choice Task

Source	SS	df	MS
Model	.532119339	3	.177373113
Residual	3.43811303	35	.098231801
Total	3.97023237	38	.104479799

Number of obs = 39
F(3, 35) = 1.81
Prob > F = 0.1641
R-squared = 0.1340
Adj R-squared = 0.0598
Root MSE = .31342

frho	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
aissnovelty	-.0166308	.0152038	-1.09	0.281	-.0474962	.0142346
aissintensity	.0193342	.0111603	1.73	0.092	-.0033225	.0419908
bistotal	-.0066967	.0042465	-1.58	0.124	-.0153175	.0019241
_cons	.8330642	.3802899	2.19	0.035	.0610347	1.605094

Figure 13. Regression Estimates for the Holt-Laury Task

Source	SS	df	MS
Model	.033898752	3	.011299584
Residual	6.58715669	35	.188204477
Total	6.62105544	38	.174238301

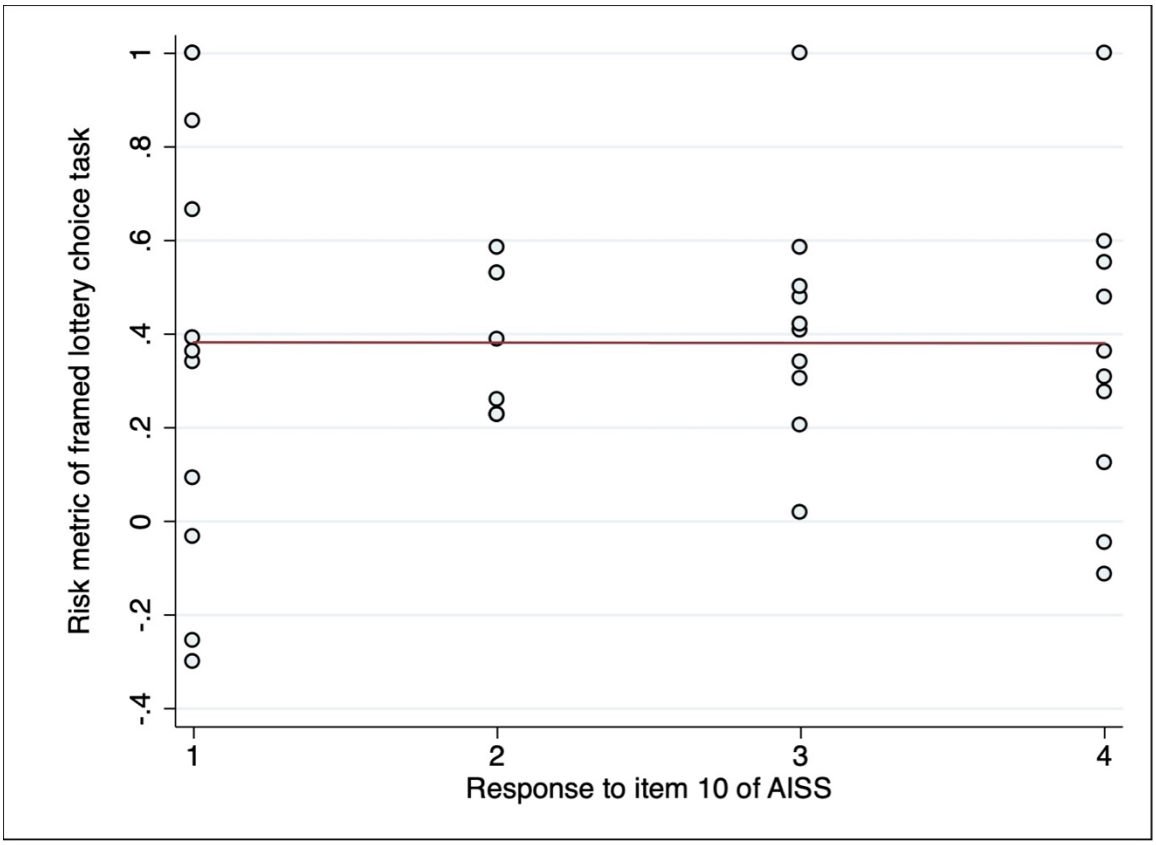
Number of obs = 39
F(3, 35) = 0.06
Prob > F = 0.9804
R-squared = 0.0051
Adj R-squared = -0.0802
Root MSE = .43383

hlrho	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
aissnovelty	-.0057164	.0210446	-0.27	0.788	-.0484393	.0370065
aissintensity	-.0018377	.0154477	-0.12	0.906	-.0331983	.0295229
bistotal	-4.07e-06	.0058779	-0.00	0.999	-.0119368	.0119286
_cons	.4173905	.5263852	0.79	0.433	-.6512284	1.486009

Both regressions explain very little of the variation within the dataset, with no significant beta coefficients at the 5% significance level.

Item 10 of the AISS was isolated and examined separately, as it relates directly to economic risk. Subject responses to this item ("I would never like to gamble with money, even if I could afford it") had little bearing on subjects' risk behavior in either of the lottery choice tasks. Two subjects reported that they strongly disagreed with the statement despite always choosing the safer option even when it was economically worse in the framed lottery choice task.

Figure 14. Risk Metric of Framed Lottery Choice Task and AISS Item 10 Response



We would expect individuals who describe themselves as more likely to engage in gambling to demonstrate more risk loving behavior, and thus a lower risk metric. Instead, subject answers to this question have little to no predictive ability for risk behavior, as shown in

figure 12. This provides further evidence that subject scores in these psychological metrics have little bearing on economic behavior. This could be due to the inaccuracy of self-evaluation; it may be the case that risk loving individuals don't view their choices as gambles, and for this reason act accordingly.

CONCLUSION

These psychological metrics are poor predictors of selection in both the framed lottery and Holt-Laury tasks. It is possible that the concepts of impulsivity and sensation seeking are largely divorced from economic decision making. Risk preferences may be separate for different types of risk. In this case, impulsivity sensation seeking could have little influence on economic risk behavior, but still influence behavior in situations carrying more personal or physical risk. It could also be the case that impulsivity and sensation seeking are relevant in economic decision making, and that AISS and BIS scores are weak metrics and inaccurate in determining subjects' levels of sensation seeking and impulsivity.

It is also possible that self-evaluation of these traits may be too inaccurate to provide a reliable metric. As evidenced by comparison of subject risk behavior and response to item 10 of the AISS.

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