

PERSONALITY, INFORMATION ACQUISITION, AND CHOICE UNDER UNCERTAINTY: AN EXPERIMENTAL STUDY

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This article studies the role of personality in choice under risk and uncertainty. We explore the hypothesis that personality plays a role in decision making in situations of uncertainty but not in situations of risk. In addition to offering support for this main hypothesis, we explore the various pathways through which personality exerts its influence. What we find is that in uncertain environments, where decision makers are able to acquire information about the unknown probability distributions they face, personality variables influence the type of information people acquire, which then influences their choice. Our experimental design brings in two novel aspects of choice under uncertainty: information acquisition and advice. The findings indicate that indeed, under uncertainty, personality matters for choice in a way it does not under risk. Furthermore, the results suggest that personality can play a role at multiple levels, such as people's preferences for certain types of information and the likelihood of following advice. (JEL C90, D03, D81)

I. INTRODUCTION

The economics of decision making under risk leaves little room for personality. Differences between people are typically summarized as differences in their risk aversion parameter, so this parameter serves as a sufficient statistic for all personality characteristics.

While this may be adequate to explain decision making under risk, where the decision maker (DM) knows with certainty the probability distributions he faces, in environments where information is sparse (one case being decisions under uncertainty) and where DMs are not informed about the probability distributions they face, the personality of the DM may play a role. In such environments, it is natural for DMs to seek out

information that would give them at least a glimpse into what the set of probability distributions they face looks like, and thereby decrease the amount of uncertainty they face. What we find in this paper is that in uncertain environments the choices that DMs make are closely related to the information they have at their disposal when making their choice and that personality variables are relevant for the type of information they gather. Since all probability distributions are known when a DM makes a choice under risk, personality cannot play the same role. Indeed, we find that only a DM's risk aversion coefficient is relevant for choice under risk.

As we discuss later in the article, there are a number of theories that might explain the type of information DMs seek when faced with uncertainty and these may be tied to personality

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ABBREVIATIONS

B: Bottom
 DM: Decision Maker
 G/L: Gains and Losses
 L: Low Variance
 M: Middle
 RRA: Relative Risk Aversion
 SR: Skewed to the Right
 SSS: Sensation Seeking Scale
 T: Top
 U: U-Shaped

characteristics. For example, due to personality differences, DMs may hold different (pessimistic or optimistic) priors over the uncertainty they face and seek different information depending on their degree of pessimism. Alternatively, as a result of their personality characteristics, they may want to be more or less confident of their choice before making it and therefore have a preference for skewness, which will lead them to seek out particular types of information (see Eliaz and Schotter 2010; Masatlioglu, Orhun, and Raymond 2016). They may also employ different choice heuristics, which require different information as inputs and the heuristics they use may be a function of personality variables.

The main point of our article is that while we expect personality to be relevant for choice under uncertainty, we do not expect such a relationship when a DM faces a choice under risk. We find support for this conjecture.¹

This hypothesis is important since if decision making is influenced by the information available to the DM and if information gathering strategies are a function of people's personality characteristics, then our results open the door for a systematic study of the impact of personality on economic behavior and outcomes, a study which is in its infancy (see Borghans et al. 2008; Almlund et al. 2011 for recent and exhaustive surveys of the personality literature and its relationship to economic decision making; and Rustichini 2009 for a discussion on the importance of including personality traits into decision theory).

Our results allow us to go even further by indicating that the impact of personality on choice under uncertainty is not limited to information gathering, but extends to choice, in the sense that when the information gathered is held constant, personality still affects choice in environments of uncertainty. This result is in contrast to what we find in our control treatment about choice under risk, where agents receive full information about the probability distributions they face and personality ceases to be relevant for choice. Hence, the importance of personality on choice under uncertainty appears to be different from choice under risk.

1. Our experiments are not meant to show that personality only matters in situations of uncertainty. Rather, we deem it plausible to expect personality to play a greater role in this type of informational environments, which appears to be a natural and relevant environment in which to study personality.

An environment where this is particularly relevant is that of personal finance where investors are faced with a set of investments, the properties of which are opaque. When investors have to choose between two projects with risky returns they tend to gather more information about these projects in order to decrease the amount of uncertainty they face. Two possible ways in which they gather information are by directly requesting information about the characteristics of these projects (e.g., by studying financial reports), or by getting advice from experts as to what project to choose (e.g., hiring a financial advisor). In this study, we look at the influence of personality on choice in each of these two environments and our treatments are meant to reflect such situations.

This article has two main parts. In the first part, we investigate Hypothesis 1, which focuses on whether personality has a differential impact on choice in risky and uncertain environments. In the second part, we study the role of personality on information acquisition in uncertain environments, and how the information acquired determines choice.² We show that personality determines the type of information sought by agents. More precisely, we present evidence that a subject's personality characteristics, as measured by the Big Five Personality Scale (Costa and McCrae 1992) and the Sensation Seeking Scale (SSS; Zuckerman 1994), are correlated to what information he decides to gather and if he decides to follow advice.³

The size of some of these effects we find is not trivial. In our experiment, subjects are able to search for information about the properties of a totally unknown probability distribution by either

2. It is important to point out that in our experiments we contrast two extreme informational situations; one where a DM faces two completely known probability distributions, and hence has no opportunity or need to gather information (what we call risk), and one where the DM has only very minimal information about the distributions he must choose between and therefore has an incentive to gather information (what we call uncertainty). We study these two extremes because they present the starkest contrast between situations where information gathering is possible and desirable and situations where it is not. This does not mean, however, that there is not a middle ground where only risk is present but information gathering is still possible. However, we have purposefully avoided these situations in order to examine the more obvious cases where the ex-ante information that subjects hold is very sparse, that is, where they do not know the full probability distributions, and where information gathering is clearly important.

3. See Schaninger and Sciglimpaglia (1981) for an early psychology study on the influence of personality traits on consumer information acquisition, or Jani, Jang, and Hwang (2014) for a recent study linking the Big Five Scale with tourists' internet search behavior.

asking for information about its upper tail, lower tail, or mid range. We find that, when controlling for personality characteristics, women are more likely to ask for information about the middle as opposed to the lower tail.⁴ In addition, the size of the marginal effects for the statistically significant components of the Big Five (Neuroticism, Extraversion, and Conscientiousness) on demand for the middle rather than the lower tail are similar in size between 0.02 and 0.03 at the average regressor of 50. The marginal impact of Sensation Seeking on both categories is -0.014 and -0.023 for the middle and top, respectively, at an average regressor of about 22.

Similarly, we show that when the information comes from an advisor, personality comes into play through two channels. First, it affects the recommendations made by the advisor. Second, it determines the likelihood that the advice is followed. In particular, our results indicate that the impact of risk aversion and personality on choice when the information comes through an advisor differs significantly from their impact in environments where subjects endogenously gather their own information. In particular, the impact of both risk aversion and personality of the DM is no longer correlated to choice once advice is offered. A similar inclination to follow advice is seen in Schotter and Sopher (2003, 2007). However, we know that some people are more likely to take advantage of advice than others, and the question then arises as to what types of people are more likely to follow advice when offered. Here again we find evidence that personality variables are likely to be a key determinant of who follows advice and also on what type of advice is offered.⁵

There is ample evidence that personality, as measured by the Big Five and the SSSs, correlates to important economic decisions. For instance, Nyhus and Pons (2005) investigate the influence of the Big Five factors on wages using household survey data from the Netherlands. They find that the economic returns of the personality factors in wage determination vary between educational groups and across genders. In a similar spirit, Mueller and Plug (2006) use the Big Five Scale to investigate how personality affected the earnings of a large group of men and women

who graduated from Wisconsin high schools in 1957 and were reinterviewed in 1992. In a political economy context, Morton, Tyran, and Wengstrom (2011, 2016) analyze data from a large sample of the Danish population to study the effects that the Big Five may have on political ideology and whether or not these traits can explain the ideological gender gap. They find that the differences in traits between men and women explain the tendency to be left- or right-wing oriented through a direct effect on ideology and through the indirect effect that these traits have on income. Müller and Schwieren (2012) study the impact of the Big Five on behavior in the trust game and find that there is a higher correlation to the first mover's behavior. Filiz-Ozbay et al. (2017) study the role that cognitive ability, gender, and personality traits have on behavior in the gift exchange game. They find that one of the traits of the Big Five Scale, Agreeableness, plays an important role in explaining the results. Anderson et al. (2016) analyze a large data set for truck drivers in the United States and find that personality traits (as measured by the Big Five) are better predictors for credit score, job persistence, and heavy truck accidents than economic preferences. Proto and Rustichini (2015) study the relationship between income and life satisfaction by looking at the Big Five personality traits and find that different traits mediate the effect that income has on aspirations and life satisfaction. In a survey, Borghans et al. (2008) summarize evidence from various psychology papers about the importance of personality traits in predicting socioeconomic outcomes including job performance, health, and academic achievement. They show correlations for the predictive validity of IQ and the Big Five personality factors on leadership ratings, job performance, longevity, college grades, and years of education. Finally, Zuckerman (2007) reviews over 2000 published articles on Sensation Seeking self-report questionnaires to show that collectively these studies have established that Sensation Seeking predicts risky driving, substance use and abuse, smoking, drinking, unprotected sex, juvenile delinquency, and adult criminal behavior.

Psychologists have studied decisions in the financial realm and how these relate to personality. However, those studies do not really speak to economists as they typically do not consider the DM's risk aversion. Furthermore, in line with their experimental tradition, these studies are not incentivized and their focus is often different, for example, on whether considering

4. The dummy for gender has an estimated marginal effect of 0.41 at the average regressor of 0.47.

5. Charness, Karni, and Levin (2013) study the effect that incentivized persuasion (similar to our advice treatment) has on ambiguity attitudes. They find that ambiguity-seeking and ambiguity-incoherent subjects are very likely to follow the recommendations of ambiguity-neutral subjects.

personality adds anything to intellect alone. Our study, although not designed to answer these questions, sheds light on some of that debate. For instance, the fact that risk aversion explains some of the decisions we observe, even controlling for personality, indicates that it is a feature of the DM that is not subsumed in the personality traits considered by those scales.

On a methodological level, the paper's contribution is to design a data set that speaks to the question at hand by revealing aspects of preferences and information sets that are not available in observational data sets. First, in one treatment, the experiment allows us to learn what features of uncertain distribution subjects want to learn about. This choice is incentivized within the experiment and thus the exhibited behavior reveals a preference that could be an important component of modeling choice under uncertainty. Similarly, the design allows us to observe not only the recommendation that advisers offer to DMs, but also which feature of the probability distribution they decide to focus on. These aspects of the design are novel and tie the data set generated to the question in a unique way.

Finally, it is important to point out that this is first and foremost an empirical paper that, we believe, is the first to establish a connection between personality and information gathering under uncertainty. While we do not provide a theory to explain the behavior we observe, we do present a number of theoretical approaches that could be used to construct one in Section V.

Despite the empirical nature of the paper, it does make a point that we think is relevant for theorists. While the literature on decision making under uncertainty has tended to treat the degree of uncertainty that DMs face as fixed or exogenous, in reality the degree of uncertainty is endogenous in the sense that DMs are able to modify it via information gathering activities. This fact, we believe, makes decision making under uncertainty a two-stage process where in the first stage the DM needs to decide whether to gather information and, if so, how. In the second stage, given the information gathered and the updated priors about the distributions faced, the DM needs to make a choice. What is needed then is a theory of both information gathering and decision making under uncertainty. In this study, we document the importance of the first stage.

The article proceeds as follows. In Section II, we describe our experimental design and in Section III we analyze our results. The data analysis proceeds by first testing our main

hypothesis. This is followed by an exploration of the various ways in which personality can have an impact in the settings we study. In Section IV, we present some related literature, while in Section V we present several possible theoretical approaches to modeling the influence of personality on information gathering under uncertainty. Finally, in Section VI we offer some observations and conclusions.

II. EXPERIMENTAL DESIGN

The experiment is composed of three treatments, which we call Control, Priority, and Advice. In each treatment, subjects have to choose between pairs of probability distributions under different information conditions. For all treatments, each of the sessions is divided into two parts. The first part of the experiment involves measuring various personality and risk aversion characteristics of the subjects by administering three tasks: the SSS (Zuckerman 1994), the Big Five Personality Scale (Costa and McCrae 1992),⁶ and the Holt-Laury risk aversion task (Holt and Laury 2002). The second part of the experiment varies by treatment but always involves six choices over lottery pairs.⁷

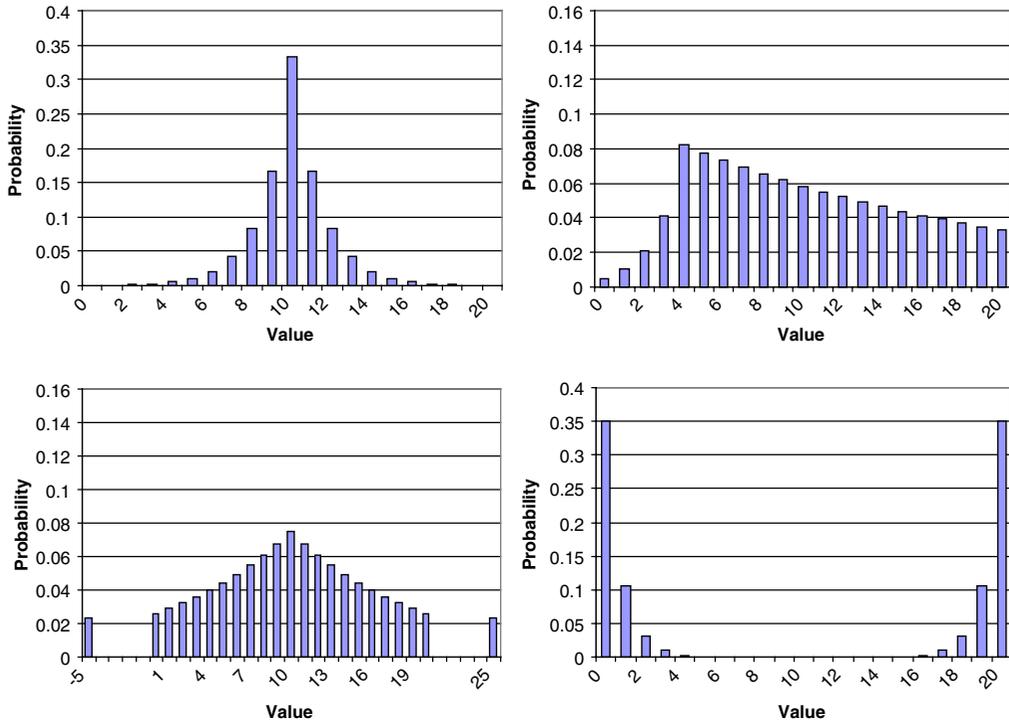
The probability distributions defining the lotteries are represented by the four distributions in Figure 1. The specific probabilities of each of these distributions are in Table A2 in the Appendix.

In the rest of the article, we will refer to the distributions with the following shorthand: L (Low variance) for the top left distribution, SR (skewed right) for the top right distribution, G/L (Gains and Losses) for the bottom left, and U for the bottom right. In most cases the lowest possible outcome is 0 and the highest possible outcome is 20, except for the G/L distribution which also puts positive probability on -5 and 25. These distributions were chosen because they are all very different from each other in important ways, such as the variance, but they all share the same mean of 10. The subjects are informed that the means are identical, and of the lower and upper bounds

6. We implemented the questionnaires using form V of the Sensation Seeking Scale (SSS-V) as described by Zuckerman (1994), and the short (120 items) version of the IPIP-NEO Big Five questionnaire available at <http://www.personal.psu.edu/~j5j/IPIP/ipipneo120.htm>.

7. Instructions for all parts and treatments can be found online at https://files.nyu.edu/gf35/public/print/Frechette_2011c_inst.pdf.

FIGURE 1
Distributions



of the support. Thus, in a standard Expected Utility model, if subjects have complete information about the distributions, their choice should be completely determined by the risk preference of the DM and the properties of the lotteries.

Given the four lotteries, we can define six lottery pairs covering all possible pair-wise combinations of these distributions. In the Control treatment, subjects have to choose one of the lotteries from each of the pairs of distributions that are presented to them sequentially on their computer screen (referred to as *Left* or *Right* distributions). This treatment serves as our control since subjects have complete information about the probability distributions that characterize these lotteries, thus representing an environment solely of risk.

In the Priority treatment, subjects face the same choices as in the Control, but they do not observe the distributions (the instructions only inform them that the distributions all have mean 10 and all range between -5 and 25). Instead, they are given the opportunity to learn some salient features of each pair: the sum of the

probabilities for outcomes 4 or less, the sum of the probabilities for outcomes 16 and above, or the sum of the probabilities for outcomes between 8 and 12. Henceforth, we will refer to these pieces of information as the Bottom (B), Top (T), or Middle (M) sections of the distributions.⁸ Before choosing among lotteries, subjects are asked to state their priority over these three pieces of information by choosing which one they would like to receive the most, second most, and third most. Then, for each choice problem, a computer randomly determines if they will be shown one, two, or three pieces of information (each is equally likely), and based on the priority they state and the random number generated by the computer, they are given the relevant information and then they make their choice.⁹ Subjects only state their

8. This elicitation of information preferences was the simplest method we could think of to obtain the preferences of the subjects over parts of the distributions that they want to learn about.

9. Notice that subjects in this treatment still face uncertainty even if they are given the three available pieces of information, as they cannot assess the exact probability of each individual outcome.

preference over these three pieces of information once, and that preference is relevant for each pair-wise choice, but a different random number is generated for each of the six choice problems they face, so for different choices they receive different amounts of information.

Finally, in the Advice treatment subjects are matched in fixed pairs. Half of the subjects are given the role of Advisors and the other half of DMs, and subjects remain with that role for the rest of the session. The Advisors' screens display the distributions relevant for each of the six choice problems, but the DMs see only blank screens. The Advisors, after observing the distributions, have to make a recommendation to the DM they have been matched with as to which lottery to choose (Left or Right), and justify their advice using one of the three types of information presented in the Priority treatment: Bottom, Top, or Middle. For example, an advisor can give one of the following pieces of advice: "Choose *Left* instead of *Right* because the probability of receiving 4 or less is 0.498 with *Right* but 0.159 with *Left*," or "Choose *Right* instead of *Left* because the probability of receiving 16 or more is 0.498 with *Right* but 0.185 with *Left*," or "Choose *Left* instead of *Right* because the probability of receiving an outcome between 8 and 12 is 0.293 with *Left* but 0.000061 with *Right*."¹⁰ DMs do not observe the distributions; they only observe advice for either the left or right distribution and the reason given to them. Once they receive their advice, they have to choose one of the lotteries. Note that the information available to the DMs is the same in this treatment as in the Priority treatment (when they receive only one piece of information), but in this treatment it comes in the form of exogenous advice rather than solicited information.

At the end of the experiment, one of the choice problems is selected at random and the choice of the DM is played out. Advisors are paid \$3.33 for each of their recommended decisions that are followed. Hence, advisors have incentives to at least offer advice that they think is persuasive.¹¹ DMs are paid the outcome of the lottery chosen. All subjects are also paid a \$13 show-up fee.

For each treatment, two sessions were conducted, for a total of six sessions. In total, there were 123 subjects (41 in the Control, 42 in the Priority, and 40 in the Advice treatment). The software was z-tree (Fischbacher 2007) for the first part and multistage (CASSELL [UCLA] and SSEL [Caltech]) for the second part. All subjects were undergraduate students at New York University (from all majors).

As mentioned above, our experimental design is constructed to investigate our main hypothesis. We have a treatment where there is pure risk and two where there is uncertainty, which can be mitigated by either information gathering (the Priority treatment) or advice (the Advice treatment). Seen through this lens, our design is easily motivated and a natural starting point. Intuitively, if personality is to be related to the choices of subjects, one would expect it to be in an environment with uncertainty (like the Priority and Advice treatments), rather than in a risky environment with complete information (Control treatment). This is why we choose to present subjects with two different types of lottery choice problems, one where there should be little scope for personality (other than risk aversion), and one where, due to uncertainty, there might be room for personality characteristics to influence behavior. The key to uncovering the impact of personality is to ask subjects to decide on what information they want to observe because, intuitively, different people might want to know different characteristics of the decision they face. Standard economic theory is silent about what parts of a probability distribution a person should seek information about, but intuition suggests that people's personality may influence this decision. In the presence of an adviser, it appears like the adviser would attempt to use information about the part of the distribution that would be most convincing to most people, but, depending on the personality of the advisee, this information may or may not be convincing. Hence, intuitively one would expect personality to play a role in both treatments under uncertainty, compared to a control treatment with complete information about the lotteries. This is the theme around which we have designed the experiment.

III. RESULTS

This section is divided into two parts: one testing our main hypothesis and the other examining the connection between personality, information acquisition, and advice taking and advice

10. This advice is all prescribed.

11. The inclusion of recommendations is a natural way for an adviser to convey information. It would be possible, however, to provide information without a recommendation, but the design of incentives for the advisers would be less clear.

giving. To analyze our results on the information acquisition, we present a set of observations that we then substantiate using our data.

Before we proceed, however, let us pause and briefly describe the results of our personality and risk preference elicitation exercises to give an insight into what the sample of subjects looks like and to verify that our sample does not vary dramatically from the norm associated with these personality scales. We also summarize the choices of our subjects over lotteries in the three treatments. This is followed by the test of Hypothesis 1. Following that, we investigate the various channels through which personality can play a role in these environments. While this final part of the section is exploratory, we hope that it yields interesting insights that can serve as the basis of future research.

A. Personality Attributes

Table 1 contains summary statistics about gender, risk preferences, and personality traits of the subjects that participated in the experiment.

Female is an indicator variable that takes the value of 1 for female subjects and 0 otherwise. The Relative Risk Aversion (RRA) coefficient takes the value of the mid-point of the interval of a RRA specification of utility implied by the Holt-Laury choices of each subject.¹² Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness are the Big Five personality traits and are explained in more detail in Table 2. Note that the Big Five questionnaires are designed to give a mean of 50 with a standard deviation of 10 for each trait. The score on the SSS is presented as an aggregate score, and also separated into its components: Thrill and Adventure Seeking, Experience Seeking, Disinhibition, and Boredom Susceptibility (see Zuckerman 1994). The SSS is calibrated to result in a mean of 23.77770 and a standard deviation of 5.6 for males, and a mean of 19.0 and standard deviation of 5.7 for females in the United States (Zuckerman 1994). As we can see, our sample appears to conform to these norms.

It is important to note that these personality scales were not created to predict economic decision making. These measures are a natural

12. 0, 9, and 10 choices of the safe options do not correspond to a finite range of RRA coefficient and consequently subjects with such decisions are dropped when considering the implied RRA.

TABLE 1
Summary Statistics

Variable	Mean	SD	Min	Max	Obs
Female	0.47				123
Holt-Laury choices	5.37	1.58	0	9	123
RRA ^a	0.38	0.43	-0.72	1.17	121
Neuroticism	49.55	8.58	25.78	72.47	123
Extraversion	50.05	8.64	29.66	76.79	123
Openness	51.90	10.17	21.81	75.88	123
Agreeableness	50.44	9.44	28.13	69.68	123
Conscientiousness	52.17	9.37	31.56	72.32	123
SSS	21.73	6.67	8	35	123
Thrill	6.94	2.59	0	10	123
Experience	6.21	2.03	2	10	123
Disinhibition	4.92	2.71	0	10	123
Boredom	3.66	2.16	0	10	123

Note: RRA, Relative Risk Aversion; SD, standard deviation; SSS, Sensation Seeking Scale, aggregate score
^aRRA implied by Holt-Laury choices.

starting point because they are well established in the psychology literature and have been found to correlate well with life outcomes, but not necessarily with the type of controlled decisions we study. Hence, the economic interpretation of these dimensions of personality might be difficult (see the discussion in Section VI).

Table 3 shows the pair-wise correlations among the different personality measures, the female indicator, and the RRA coefficient. It is interesting to note that risk aversion is not significantly correlated to any of the Big Five personality traits and its correlations with the components of the SSS are not high.¹³

The choices of our subjects over lottery pairs in the three treatments are summarized in Table 4. We consider the Control treatment as the baseline because this is the only treatment where subjects have full information about the distributions they face. As a result, we might consider the choices made there as reflecting the subjects' true preferences over these distributions. Note that in each pair, the distribution on the right is the riskier one.

One result that is clear is that the choices made for the same lottery pairs change as we move across treatments. For example, while the SR distribution is greatly preferred to the L in the

13. This observation may further illustrate the fact that these personality scales are not properly designed for economic decision making. Even if the Big Five were constructed in such a way that all personality characteristics can be associated to one of these traits, it is not clear which combination of traits (if any) could characterize a person's level of risk aversion.

Control treatment, the opposite is true when we move to the Priority treatment.

These results should give readers a first indication that information gathering can have a dramatic impact on choice because the only thing that varies across these treatments is the information available to subjects and the manner in which that information is acquired. If one considers the choices made in the Control treatment as the welfare maximizing choices for the subjects, since they have full information there, our results from Table 4 demonstrate the impact on welfare of different informational conditions in the presence of uncertainty. As we will see, a large part of this variation can be explained by the different, personality-influenced, information acquisition strategies that subjects use in these different treatments.

B. Impact of Personality on Choice in Risky and Uncertain Environments: Test of Hypothesis 1

As stated above, in our experiment we expect that if personality is to have an impact on choice it is likely that it will only be felt in environments characterized by uncertainty and not risk. This expectation is summarized by our main hypothesis, Hypothesis 1.

HYPOTHESIS 1: *Personality characteristics, either the Big Five or Sensation Seeking, only affect choices in treatments with uncertainty, not in the Control treatment involving solely choices under risk.*

Table 5 reports the main regressions that test this hypothesis and find support for it. They are probit regressions where the dependent variable is the choice of the riskier distribution (the

TABLE 2
Big Five Personality Traits and Their Facets

Trait	Facet	Description
Neuroticism		
Identifies individual tendency to experience psychological distress	Anxiety	Level of free floating anxiety
	Angry hostility	Tendency to experience anger, frustration, bitterness, etc.
	Depression	Tendency to experience guilt, sadness, despondency and loneliness
	Self consciousness	Shyness or social anxiety
	Impulsiveness	Tendency to act on cravings and urges rather than delaying gratification
	Vulnerability	General susceptibility to stress
Extraversion		
Quantity and intensity of energy directed outward into the social world	Warmth	Interest in and friendliness toward others
	Gregariousness	Preference for the company of others
	Assertiveness	Social ascendancy and forcefulness of expression
	Activity	Pace of living
	Excitement seeking	Need for environmental stimulation
	Positive emotion	Tendency to experience positive emotions
Openness to experience		
The active seeking and appreciation of experiences for their own sake	Fantasy	Receptivity to the inner world of imagination
	Esthetics	Openness to inner feelings and emotions
	Feelings	Social ascendancy and forcefulness of expression
	Actions	Openness to new experiences on a practical level
	Ideas	Intellectual curiosity
	Values	Readiness to re-examine own values and those of authority figures
Agreeableness		
The kinds of interactions an individual prefers, from compassion to tough mindedness	Trust	Belief in the sincerity and good intentions of others
	Straightforwardness	Frankness in expression
	Altruism	Active concern for the welfare of others
	Compliance	Response to interpersonal conflict
	Modesty	Tendency to play down own achievements and be humble
	Tender mindedness	Attitude of sympathy for others
Conscientiousness		
Degree of organization, persistence, control, and motivation in goal directed behavior	Competence	Belief in own self efficacy
	Order	Personal organization
	Dutifulness	Emphasis placed on importance of fulfilling moral obligations
	Achievement striving	Need for personal achievement and sense of direction
	Self discipline	Capacity to begin and complete tasks despite boredom or distractions
	Deliberation	Tendency to think things through before acting or speaking

Source: Costa and McCrae 1992.

TABLE 3
Correlations Between Personality Traits, RRA, and Gender

	Female	Risk Aversion	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness	SSS	SSS: Thrill	SSS: Experience	SSS: Disinhibition	SSS: Boredom
Female	1											
Risk aversion	0.21**	1										
Neuroticism	-0.14	0.09	1									
Extraversion	-0.17*	-0.09	-0.48***	1								
Openness	-0.13	-0.09	-0.20**	0.32***	1							
Agreeableness	0.03	-0.06	-0.14	0.05	0.30***	1						
Conscientiousness	-0.06	-0.07	-0.46***	0.25***	0.18**	0.22**	1					
SSS	-0.25***	-0.17*	-0.16*	0.44***	0.46***	-0.15*	-0.12	1				
SSS: thrill	-0.21**	-0.16*	-0.20**	0.33***	0.20**	-0.04	-0.08	0.64***	1			
SSS: experience	-0.05	-0.07	-0.06	0.23***	0.37***	0.07	-0.13	0.75***	0.29***	1		
SSS: disinhibition	-0.16*	-0.02	-0.09	0.41***	0.30***	-0.16*	-0.06	0.79***	0.28***	0.58***	1	
SSS: boredom	-0.28***	-0.26***	-0.07	0.23**	0.26***	-0.29***	-0.10	0.61***	0.16*	0.31***	0.31***	1

*Significant at 10%; **significant at 5%; ***significant at 1%.

TABLE 4
Frequency Choice for the Riskier Distribution, by Treatment

Treatment Pair	Control Frequency (%)	Priority Frequency (%)	Advice Frequency (%)
L vs. SR	60.98	16.67***	40.00
L vs. G/L	26.83	38.10	30.00
L vs. U	12.20	35.71**	15.00
SR vs. G/L	60.98	45.24	45.00
SR vs. U	26.83	50.00**	35.00
G/L vs. U	39.02	50.00	40.00

*Significantly different from the frequency in the Control treatment at 10%; **significant at 5%; ***significant at 1%.

marginal effects are reported in Table 6). In the case of the priority treatment, this is for the subset of cases where subjects received only one piece of information (as these are the cases with the most uncertainty and the closest to the condition in the Advice treatment). The regression for that treatment also includes a set of indicator variables capturing the subjects preferences for information: which of T, M, or B, is ranked first, second, and third. In addition, the regression for the Advice treatment includes the advice given, a dummy variable indicating if the suggestion was to choose the risky or safe distribution, and two indicator variables distinguishing if the evidence provided (the reason) was about B, M, or T. These additional variables are not reported to keep the table easier to read. The key results are reported as “p value: test of H1,” which indicates that the joint test that personality variables are jointly significant cannot be rejected for the control, but can be rejected at the 10% and 5% levels for the Priority and Advice treatments, respectively. One may worry about the fact that with multiple tests, the false discovery rate is not the same as the confidence level of the test. We note that even with the crudest of corrections for multiple hypothesis tests, the Bonferroni correction, the joint test is still rejected at the 5% level in the case of the Advice treatment.¹⁴ With the correction, it misses the significance threshold at the 10% level in the Priority treatment however, since the corrected threshold is 0.333.¹⁵

14. It is well known that the Bonferroni correction is too conservative.
15. The correction is α divided by the number of hypotheses tested.

TABLE 5

Probit Estimates of the Factors Correlated to Riskier Choices

Variable	Treatments		
	Control	Priority ^a	Advice ^b
RRA	-0.346** (0.174)	0.054 (0.537)	-0.603** (0.263)
Female	-0.184 (0.169)	-0.643 (0.459)	.575** (0.270)
Neuroticism	0.001 (0.009)	0.002 (0.034)	0.004 (0.011)
Extraversion	-0.014 (0.016)	-0.096** (0.041)	0.020 (0.017)
Openness	-0.005 (0.010)	0.073** (0.030)	-0.013 (0.017)
Agreeableness	0.002 (0.009)	0.008 (0.022)	-0.022* (0.013)
Conscientiousness	-0.004 (0.008)	0.053** (0.024)	-0.003 (0.012)
SSS	0.008 (0.022)	0.006 (0.040)	0.020 (0.022)
Constant	0.711 (0.729)	-2.818 (3.841)	-0.993 (1.724)
<i>p</i> Value: test of H1	0.854	0.055	0.012

Note: Clustered (by subject) standard errors in parentheses.

^aThis is for the cases where subjects receive one piece of information. Not reported: The subjects' information preference (over the order for B, M, and T) is also controlled for as a set of dummy variables.

^bNot reported: The advice received is also controlled for as a dummy variable (risky or safe distribution). Not reported: The reason used for the advice (B, M, or T).

*Significant at 10%; **significant at 5%; ***significant at 1%.

C. Personality, Information Acquisition, and Choice

Having established the evidence with respect to our main question, what follows is a more exploratory analysis investigating the respective roles of the specific factors we control for on the various steps leading to a final choice. As we unpack the various treatments, multiple hypotheses tests will be performed with no correction "à la" Bonferroni. As will become clear, the various dependent variables explored are highly correlated and as such the proper corrections for multiple hypothesis tests are not straightforward. Hence, one should interpret these results with caution, but we do point out that some of the results, taken together, appear to form a logical and plausible chain.

Before moving to the unpacking of the Priority and Advice treatment, we mention the other results from Table 5. First, there is the finding that risk aversion matters for choices in the Control

TABLE 6

Marginal Effects of the Factors Correlated to Riskier Choices

Variable	Treatments		
	Control	Priority ^a	Advice ^b
RRA	-0.131** (0.066)	0.021 (0.209)	-0.200** (0.090)
Female	-0.069 (0.063)	-0.249 (0.175)	0.230** (0.103)
Neuroticism	0.000 (0.004)	0.001* (0.013)	0.002 (0.004)
Extraversion	-0.005 (0.006)	-0.037** (0.016)	0.010 (0.006)
Openness	-0.002 (0.004)	0.028** (0.012)	-0.006 (0.005)
Agreeableness	0.001 (0.003)	0.003 (0.008)	-0.007* (0.004)
Conscientiousness	-0.002 (0.003)	0.021** (0.009)	-0.000 (0.004)
SSS	0.003 (0.008)	0.002 (0.015)	0.006 (0.007)

Note: Clustered (by subject) standard errors in parentheses.

^aThis is for the cases where subjects receive one piece of information. Not reported: The subjects' information preference (over the order for B, M, and T) is also controlled for as a set of dummy variables.

^bNot reported: The advice received is also controlled for as a dummy variable (risky or safe distribution). Not reported: The reason used for the advice (B, M, or T).

*Significant at 10%; **significant at 5%; ***significant at 1%.

and the Advice treatments. As expected, more risk averse subjects exhibit a higher likelihood of selecting the distribution with lower variance. Surprisingly, gender only has a significant impact in the Advice treatment where it leads women to make riskier choices than men.

In the Priority treatment, the dummy variables indicating the order preference for information are jointly significant ($p < 0.01$). In the Advice treatment, the results indicate that the advice given affects the choices ($p < 0.01$) as well as the reason used (joint hypothesis that the dummy variables are equal to the excluded category: $p < 0.1$).

D. Information Acquisition under Uncertainty: The Priority Treatment

For the Priority treatment, the preferences for learning different features of the distribution are represented by the popularity of each possible permutation of information demand and of the most popular first choice in Table 7. As we can see in the last column on the right, half

TABLE 7
Preferences over Different Information

Info	Rank						Ranked First
	1	2	3	4	5	6	
Bottom	1	1	2	2	3	3	50.00
Middle	3	2	1	3	1	2	26.19
Top	2	3	3	1	2	1	23.81
Frequency (%)	33.33	16.67	7.14	7.14	19.05	16.67	

TABLE 8
Multinomial Probit of the Factors Correlated to Demand for the First Priority in the Priority Treatment

Variable	Estimates		Marginals	
	M	T	M	T
RRA	-2.24* (1.232)	-1.389 (1.052)	-0.363 (0.234)	-0.173 (0.247)
Female	2.438** (1.053)	0.847 (0.811)	0.411*** (0.156)	0.015 (0.177)
Neuroticism	0.18** (0.076)	0.08 (0.057)	0.032** (0.014)	0.005 (0.014)
Extraversion	0.168* (0.092)	0.091 (0.064)	0.028* (0.017)	0.009 (0.016)
Openness	0.05 (0.049)	0.049 (0.047)	0.007 (0.010)	0.009 (0.011)
Agreeableness	-0.059 (0.061)	-0.049 (0.049)	-0.008 (0.012)	-0.008 (0.012)
Conscientiousness	0.11** (0.054)	0.033 (0.047)	0.021** (0.011)	-0.001 (N/A)
SSS	-0.116 (0.089)	-0.125* (0.074)	-0.014 (0.017)	-0.023 (0.018)
Constant	-20.763** (8.94)	-7.667 (6.966)		

Notes: Bottom is the base outcome; standard errors in parentheses; one standard error is reported as N/A because the software cannot compute it.

*Significant at 10%; **significant at 5%; ***significant at 1%.

of the subjects want to learn about the bottom part of the distribution first, with the other two options almost equal among the rest of the subjects. The most popular order (for one third of the subjects) is to learn first about the bottom, followed by the top and finally about the middle.

OBSERVATION 1. Some personality traits, risk preferences, and gender affect the demand for information under uncertainty.

Table 8 shows the results of multinomial probits with the same set of regressors as for the probits studying choices, but with the information ranked first as the dependent variable. First,

note that personality measures are not jointly significant. However, some traits are significant, in particular when considering the impact of focusing on the middle rather than the bottom of the distribution. Higher scores on the Neuroticism, Extraversion, and Conscientiousness scales increase the likelihood of requesting information about the middle first, rather than the bottom. A higher score on the SSS results in a higher probability of demanding to know about the bottom rather than the top first. Risk aversion also appears to have an impact, that is to say, more risk averse subjects are more likely to want information about outcomes in the bottom of the distribution, rather than the middle. Women are more likely to rank the middle instead of the bottom first as compared to men. The size of some of these effects is not trivial. The difference between men and women in the likelihood of asking about the middle rather than the bottom is 0.41. The size of the marginal effects for the statistically significant components of the Big Five on demand for the middle rather than the bottom are similar in size, between 0.02 and 0.03 at the average regressor of 50. Similarly, risk preference has an estimated marginal effect of -0.36 with an average regressor of 0.49. The marginal impact of Sensation Seeking on both categories is -0.014 and -0.023 for the middle and top, respectively, at an average regressor of about 22. For all other regressors, the marginal impact is much smaller in the case of the top category, in most cases smaller by at least a factor of 10.

In short, when subjects face an informationally sparse environment, some aspects of personality appear to have a significant impact on what information they acquire.

OBSERVATION 2. The information received by DMs affects the incidence of riskier choices in environments of uncertainty where DMs demand information according to their priority ranking.

As we discussed before, how people choose when they are only partially informed about the probability distributions they face is, to a large degree, a function of the information they have chosen to gather prior to making their choice. Given that all distributions in the experiment have the same mean, we look at the impact of information acquisition on the riskiness of the choice made, that is, whether or not they choose the higher variance distribution given the information they have gathered. We have already established

TABLE 9

Probit Estimate of the Relation between Information Observed and Riskier Choices in the Priority Treatment

Variable	10
Observed bottom	0.383 (0.348)
Observed top	1.148*** (0.437)
Observed middle	-0.757* (0.394)
Observed B and T	0.923*** (0.227)
Observed B and M	-0.486 (0.373)
Observed M and T	-0.070 (0.389)
Preference: B-T-M	-0.735** (0.349)
Preference: B-M-T	-0.300 (0.418)
Preference: T-B-M	-0.545 (0.344)
Preference: T-M-B	0.024 (0.312)
Preference: M-B-T	-0.219 (0.247)
Constant	-0.103 (0.275)

Notes: The default is to observe three pieces of information; clustered (by subject) standard errors in parentheses.

*Significant at 10%; **significant at 5%; ***significant at 1%.

that personality plays some role in determining what information the DM seeks, next we establish the presence of a link between the information received and choice.

Table 9 shows how the information about the distributions actually observed affects choices in the Priority treatment (viewing all three features is the default). Clearly, when only one piece of information is observed, which one it is affects the decision. To get a sense of the size of these impacts, Table 10 shows the frequency of riskier choices in the Control treatment and in the Priority treatment, depending on which piece of information is received for the cases where subjects observe either one or three pieces of information. Note that subjects who only receive information about the Top of the distribution choose the riskier option 81% of the time, while subjects that observe information about the Bottom and Middle choose the riskier option 39.47% and 18.18%, respectively. This suggests that demanding and receiving information about the Top may lead to riskier choices. When subjects observe all three pieces of information the frequency of riskier

TABLE 10

Frequency of Choice of the Riskier Distribution in the Control and Priority Treatments, for Some of the Key Cases of Information Observed

Treatment	Information	Frequency (%)
Control		37.80
Priority	Bottom	39.47
	Middle	18.18
	Top	80.95
	B-M-T	30.77

choices is 31%, not too different from what is observed in the control.¹⁶

In an informationally sparse world, that is, where uncertainty is present, DMs may resort to many devices to help them make choices. Here personality can come in via the likelihood of following the advice given by the advisor.

OBSERVATION 3. Under uncertainty, personality traits and gender affect the probability with which a DM follows advice.

As observed in prior research (see Schotter and Sopher 2003, 2007) subjects appear eager to follow advice. In fact, in our experiment subjects follow the advice given 85% of the time. This does not mean, however, that personality is not important for advice following. Table 11 shows the results of probit estimates where the dependent variable takes the value of 1 if the subject follows the advice given, and zero otherwise. The independent variables are risk aversion, gender, personality measures, and dummies for the advice as well as the reasons given as advice.

The main determinants of whether advice is followed or not are gender and personality. The personality measures are jointly significant ($p < 0.01$). For example, people with high scores on Extraversion and Agreeableness appear to follow advice more often (marginal effect of 0.008 and 0.01, respectively, at the average regressor of about 50), and people with high scores on Openness to Experience and Conscientiousness follow advice less often (marginal effect of -0.009 and -0.008, respectively, at the average regressor of about 50). Also, in all of the specifications

16. Notice that even when subjects observe all three pieces of information they still face some uncertainty since they do not know the probabilities associated to each specific outcome.

TABLE 11

Probit of the Factors Correlated to Following Advice, for Deciders in the Advice Treatment

Variable	Estimates	Marginals
Advice for the risky distribution	-1.101** (0.506)	-0.185* (0.100)
Information about B	0.65 (0.525)	0.062* (0.037)
Information about T	1.089* (0.591)	0.106** (0.046)
RRA	-0.221 (0.528)	-0.029 (0.067)
Female	1.501*** (0.474)	0.144*** (0.029)
Neuroticism	0.007 (0.015)	0.001 (0.002)
Extraversion	0.063*** (0.02)	0.008*** (0.002)
Openness	-0.065** (0.02)	-0.009** (0.003)
Agreeableness	0.074*** (0.021)	0.01*** (0.003)
Conscientiousness	-0.055*** (0.021)	-0.007*** (0.003)
SSS	0.038 (0.05)	0.005 (0.006)
Constant	-1.091 (2.162)	

Note: Clustered (by subject) standard errors in parentheses.

*Significant at 10%; **significant at 5%; ***significant at 1%.

women appear to follow advice more often than men. Risk aversion does not explain the decision to follow advice.

While we have established a link between personality and advice following there may also be a personality component in advice giving. This is important because if the type of advice given is determined by the personality of the advisor, and the likelihood of it being followed depends on the personality of the advisee, then the match between advisors and advisees may be important in determining the effectiveness of advice.

OBSERVATION 4. The advice given (the suggested choice) is correlated to gender and personality for advisors.

To support this observation, we present Table 12 which uses the data from our subject advisors and shows the results of probit estimations where the dependent variable takes the value of 1 if the subjects advised the choice of the riskier distribution, and zero otherwise. The independent variables are risk aversion, gender, and personality measures.

TABLE 12

Probit of the Factors Correlated to Giving Advice toward the Riskier Option, for Advisers in the Advice Treatment

Variable	Estimates	Marginals
RRA	0.114 (0.151)	0.043 (0.057)
Female	0.34** (0.152)	0.125** (0.054)
Neuroticism	0.011 (0.010)	0.004 (0.004)
Extraversion	0.003 (0.007)	0.001 (0.003)
Openness	-0.018*** (0.006)	-0.007*** (0.002)
Agreeableness	-0.010 (0.007)	-0.004 (0.003)
Conscientiousness	0.019** (0.010)	0.007** (0.004)
SSS	0.016** (0.007)	0.006** (0.003)
Constant	-1.212 (0.870)	

Note: Clustered (by subject) standard errors in parentheses.

*Significant at 10%; **significant at 5%; ***significant at 1%.

In the case of advice giving, the personality measures are jointly significant ($p < 0.1$). As we can see, females appear to give the riskier option as advice more often than men (marginal effect of 0.125 at the average regressor of about 0.5), and subjects who are more open to experience appear to give the riskier advice less often (marginal effect of -0.007 at the average regressor of about 50). The fact that females suggest riskier options more often is interesting since women typically are risk averse and sometimes more so than males when making choices for themselves in situations of risk (see Croson and Gneezy 2009; Niederle 2016), suggesting a kind of split attitude for females when it comes to choosing for themselves when facing risk and advising others when facing uncertainty. Finally those who score higher on average on the SSS and on Conscientiousness tend to suggest the more risky choice (marginal effect of 0.007 and 0.006, respectively, at the average regressor of about 50).

OBSERVATION 5. Gender and elements of personality have a significant impact on the type of information offered as justifications by advisors.

As we have mentioned before, in our experiment advice giving has two parts: a

TABLE 13

Multinomial Probit Estimate of the Factors Correlated to the Reason Given as Advice, for Advisers

Variable	Estimates		Marginals	
	M	T	M	T
RRA	-0.567 (0.56)	-0.645 (0.497)	-0.035 (0.103)	-0.050 (0.078)
Female	1.223** (0.476)	1.393*** (0.35)	0.095 (0.113)	0.113* (0.062)
Neuroticism	0.032 (0.039)	0.023 (0.022)	0.005 (0.008)	-0.001 (0.005)
Extraversion	0.036 (0.039)	0.039 (0.025)	0.003 (0.007)	0.003 (0.004)
Openness	-0.038 (0.032)	-0.068*** (0.023)	0.003 (0.005)	-0.010*** (0.003)
Agreeableness	-0.002 (0.028)	-0.016 (0.015)	0.003 (0.006)	-0.004 (0.004)
Conscientiousness	-0.018 (0.032)	0.023 (0.025)	-0.010 (0.007)	0.010* (0.005)
SSS	-0.074** (0.037)	-0.043 (0.027)	-0.013* (0.007)	0.004 (0.004)
Constant	1.838 (3.472)	0.827 (2.479)		

Notes: Bottom was used as the base outcome; standard errors in parentheses; one standard error is reported as N/A because the software cannot compute it.

*Significant at 10%; **significant at 5%; ***significant at 1%.

recommendation and a piece of information used as a justification for the advice. Observation 7 suggests that personality is relevant for the recommendation but there might be an additional personality component involved in the type of justification used to support it. Table 13 shows what factors determine the reason given as advice, that is, bottom, middle, or top of the distribution, using a multinomial probit where the base outcome is to give bottom as advice. Again the various measures of personality are jointly significant ($p < 0.01$), with sensation seeking decreasing the chance of a M suggestion compared to B, while Openness reduces the use of T compared to B. The table also reveals that females are less likely to justify a recommendation by pointing to the bottom of the distribution.

E. Summary of Results

Since we have presented a fair number of results, it might make sense to pause and take stock of what we have learned before proceeding to a discussion and our conclusions. The key results are the following. Consistent with Hypothesis 1, the key determinant of

choice under risk is risk aversion. However, personality, risk attitudes, and gender affect multiple aspects of behavior under uncertainty. In particular, there is strong evidence that personality directly affects choices in the Advice treatment and some evidence that it does in the Priority treatment. In addition, personality also appears to have an indirect effect on choice via the information demanded or the likelihood of following advice.

In discussing our results further, it is useful to make a distinction between direct and indirect relationships. The relation between information demand and personality in the Priority treatment, between following advice and personality in the Advice treatment, and between personality and advice giving in the Advice treatment are all direct relations. However, for instance, the relationship between personality and choice in the Priority treatment is indirect since it is mediated by the intermediate step of information demand. To summarize these direct and indirect relationships, Table 14 presents the main statistically significant relationships we have uncovered.

As we can see from Table 14, when it comes to information demand, Neuroticism, Extraversion, and Conscientiousness all increase the probability that a subject ranks M first rather than B. With respect to indirect relationships, in our study personality affects the information demanded, which in turn affects choices. Table 14 contains the results for the Priority treatment when we

TABLE 14

Key (Statistically Significant) Relations between Personality Traits and Behavior

Treatment		N	E	O	A	C	SSS
Direct							
Control	Riskier choice						
Priority Advice	Info. demand ^a	+M	+M			+M	-T
	Follow advice		+	-	+	-	
Advice	Give risky advice			-		+	+
Indirect							
Priority ^b	Riskier choice		+		-		
Advice	Riskier choice						

Notes: A, Agreeableness; C, Conscientiousness; E, Extraversion; N, Neuroticism; O, Openness to Experience.

^aCompared to the baseline of ranking B first in the priority.

^bFor the case when subjects observe three pieces of information.

pool the data over the cases where subjects received information about B, M, and T, and hence all have the same information. In this case, personality is correlated to the riskiness of choices, even after controlling for information preferences. In particular, Extraversion has a positive impact on the riskiness of choices while Agreeableness has a negative impact.

With regards to the Advice treatment, Extraversion and Agreeableness increase the likelihood of following advice, while Openness and Conscientiousness decrease it. Openness decreases the probability that an advisor gives the riskier advice while Conscientiousness and SSS increase it. Personality does not determine riskier choices in the Advice treatment, even after controlling for the type of advice given.

Risk aversion also plays an interesting and subtle role in all of the relationships discussed above. As mentioned earlier, it is the only statistically significant predictor of choice in the Control treatment. With respect to information demand, Risk aversion decreases the demand for M in the priority treatment, so that more risk averse agents are less likely to rank M first as opposed to B. With respect to advice giving, Risk aversion increases the likelihood of giving B as a justification for choice in the Advice treatment and it decreases the likelihood of riskier choices, but it does not have an impact on who follows advice.

When we turn our attention to gender, we find that while it does not have a conclusive impact on choices in the Control treatment, it does increase the demand for M by females in the Priority treatment. In the advice treatment, females are more likely to follow advice and more likely to give riskier advice.

One thing that is important to point out as we look across our regression results is that while personality traits are significant across specifications, it is not always the same traits, nor is it necessarily in the same direction. This is not surprising, however, since each regression explains a different phenomenon. In particular, in each regression subjects are presented with different types of choices (or tasks), and there is no reason a priori why the same personality traits should explain different tasks in the same way. For example, while Neuroticism and Conscientiousness increase the likelihood of asking for information about the middle of the distributions as opposed to the bottom, it is Conscientiousness and Agreeableness that are significant in determining whether a subject follows advice.

Neuroticism appears not to be significant here. This finding is somewhat expected since the personality characteristics that are responsible for information demand do not have to be the same that determine whether a person is more likely to follow advice. Our point is that the Big Five and SSS personality scales appear to be correlated to certain types of behavior under uncertainty, but which constellations of traits are important for any given type of behavior varies with the task performed by subjects.

IV. RELATED LITERATURE

There is relatively little literature that directly relates to the questions of personality, information acquisition, and choice discussed here. The only study we know of that relates personality to information demand is Gerber et al. (2011).¹⁷ This study correlates the Big Five to political interest, knowledge, and the consumption of different types of political media. They use data from an internet survey of American registered voters which attempts to be close to a representative sample of the population. The survey they use was administered before the 2008 election and contains data on 8,664 individuals. They find that Openness, Agreeableness, and Extraversion are all positively correlated to the consumption (in the previous week) of at least one of the three forms of media they study: television, internet or newspaper. When they focus on whether the individuals watched national or local news, what they find is that Agreeableness and Extraversion increase the likelihood of watching national news, while Agreeableness and Conscientiousness increase the chance of watching local news and Openness decreases it. Clearly, their exercise is very different from ours. However, one comparison which may be legitimate is that in their case, each of the five personality dimensions matters for some aspect of whether individuals consume news or not, and in what format, except for Neuroticism. In our case, Neuroticism does affect the kind of information demanded, but Openness and Agreeableness never come into play. This could simply be because the realms of these two studies are so different, or because the decision to consume some information is different from the decision to choose what information to focus on.

17. Modnak and Halperin (2008) also correlates the Big Five to media consumption, but it is more general consumption rather than on a specific topic.

We also analyze the impact that personality has on choice. The studies that would appear the most relevant for the impact of personality on risky choices are those related to the role of personality in gambling.¹⁸ McDaniel (2002) finds that the SSS is positively correlated to interest in gambling in a sample of 555 adults (18 and above) from the eastern United States surveyed by telephone.¹⁹ Lauriola and Levin (2001), using a sample of 76 Italian adults, conclude that Openness and Neuroticism affect riskier choices (they offer a series of choices between a safe alternative and a riskier one). Furthermore, the impact of Neuroticism varies for the loss and gain domains. However, their results are either not statistically significant or barely so. Our results suggest a more complicated role for personality, one where the impact of personality traits on choice interacts with the way in which the information is being presented to the subject. Nicholson et al. (2005) study a sample of students and executives, including MBAs and executives in training programs at the London Business School (sample size 1669) looking to validate a set of survey questions on the propensity to take risks in various areas (physical status, lifestyle, and livelihood, which includes career and financial risk).²⁰ The answer to their question on financial risks is significantly correlated to all five domains of the Big Five. More specifically, they find a positive relation to Extraversion and Openness, and a negative relation to Neuroticism, Agreeableness, and Conscientiousness. They also report that males score higher on risk taking, but this correlation appears to have been established without controlling for personality (and similarly, the impact of personality is established without controlling for any other factors). Similar to them, we find

18. Even though in gambling situations probabilities can be objectively known, it appears reasonable to argue that individuals are not fully cognizant of them. Thus, it is similar to an environment with uncertainty.

19. One study, by Paunonen and Ashton (2001), correlates the Big Five to a survey question about buying lottery tickets and another about the willingness to gamble. Unfortunately, they do not provide information in the paper about which of the five components has a statistically significant correlation to the answers. Another study by Breslin et al. (1999) focuses on the interaction of drinking and Sensation Seeking and the impact this has on risky choice behavior in the gains versus losses domain.

20. Lo, Repin, and Steenbarger (2005) studies an even more specialized group, namely day-traders that were taking part in an online training for day-traders. They did not find that any of the Big Five dimensions correlated significantly with trading performance.

that males take riskier choices (in our case even controlling for personality and risk aversion).

With respect to gender, there is some evidence that women are more risk averse than men when making decisions under risk (see Croson and Gneezy 2009; Eckel and Grossman 2008, for two surveys).²¹ Borghans et al. (2009) study how risk and ambiguity aversion vary across men and women and whether the differences in these parameters can be explained by personality measures. They find that differences in ambiguity aversion cannot be explained by personality traits. However, similar to Croson and Gneezy (2009), they find that women are more risk averse than men and that differences across risk aversion parameters can be explained by personality measures, in particular by Agreeableness and Neuroticism from the Big Five Scale, and by ambition, as measured by Duckworth et al. (2007). Eckel and Grossman (2002) study risk attitudes between men and women and measure personality characteristics using the SSS. They find that women are consistently more risk averse than men and that men appear to overestimate the risk aversion of women when predicting choices between gambles. However, they find no significant gender difference in the overall SSS scores and they find very low predictive power of the SSS on gamble choices.

V. MOTIVES FOR INFORMATION GATHERING: SOME THEORETICAL APPROACHES

There are two main questions that we need to answer in order to fully understand how personality affects decision making under uncertainty. First, why do people desire information in the first place and why a particular type of information? Second, what is it about a DM's personality that leads him to desire the type of information he does? Below we sketch a few of our thoughts on the motives that people may have for information gathering. While a complete theory of personality is beyond the scope of this study, we do hope that our thoughts below can be useful to others who are interested in pursuing these topics.

A. *Pessimistic Priors*

As shown by Sharpe, Martin, and Roth (2011), there is a strong statistical correlation between

21. Nevertheless, as pointed out by Niederle and Vesterlund (2011), there are some studies that do not find gender differences in risk preferences.

dispositional optimism and four of the Big Five personality traits (Neuroticism, Extraversion, Agreeableness, and Conscientiousness). Probably the most straightforward answer to the question of how personality can affect information gathering works through a subject's level of optimism (or pessimism) about the unknown distributions he faces and the relationship of personality traits to this characteristic. Under this interpretation, the subject remains an expected utility maximizer but his level of optimism simply affects the type of priors he has over the payoff distributions he faces. While one might think it natural for pessimists to concentrate their attention on the left tail of the distribution, with optimists caring more for the right tail, this may not necessarily be the case. However, as long as pessimists and optimists seek different information, then all that is needed is to connect a subject's level of optimism with some constellation of personality traits in order to explain the impact of personality on information gathering.

The type of ambiguous decision environments we place our subjects in are relatively scary when compared to environments characterized solely by risk. As such, they may call forth some type of ambiguity averse behavior. A famous theory of decision making under ambiguity by Gilboa and Schmeidler (1989) suggests that when faced with ambiguity, a DM is likely to assume he is facing the worst possible probability distribution in the set of feasible distributions and choose that action which is best against this pessimistic assumption. So Gilboa and Schmeidler's DMs are extremely pessimistic when faced with ambiguity.

However, not all subjects are likely to be this pessimistic and, hence, we might expect some variability across people concerning how pessimistic they are. To this end, Ghirardato, Maccheroni, and Marinacci (2004) have created an alternative theory where DMs choose as if they were characterized by a combination of pessimism and optimism with a weight, α , defining the exact convex combination of the two. If a theory of personality and decision making under ambiguity is to be formulated, one might investigate what factors determine a DM's α . We expect that personality variables are likely to play a role here and hence in determining the information that such types find desirable.

B. Probabilities Inside the Utility Function

A second possibility for why personality affects information acquisition may stem from

the idea that the prize space over which a person's utility function is defined contains not only tangible outcomes but also emotional states defined by probability distributions. As Caplin and Leahy (2001) have demonstrated, the utility of a particular outcome may depend both on the anticipated outcome itself and on the probabilities that this outcome may occur, with the probability entering independently into a DM's utility function.²² This is particularly true when the decision has an emotional component to it, such as when medical decisions are being made and anxiety about outcomes is paramount.

In such a situation, different personality types may be inclined to search for different types of information because their utility at the moment of decision making is affected by the beliefs they hold at that moment. Neurotics may want to assure themselves that they are making a choice that, a priori, guarantees them either the largest minimum outcome or perhaps, as our regressions indicate, the largest middle outcome. People who rank high on the SSS or Openness to Experience may derive utility from thinking that they are more likely to receive a good outcome and hence inquire about the top of the distribution, and so on. Whatever their motive, the idea here is for DMs to choose their beliefs optimally much like Brunnermeier and Parker (2005) suggest. They search for information in order to find those beliefs they would like to hold and we suspect that their preferred beliefs are a function of personality variables.

The two sketches of a theory of personality and decision making outlined above are certainly not exhaustive. Other theories can be easily constructed. Still, they all would need to share some common features. First, the role of personality may be dramatically different as we move from risky to ambiguous environments. Second, the information people gather will depend on their personality.

Two more theories that might appear like plausible avenues through which personality might affect information-gathering decisions are heuristics and preferences over higher moments of the distribution. We review these two possibilities below. Note that while these theories are equally applicable for decision making under risk and uncertainty it is only in the ambiguous

22. See also Brunnermeier and Parker (2005) for a model where probabilities or beliefs enter directly into a DM's utility function.

situations where they have an influence on the information-gathering strategies of subjects.

C. Heuristics

There has been a considerable amount of work done by psychologists (see Brandstatter, Gigerenzer, and Hertwig 2006; Gigerenzer 2004, to name only two), and economists (e.g., Rubinstein 1988), indicating that in a risky choice environment, where DMs see all relevant probability distributions, rather than weighting, multiplying, and adding probabilities and payoffs as is expected of them under the Expected Utility Hypothesis, they employ a heuristic where they proceed lexicographically and compare features of lotteries, that is, their minimum payoffs or the probability of a minimum payoff. Rubinstein (1988), for example, demonstrates that when comparing two lotteries DMs compare the similarities of the probabilities and payoffs in a lexicographical manner. Brandstatter, Gigerenzer, and Hertwig (2006) proceed in a similar manner but assume a fixed order for comparisons using what they call a “priority heuristic” which compares the minimum gain of two gambles, then the probability of the minimum gain, and then finally the maximum gain. This priority order is justified empirically rather than theoretically and, as is true for Rubinstein (1988), is assumed to be the same for all individuals.

There are some modifications that need be made on the Brandstatter, Gigerenzer, and Hertwig (2006) and Rubinstein (1988) theories before they can be employed here. First, those theories were constructed for complete information settings and not for the settings we examine under uncertainty. However, it is obvious that our subjects could use such heuristics simply by asking questions in the order most closely associated with either heuristic and by modifying it where necessary. Furthermore, Brandstatter, Gigerenzer, and Hertwig (2006) and Rubinstein (1988) assume that all people search identically using their heuristics. Clearly, we assume heterogeneity across DMs and assume that this heterogeneity can be explained by personality. What is missing is a theory that connects personality and heuristic choices (and hence information gathering).

D. Preferences over Higher Moments

In recent years, a number of empirical and theoretical papers have been written indicating that individuals have a preference for (positive)

skewness in the distribution of payoffs they face and that risk averse individuals are prepared to accept a lower expected payoff or a higher level of overall riskiness if the distribution of payoffs is more skewed to the right.²³

These results may have direct relevance for the type of information inquiries we might see in experiments like ours since such inquiries may be aimed at finding out information about these higher moments. Eliaz and Schotter (2010) demonstrate that if a DM has a preference for confidence in his decision and, as a result, has the probability of making the correct decision as an argument in his utility function, he will have a preference for negative skewness. As a result, he might also wish to gather information about these higher moments and hence ask questions that would be informative about them.

If this is the motive for information acquisition, then if we were to build a theory of personality and choice we would need a model that connects a subject’s personality to his preferences over moments of a distribution.

VI. DISCUSSION

This study was motivated by a hypothesis that if personality were to have an influence on choice, it would be in uncertain rather than risky environments, which is substantiated by the data. We have demonstrated that personality may have a significant impact on economic decision making through its effects on information gathering in environments of uncertainty. The path of this influence is in part indirect since we establish that differences in personality characteristics, as measured by the Big Five personality scale and the SSS, lead DMs to seek out different types of information which then, conditional on the information observed, alters the decisions they make. We also show that when information is transmitted by an advisor, personality influences both the advice given and the likelihood that the advice is followed.

However, when decisions are made solely under risk, that is, in environments where the DM knows with certainty the exact probability distribution he or she faces, personality fails to be a

23. See Scott and Horvath (1980) for an early contribution and Chiu (2005) for a more thorough choice theoretic treatment of the issue. Menezes, Geiss, and Tressler (1980) discuss skewness in a choice-theoretic framework by introducing the concept of increasing downside risk, a concept that may have relevance for our discussion here.

significant determinant of choice. In such circumstances, what matters for choice is the DM's level of risk aversion.

Research in economics has largely focused on understanding how people make decisions in a world characterized by uncertainty. In this paper, we are interested in the fact that some of this uncertainty can be alleviated by seeking information, and we find that in this search to diminish uncertainty personality plays a role. This finding may have important implications in various economic settings, such as the matching between financial advisors and advisees, or the process of hiring people in organizations.

The decision environment appears to play a crucial role when studying the effects of personality on choice in the presence of uncertainty, where the probability distributions faced by the DM are unknown. On the one hand, the impact of personality on choice appears to be mediated through information acquisition when DMs choose the information they wish to acquire. On the other hand, personality ceases to be important for choice when information is received via advice, rather than solicited directly. This implies that the decision environment, defined by how the information is received, matters for choice. This is plausible because some people tend to follow advice so diligently that they might ignore the actual information offered to justify the recommendation.

As we have suggested, if progress is to be made in connecting personality with decision making, a theory of personality will be needed. The existing scales to measure personality characteristics are mostly descriptive and are not designed to predict economic outcomes. For this reason, the meaning of these dimensions of personality might not be straightforward to interpret when it comes to economic behavior. For example, it might be the case that Extraversion, as measured by the Big Five, is a reliable predictor of how likely someone is to follow advice. However, what Extraversion captures in terms of economic decision making and advice taking in that realm is far from obvious. The specific questions that are used to construct these measures are difficult to relate to observable economic choices.

One component of such a theory will certainly be the specification of a link between the different personality characteristics, that is, Openness

to Experience, Neuroticism, and so forth, and information search. Furthermore, a link will be needed between personality traits and individual welfare. For example, do neurotics or conscientious types do better because they gather more relevant information about the world they face before making decisions, or do they do better because, conditional on any information gathered, they make better choices?

One might envision a number of theoretical explanations for information gathering in situations of uncertainty and the role played by personality. For example, DMs may rely on heuristics when making decisions under risk (see Brandstatter, Gigerenzer, and Hertwig 2006; Gigerenzer 2004; Rubinstein 1988). Under these theories when DMs make risky decisions, rather than weighting, multiplying, and adding probabilities and payoffs, they proceed lexicographically and compare features of lotteries, that is, their minimum payoffs or the probability of a minimum payoff, and so on. Brandstatter, Gigerenzer, and Hertwig (2006), for example, assume a "priority heuristic" where the DM compares first the minimum gain of two gambles, then the probability of the minimum gain, and finally the maximum gain. If such a heuristic is used under risk, it would be interesting to understand what type of information would be gathered under uncertainty. Personality may play a role in this information acquisition stage.

Alternatively, the impact of personality on information gathering may work through another related personality characteristic, for example, the degree of pessimism of the DM. For example, Gilboa and Schmeidler (1989) suggest that when faced with uncertainty, a DM who is uncertainty averse is likely to assume an extremely pessimistic stance. This would imply a demand for specific types of information in our setting. But not all DMs are this pessimistic. Ghirardato, Maccheroni, and Marinacci (2004) allow for a combination of optimism and pessimism (weighted by an α parameter, $0 \leq \alpha \leq 1$). This suggests that personality may affect decision making and information acquisition under uncertainty by affecting how pessimistic or optimistic a DM is and hence, the α they use in making decisions. Defining a link between the Big Five personality traits, a DM's degree of pessimism, and information gathering is part of our future agenda.

APPENDIX

TABLE A1

Correlations between Personality Traits and Ranking of Pieces of Information in the Priority Treatment

Position in Ranking	Reason	Female	Risk Aversion	Neuroticism	Extraversion	Openness to Experience	Agreeableness	Conscientiousness	Sensation Seeking
(1)	B	-0.169	0.126	0.17	-0.381**	-0.122	0.032	-0.269*	-0.056
(2)	T								
(3)	M								
(1)	B	0.021	0.069	-0.269*	0.41***	0.194	-0.04	0.123	0.26*
(2)	M								
(3)	T								
(1)	T	0.066	0.039	0.075	-0.146	-0.259*	0.046	0.042	-0.258*
(2)	B								
(3)	M								
(1)	T	-0.107	-0.018	-0.019	0.076	0.189	-0.06	-0.071	0.055
(2)	M								
(3)	B								
(1)	M	-0.119	-0.021	0.194	-0.093	0.138	-0.196	-0.00	0.134
(2)	B								
(3)	T								
(1)	M	0.319**	-0.203	-0.106	0.152	-0.138	0.155	0.247	-0.15
(2)	T								
(3)	B								

*Significant at 10%; **significant at 5%; ***significant at 1%.

TABLE A2

Distributions Subjects Were Shown

Choice	Value	Probability			
		L	SR	G/L	U
0	-5	0	0	0.023504	0
1	0	0.000326	0.005157	0.026115	0.350001
2	1	0.000651	0.010314	0.029017	0.105
3	2	0.001303	0.020629	0.032241	0.0315
4	3	0.002606	0.041257	0.035824	0.00945
5	4	0.005212	0.082515	0.039804	0.002835
6	5	0.010423	0.077924	0.044227	0.000851
7	6	0.020847	0.073588	0.049141	0.000255
8	7	0.041694	0.069494	0.054601	7.65E-05
9	8	0.083388	0.065627	0.060668	2.3E-05
10	9	0.166775	0.061976	0.067409	6.89E-06
11	10	0.33355	0.058528	0.074898	2.07E-06
12	11	0.166775	0.055271	0.067409	6.89E-06
13	12	0.083388	0.052196	0.060668	2.3E-05
14	13	0.041694	0.049292	0.054601	7.65E-05
15	14	0.020847	0.04655	0.049141	0.000255
16	15	0.010423	0.04396	0.044227	0.000851
17	16	0.005212	0.041514	0.039804	0.002835
18	17	0.002606	0.039204	0.035824	0.00945
19	18	0.001303	0.037023	0.032241	0.0315
20	19	0.000651	0.034963	0.029017	0.105
21	20	0.000326	0.033018	0.026115	0.350001
22	25	0	0	0.023504	0
Variance		3.907492	26.209200	40.031050	92.224839

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