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"Personality Traits and Strategic Behavior: Anxiousness, Aggressiveness and Entry Games"

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Abstract

We demonstrate that personality has a systematic effect on strategic behavior. We focus on two personality traits: anxiousness and aggressiveness, and consider a 2-player entry game, where each player can guarantee a payoff by staying out, a higher payoff if she is the only player to enter, but a lower payoff if both players enter. We find that: anxious players enter less; aggressive players enter more; players are more likely to enter against anxious than non-anxious players; and players are less likely to enter against aggressive than non-aggressive players. We discuss the possible mechanism through which personality affects strategic behavior.

1. Introduction

Game theory typically ignores players' personalities[4]. The purpose of this paper is to demonstrate that personality predispositions have a systematic effect on the players' strategic behavior. Allport (1937, 1961) defines personality as the dynamic organization of characteristics that creates a person's cognitions, motivation and *behavior*. Over the years the study of personality psychology and individual differences encompassed many theoretical approaches. In this paper, we focus on a trait (disposition) approach. Trait approaches assume that personality traits differ across individuals, but are stable within an individual (during adulthood) and over time (McCrae & Costa, 1990), and that these traits *shape the person's behavior*[5].

The Five-Factor personality (FFM) Model (Costa & McCrae, 1992; Goldberg, 1993; Russell & Karol, 1994; also known as the "Big 5" model) is a prominent theory of personality. According to this model, there are five major personality dimensions (or domains): Neuroticism, Extraversion, Conscientiousness, Agreeableness and Openness to Experience. Each of these dimensions is further composed of several different facets. The Big-5 model is empirically based, and the 5 factors as well as their facets have been derived using factor analysis[6].

This paper focuses on two of the facets of the Neuroticism domain. Neuroticism, also defines as low emotional stability (Goldberg, 1993) is characterized by a tendency to experience negative affectivity and psychological distress. Neurotic individuals are "ineffective in their attempts to cope with stress and are prone to engage in irrational thought" (Betterncourt et al., 2006, p. 754). They are more likely to experience anxiety, anger, guilt and depression, and interpret ordinary situations as threatening (Matthews & Deary, 1998). The facets of neuroticism include anxiety, angry hostility[7], depression, self-consciousness, and impulsiveness. We limit the current investigation to the connection between anxiousness and aggressiveness[8] (angry hostility) and strategic behavior.

The choice of anxiousness and aggressiveness provides a particularly interesting contrast. While according to the Big-5 model both traits have a mutual origin (high neuroticism), their psychological

4 At best, it can be said that personality is implicitly incorporated into the players' payoffs.

5 Examples can be found in Barrick & Mount, 1991; Hurtz & Donovan, 2000; Hogan & Holland, 2003; Mount, Barrick & Strauss, 1994; Barrick, Mount & Judge, 2001; Propat, 2009; Roberts et al. 2007; but see Morgeson et al. 2007, for a different perspective.

6 Most of the criticism of the Big 5 model revolves around the fact that the model is data driven rather than theory driven. See, for example, the comprehensive review by Block (2010).

7 As opposed to antagonistic hostility that is associated with the (low) Agreeableness domain. We define and measure aggressiveness as angry hostility rather than antagonistic hostility.

8 We use the term anxiousness and aggressiveness to refer to the *traits*, while anxiety and aggression refer to states or behaviors.

experience and behavioral implications are very different. Anxiousness creates feelings of fear, worry, uneasiness, and dread (Bouras & Holt, 2007), and promotes behavioral patterns of withdrawal. Anxious individuals tend to be hyper vigilant and succumb to feelings of threat (Staw, Sandelands & Dutton, 1981). In contrast, aggressiveness is intended to increase social dominance, and cause pain or harm to others (Ferguson & Beaver, 2009) and is associated with approach-behaviors such as risk taking (Lerner & Keltner, 2001)[9].

There is very little research connecting personality and economic or strategic behavior (notable exceptions are Anderson et al., 2011; Battigalli & Dufwenberg, 2007; 2009; Johnson, Rustichini & MacDonald, 2009). In contrast, psychological research accumulated a lot of evidence regarding traits and specific behaviors. In the context of the traits that are relevant to this study, Betterncourt et al. (2006) present a meta-analytic review of personality and aggressive behavior. They conclude that personality should be included as a central variable in models of aggressive behavior. Marshall and Brown (2006) demonstrate that people who are higher on the aggressiveness *trait* are more reactive to provocation, resulting in more aggressive *behavior*. In a more related study, Lauriola and Levin (2001) demonstrate that individuals high in Neuroticism engage in less risky decisions in the gains domain, but more risk taking in the domain of losses. It is noteworthy that the psychological literature focuses on individual behavior and decisions, and as such, is not directly applicable to strategic situations (games).

In contrast, we investigate anxiousness and aggressiveness in a 2-player symmetric entry game, where each player can guarantee a certain payoff by staying out, or obtain a higher payoff if she is the only player to enter but a lower payoff if both players enter. We selected this game for several reasons. First, a player in this game has to choose between an avoidance option (stay out), and a risky conflict, or approach option (enter). These two options correspond directly to the behavioral implications of the personality traits we wish to investigate, and create exactly opposite predictions regarding players' behavior. Second, the game is simple and easy to explain and analyze. Finally, the choice of an optimal strategy in an entry game is mainly affected by the player's beliefs regarding the behavior of the other players, so it highlights strategic considerations. As such, the game is a perfect vessel to look not only at the effect of personality on behavior, but also at the effect of the players' mental models or "theory of mind" of the personality of the other players.[10]

There is a consensus regarding the importance of expectations and beliefs to decision theory in

9 See method section for a description of how anxiousness and aggressiveness are measured.

10 A theory of mind ascribes mental states to the self or others (Premack & Woodruff, 1978) and enables attribution of motivation and intentions to others (Frith & Frith, 2003). It allows generating hypotheses and developing lay theories about mental states (Wegner & Vallacher, 1991) and making predictions about others' behavior, on the basis of assumed mental states (Fodor, 1992).

general and game theory in particular. For example, Bicchieri (1988) stated that "in interactive situations, such as those treated in game theory, what is rational to do depends on what one expects that other agents will do" (p. 135). We choose to extend these claims, by incorporating expectations and beliefs regarding opponents who possess anxious and aggressive personality traits.

In this paper, we develop a theoretical model, and use a controlled laboratory study, to manipulate players' expectations regarding the personality dispositions of others. While laboratory experiments are often limited in their external validity, the use of a theory driven lab study allows in this case for maximum control, and for the disentangling of the effects of a player's own personality from the player's beliefs regarding the personality of others.

To the extent that people have theories of mind regarding the effect of others' personalities on their strategic behavior, and use those theories to shape beliefs, we expect that manipulating information regarding the level of anxiousness and aggressiveness of the opponents in the entry game will interact with the player's own aggressiveness and anxiousness in belief formation, and, in turn, will lead to different behavior in the entry game.

The rest of the paper proceeds as follows. In the section below we outline how anxiousness and aggressiveness of a player, together with her mental model of the anxiousness and aggressiveness of her opponents, are expected to shape beliefs, and in turn affect behavior in the entry game. We then describe the experimental method and procedure. The following section outlines the results. We conclude with a general discussion of anxiousness and aggressiveness as predictors of strategic behavior, speculate on the mechanism behind our findings, and present some limitations and avenues for future research.

2. Theory

We model anxiousness and aggressiveness in the following way. We assume that a non-anxious player in a two player game holds certain beliefs about the strategy employed by the opponent, denoted σ, to which she best responds. Under identical circumstances, an anxious player holds beliefs that are a mixture between σ and the other player's minmax strategy[11]. In other words, compared to a non-anxious player, an anxious player believes that the opponent tries to minmax him, or to play so as to hurt him as much as possible, with a positive probability.

We parameterize a player's level of anxiousness by $\alpha \in [0,1]$. We assume that whereas a non-

11 A player's minmax strategy in a two-player strategic form game is the strategy that minimizes the opponent's payoff under the assumption that the opponent responds optimally.

anxious player (with $\alpha = 0$) best responds to whatever she believes to be σ, the opponent's strategy, a player with level of anxiety α best responds to a strategy that is a mixture $(\alpha , 1- \alpha)$ of the opponent's minmax strategy and σ, respectively.

We model aggressiveness in a similar way. We assume a non-aggressive player in a two player game holds certain beliefs about the strategy employed by the opponent, denoted θ, to which he best responds. Under identical circumstances, an aggressive player holds beliefs that are a mixture between θ and the opponent's "maxmax" strategy.[12] That is, compared to a non-aggressive player, an aggressive player believes that the opponent tries to "maxmax" her, or accommodates her as much as possible, with a positive probability.

We parameterize a player's level of aggressiveness by $\beta \in [0,1]$. We assume that whereas a non-aggressive player (with $\beta = 0$) best responds to whatever he believes is θ, a player with level of aggression β best responds to a strategy that is a mixture $(\beta , 1- \beta)$ of the other player's maxmax strategy and θ, respectively.

The "entry game" we consider is a symmetric two player game in which the players need to decide simultaneously whether to enter or stay out, as follows:

	Enter	Stay out
Enter	-15,-15	15,0
Stay out	0,15	0,0

If we denote entry by 1 and staying out by 0, then we can express a player's strategy by a number between 0 and 1 that describes the probability that the player enters. If we interpret the payoffs in the game more realistically as monetary payments rather than 'utils' or units of utility then the best response of a player in this game would be to enter if he believes that the other player enters with a small probability, and to stay out if he believes that the other player enters with a large probability where "small" and "large" depend on the player's attitude towards risk. If the player is risk neutral, then small means smaller than ½ and large means larger than ½. Risk averse and risk loving players would have a higher and lower threshold, respectively. For simplicity, we proceed as if the elements in the game matrix are indeed payoffs rather than utilities, or as if these are monetary payments but the players are risk neutral. The adaptation of the text below for risk averse or risk loving players is straightforward. The minmax strategy in this game is to enter, and the maxmax strategy is to stay out.

12 A player's maxmax strategy in a two-player strategic form game is the strategy that maximizes the opponent's payoff under the assumption that the opponent responds optimally.

Thus, the discussion above implies that, ceteris paribus, anxious players should be less likely to enter than non-anxious players, and aggressive players should be more likely to enter than non-aggressive players. More specifically, if a non-anxious player believes that the opponent enters with probability q and therefore enters if and only if $q < ½$, then a player with a level of anxiety α enters if and only if $\alpha + (1- \alpha)q < ½$ or $q < (½ - \alpha)/(1- \alpha)$, which is smaller than ½. If a non-aggressive player believes that the opponent enters with probability q' and therefore enters if and only if $q' < ½$, then a player with a level of aggression β enters if and only if $\beta \cdot 0 + (1- \beta)q' > ½$ or $q' < 1/2(1- \beta)$, which is smaller than ½.

If it is indeed widely believed that anxious and aggressive players are relatively less and more likely to enter, respectively, as explained above, then players should be relatively more likely to enter against anxious players compared to non-anxious players, and less likely to enter against aggressive players compared to non-aggressive players. If a player believes that the opponent believes that he would enter with probability q, and therefore the opponent enters if and only if $q < ½$, then the player himself would enter if and only if the opponent stays out or if $q > ½$. If the opponent is believed to have a level of anxiety α, then as explained above the opponent would enter if and only if $q < (½ - \alpha)/(1- \alpha)$, and so the player herself, who enters if and only if the opponent stays out, would enter if and only if $q > (½ - \alpha)/(1- \alpha)$, which is decreasing in the opponent's level of anxiety α. Similarly, a player willingness to enter is decreasing in the opponents' level of aggresiveness, β.

Finally, it should be said that we view our model as merely suggestive. It is only meant to clarify our intuitions about the characteristics of anxious and aggressive behavior. Although it is possible to extend the model and define equilibria in games played by anxious and aggressive players, we prefer not to do it because while our intuitions about the comparative statics of anxiousness and aggressiveness are strong, we feel less strongly about equilibrium behavior that anyway requires stronger common knowledge assumptions that are probably not satisfied in practice.[13] It is also possible to model anxious and aggressive behavior as stemming from anxious and aggressive players' different perceptions of the payoffs of the game. We believe this is a less elegant formulation because it necessarily depends on the particular game that is played by the players. In contrast, the belief formulation above is universal, and can be easily applied to any game.

13 We also abstract away from the fact that anxious or aggressive players may have different beliefs about the opponents' belief about them. Notice that a player in our game is only interested in the opponent's behavior. He does not care about what leads to this behavior. Thus, the fact that anxious and aggressive players may have different beliefs about the other player's belief about themselves is unimportant (or anyway is incorporated into their beliefs about the opponent's behavior). It is as if anxious and aggressive players believe that the opponent is more likely to believe them to indeed be more anxious and aggressive, respectively.

3. Testable Implications

The model above suggests that anxiousness and aggressiveness work in opposite directions. Ceteris paribus, anxiousness is expected to be negatively correlated with entry behavior, while aggressiveness should be positively correlated with entry behavior. Recall, however, that there are theoretical and empirical reasons to expect anxiousness and aggressiveness to be positively related. As two manifestations of the same higher order factor, Neuroticism, individuals high in anxiousness are hypothesized (and empirically found) to be high in aggressiveness and vice versa, suggesting the possibility of mutual suppression.

Cohen and Cohen (1975) define suppression as a situation in which the total amount of variance explained by two independent variables is higher than the sum of variance explained by each of the variables separately. This essentially means that $R^2_{x1x2y} > r^2_{x1y} + r^2_{x2y}$ [14](see also Brass, 1985, for a similar definition and example of suppression between job characteristics and technical uncertainty in their relation to job satisfaction).

Despite the fact that suppression is very rare in multiple regression, evidence of mutual suppression between different facets of the same domain within the Big 5 model has been previously documented. Moon et al. (2003) investigate depression and anxiousness, which are also facets of the neuroticism domain. They demonstrate mutual suppression of the two facets in an "escalation of commitment" dilemma: there is a positive relationship between anxiety and level of commitment, and a negative relationship between depression and level of commitment. As a result, the broad factor of Neuroticism shows no relationship with escalation of commitment, and a specific effect of a facet can be observed only when partialling out the effect of the other facet. In a different study, Moon (2001) shows that duty and achievement striving, two facets of conscientiousness, have opposite effects on escalation of commitment, and thus mask the predictive validity of overall conscientiousness on level of commitment.

Thus, we need to exercise caution in predicting the combined effect of anxiousness and aggressiveness. It is possible that mutual suppression of anxiousness and aggressiveness will act to cancel the overall effect of each trait, or that one trait will mitigate the effect of the other.

We hypothesize that:

- H1: Ceteris paribus (particularly controlling for level of aggressiveness), anxious players should be less likely to enter than non-anxious players;
- H2: Ceteris paribus (particularly controlling for level of anxiousness), aggressive players should

14 Where x_1 and x_2 are independent variables, y is a dependent variable, r^2 denotes a Pearson bivariate linear correlation, and R^2 denotes the multiple correlation (unadjusted amount of variance explained by the regression).

be more likely to enter than non-aggressive players;

- H3: when given information regarding the opponent's level of anxiousness, all players should be more likely to enter against anxious players, less so against randomly chosen players and even less against non-anxious players; and
- H4: when given information regarding the opponent's level of aggressiveness, all players should be less likely to enter against aggressive players, more so against randomly chosen players and even more against non-aggressive players.

4. Experiment

Participants

One hundred and six people participated in the online experiment. Participants were recruited through the subject pool of an experimental economics laboratory. Males and females participated in about equal proportions (55% female, and 45% male). The experiment lasted about 45 minutes, and participants earned an average of £10 Sterling (approx $16 US, or 12 Euros). While we did not collect age information in this experiment, the distribution of subjects in the subject pool is as follow: about 40% are students aged 18-25, and the other 60% are all over 18, with average age in high 30s early 40s. The participants come from diverse backgrounds, and thus this experiment is not vulnerable to the standard problem of generalizing from a student only population.

Experimental Design

A one way within-subjects design with 5 levels was employed. The within-subjects factor represented the type of opponent the participants faced: aggressive, non-aggressive, anxious, non-anxious or random. Aggressiveness and Anxiousness were measured as covariates.

Measures

Anxiousness: In line with Leary (1983, p. 67) we define interaction-anxiousness as the inclination to feel "anxiety resulting from the prospect or presence of interpersonal evaluation in real or imagined social settings" (pp. 67). Anxiousness was measured using a self-report questionnaire taken from Leary. This scale consists of 15 items such as "I often feel nervous even in casual get-togethers" and "I seldom feel anxious in social settings" (reversed item). Responders were asked to indicate the degree to which the statement is characteristic or true for them, on a five-point scale ranging from "not

at all" to "completely characteristic". See the Appendix for the full questionnaire.

Aggressiveness: We used an aggressiveness measure taken from Bryant and Smith (2001). This 12 item scale is originally based on the Buss and Perry (1992; see also Buss & Warren 2000) self-report aggression questionnaire, but is adjusted for better construct validity of the four facets of aggressiveness: physical aggression, verbal aggression, anger and hostility. Participants were asked to rate the degree each statement is characteristic for them using the same 5-point scale used for the anxiousness measure. Sample items are "Given enough provocation, I may hit another person" (physical aggression); "I can't help getting into arguments when people disagree with me" (verbal aggression); "I have trouble controlling my temper" (anger); and "Other people always seem to get the breaks" (hostility). See the Appendix for the full questionnaire.

Procedure

The experiment was conducted online, and all 106 participants participated simultaneously. The participants signed in using a special link they received in an email that was active only at the time the experiment was scheduled. They were then welcomed to the experiment and asked to fill-in the two personality questionnaires. They were requested to answer the questions honestly, and told that they need to complete the entire questionnaire in order to advance to the second part of the experiment.

After participants completed the questionnaires, they received instructions for the rest of the experiment. Each participant was instructed to act as the manager of a small firm that is considering the expansion of its operations, who is facing a competitor who is also considering possible expansion. If she decides to not expand operations, her profits will remain unchanged regardless of the competitor's choice. If she decides to Expand, then if the competitor does not, her profit will increase by 15 units; however, if her competitor decides to expand as well, her profits decrease by 15 units. She was told that her competitor was facing the same decision with the same payoffs, and that this was common knowledge. The conversion rate in this experiment was 1p (0.01 Sterling, or 0.016 US dollars) per unit.

Participants were told that in each round they will be matched randomly with a different opponent who is also participating in the experiment. They would not know who that competitor is, but were given some information regarding his or her personality. The game was played for 45 rounds, but feedback regarding the behavior of the opponents was not given until the end of all rounds. The matching was done by computer, such that each player played 9 rounds against each possible personality type: anxious, non-anxious, aggressive, non-aggressive, and random (no information given). Personality types were computed based on a median split of the scores of the personality

questionnaires from the first part of the experiment. At the end of the experiment each participant was paid in amazon vouchers sent to their email accounts.

5. Results

Personality scales

Anxiousness: each participant was given an anxiousness score corresponding to the sum of her ratings on all 15 items in the anxiousness scale (after recoding the reversed items). The range of the scores was from 15 (lowest possible score) to 74 (the highest possible score is 75), with a mean of 39.5, a median of 39 (the mean and median corresponded with the midpoint of the scale), and a standard deviation of 11.5. The scale was adequately reliable (Cronbach's α of .90).

Aggressiveness: the aggressiveness score for each participant was computed by summing the replies of all 12 items in the aggressiveness questionnaire. The scores ranged from 12 to 41 (theoretical range is 12 to 60). The distribution of scores was positively skewed, $M = 20.7$, median = 19 and $STD = 6.4$. The scale exhibited reasonable reliability (Cronbach's α of .81).

As expected from two facets of the Neuroticism domain, anxiousness and aggressiveness are significantly correlated, $r = .29$, $p < .01$.

Entry behavior

To avoid violations of independence, the analysis is conducted at the level of the participant. For each participant, we calculate the average entry rate against each type of opponent, and an overall entry rate. Thus, each participant provides 5 dependent measures of entry rates. Recall that the experiment involved no feedback regarding the behavior of opponents till the end of all 45 rounds, and thus single participants can be treated as independent units.

Table 1 reports the average entry rates against the 5 types of opponents. The highest entry rates are against non-aggressive and anxious opponents, followed by random opponents, then non-anxious opponents, and finally aggressive opponents. A repeated measures one way analysis of variance reveals a significant effect of opponent type ($F_{(4,420)} = 49.76$, $p < .001$). The effect size is substantial, $\eta_p^2 = .32$, so the type of opponent accounts for a large share of the observed variance in entry behavior. A series of post hoc contrasts of the estimated marginal means using a Bonferroni adjustment for multiple comparisons reveal that as predicted by H3, participants enter more against anxious opponents than against non-anxious opponent ($M = .77$ and .55 respectively), with entry rate against random opponents in the middle ($M = .69$, marginally less than against anxious opponents, significantly more than against

non-anxious opponents); Similarly, and as predicted by H4, participants enter less against aggressive opponent than non-aggressive opponents (M = .31 and .83 respectively), with entry rates against random opponent in the middle (M = .69, significantly different than both).

Opponent Type	Non-Aggressive	Anxious	Random	Non-Anxious	Aggressive
Mean Entry Rate	.83	.77	.69	.55	.31
Standard Deviation	.25	.33	.31	.37	.37

Table 1: Mean Entry Rates against Different Opponent Types (N = 106 participants)

Next, we tested the effect of a player's own predispositions, as measured by the two personality questionnaires, on entry behavior. Table 2 shows the bivariate correlations between the personality traits and overall entry behavior. The Table shows a significant, negative correlation between anxiousness and entry behavior (r = -.22, p < .05), in support of H1, but a non-significant correlation between aggression and entry behavior (r = .13, n.s.), in contrast to H2. Since anxiousness and aggressiveness are theoretically and empirically correlated, we also computed the partial correlation between aggressiveness and entry behavior, controlling for anxiousness. This partial correlation is positive and significant (r = .21, p < .05). This result indicates that anxiousness acts as a *suppressor* of the positive relationship between aggressiveness and entry behavior. To test that, we run an OLS regression using the overall entry rate as a dependent variable (averaging over the different opponents), and the personality scores as independent (measured) variables. The regression explains 8.6% of the variance in entry behavior, which is modest but significant (R^2 = .086, $F_{(2,105)}$ = 4.86, p < .01). The anxiousness coefficient is negative and significant (standardized β = -.276, t = -2.81, p < .01) and the aggressiveness coefficient is positive and significant (standardized β= .208, t = 2.11, p < .05). The results of the regression support H1 and H2. Note that consistent with the Cohen and Cohen's (1975) definition of suppression, R^2 is larger than the sum of the squared bivariate correlations ($R^2_{x1x2y} = .086 > r^2_{x1y} + r^2_{x2y} = .063$, where y is the entry rate, $x1$ the anxiousness score and $x2$ the aggressiveness score).

	X	*SD*	Correlations		
			1.	2.	3.
1. Anxiousness	39.5	11.5	.90		

2. Aggressiveness	20.7	6.4	.288**	.81	
3. Entry rate	.63	.19	-.216*	.128	--

Table 2: Descriptive Statistics and Pearson Linear Correlations between Personality Scores and Entry Behavior

Note. *correlation is significant at .05 level, ** correlation is significant at .01 level, $N = 106$ for all correlations, alpha reliabilities for scales are presented on the diagonal.

Finally, we combine the effects of personality traits with opponent types together. We rerun the repeated measures analysis of variance reported above, adding the anxiousness and aggressiveness scores as covariates. The analysis shows a significant effect of opponent type ($F_{(4,412)} = 4.41$, $p < .005$), a significant negative effect of the player's own anxiousness score ($F_{(1,103)} = 7.87$, $p < .01$), a significant positive effect of the player's aggressiveness score ($F_{(1,103)} = 4.46$, $p < .05$), but no significant interaction between the player's personality and the opponent's personality.

The interpretation of the results is as follows. First, players are sensitive to the personality type of the opponents. Second, anxious players are less likely to enter the market, but aggressive player are not more likely to enter the market. However, when the level of anxiousness is help constant, more aggressive players are indeed more likely to enter the market.

We note that in order to control for subjects' attitude for risk, a subset of 63 subjects took the Holt and Laury[15] (2002) risk attitude questionnaire. We found no correlation between subjects' risk attitude (as measured by the questionnaire) and entry behavior, and no correlation between subjects' risk attitude and subjects' aggressiveness or anxiety scores. The first finding is consistent with previous research (e.g., Heinemann, Nagel & Ockenfels) that found no correlation between attitudes to risk (as measured by risk aversion) and attitudes to uncertainty, or "strategic risk," as in the game considered in our experiment. The second finding is consistent with the psychological literature on traits and also a recent experiment by Artinger and Vulkan (2012) that found no correlation between personality traits - including in addition to anxiety and aggression, also the Big 5 - and risk attitude as measured by the Holt and Laury (2002) questionnaire.

6. Conclusions

There are many examples that demonstrate both experimentally and empirically that actual behavior is more diverse than what is prescribed by game theoretic considerations alone (see section 2 of Crawford et al., 2010, for a summary of several such cases). Indeed, much of the older literature on bounded rationality (starting in the 60s with Herbert Simon's work) can be viewed as an attempt to deal

15 Of course, the Holt and Laury (2002) questionnaire is only one way to measure the risk attitude of subjects. But while we cannot rule out the possibility that a different questionnaire would show some correlation, the fact that there is an agreed way to measure personality traits and that this measure is stable underscores the advantage of relying on personality traits rather than risk attitudes as a useful tool for accounting for strategic choice

with the heterogeneity of agents (see, e.g., Rubinstein, 1998, for a summary of bounded rationality literature). Nevertheless, there seem to be no consensus on the proper way to address these discrepancies, and consequently many intriguing insights and observations remain outside the core of economics, game theory and their applications.

Recent years have seen a big growth in literature on k - level reasoning, which presents an attempt to address the issue of heterogeneity (e.g., Camerer, Ho & Chong, 2004; Crawford & Iriberri, 2007; Ho, Camerer & Weigelt, 1998; Nagel, 1995; Stahl & Wilson, 1994; 1995). We present an alternative and complementary approach. We draw on the well-developed body of research from psychology that investigates personality as a leading cause to individual differences, and apply it to strategic behavior. There are several advantages to this approach. First, decades of research on personality have led to a good understanding of what personality is and to the realization that personality is largely stable in the adult life and shapes adult behavior in consistent ways. Second, the methodology of measuring personality is well developed, and there are simple, reliable and valid instruments to measure specific personality traits, both in the lab and in real settings (such as selection processes, or personnel evaluations). Finally, by including mental models of personalities of others, we extend the use of personality to belief formation which is a critical aspect of strategic decision making, and a central part of game theory.

In this paper we demonstrate that aggressiveness and anxiousness – both very different manifestations of neuroticism – have a consistent and intuitive effect on strategic behavior in a simple entry game. While the sizes of the effect of the player's personality are moderate in size, the sizes of the effect of the other player's personality are bigger, and together account for a substantial portion of the variance in individual behavior.

This paper also shows the strength of approaching the question of personality from a solid theoretical foundation. The suppression between anxiousness and aggressiveness, which is a fascinating and rare statistical phenomenon, can be interpreted only within the framework of an established model of personality. The understanding that personality traits are complex and interact with each other in non-trivial ways, guided our choice of contrasting two facets of the same personality domain. As such, they are both behavioral manifestations of the same core trait, but opposed in their directions. Therefore, we were able to control for their coexistence within people, and uncover their differential effects. Had our choice of traits not been theoretically motivated, we would come to the wrong conclusion that aggressiveness does not affect behavior in the market entry game.

We have demonstrated that anxiousness and aggressiveness affect entry game behavior, but

there is still much unknown about the process that creates this effect. We would like to tentatively suggest a few possible mechanisms. Toward this end, let us analyze the cognitive and behavioral process of choosing an action in the entry game.

It is safe to assume that for most of the participants the market entry task was not a task they were familiar with or have participated in before. The artificiality of the laboratory game guarantees that people do not have direct experience and knowledge about the real distribution of behavior in this game. As a result, following a phase of learning and understanding the rules, the possible actions, and the potential payoffs, the participants have to analyze the decision problem in order to choose an action.

Consider first the case where no information about the opponent is given. The players have to engage in two processes. First, they have to form beliefs regarding the behavior of others. As suggested by our model, this is a first opportunity for personality to interact with behavior. We assume that people with different levels of anxiousness and aggressiveness form different beliefs. To illustrate, we suggest that anxious people assume that the others are 'out to get them'. As a result, they put a higher probability that the opponent will choose an action meant to hurt them ('enter' in this game). Forming such a belief is almost a direct consequence of the way anxiousness is defined: recall that anxious individuals experience dread, are hyper vigilant and succumb to feelings of threat.

Once beliefs are formed, players have to choose how to best reply to those beliefs. At this point risk attitude may come into play. The standard assumption in game theory is that risk attitude is already part of the outcomes (treating those as utilities, and not as direct monetary values). But in a laboratory it is impossible to pay participants with units of utility, and as a result our participants play for real money. This means that when facing an expected probability distribution over the actions of the opponent (formed in the belief formation stage), participants' choices depend on their attitude to risk. This is the second opportunity for personality to interact with choice – anxious and aggressive individuals may also differ in their degree of risk aversion. Recall that anxiousness promotes fear and negativity that is associated in the literature with higher perceptions of risk and more risk averse choices (Johnson & Tversky, 1983), while aggressiveness is associated with risk taking (Lerner & Keltner 2001).

Finally, consider the case where players are exposed to information regarding the personality of the opponent. If players not only behave differently as a function of anxiousness and aggressiveness levels, but are also aware of the effects of these traits on behavioral inclination, such information should come into play in the belief formation phase. Specifically, players expect anxious opponent to form more negative beliefs and take less risk, and expect aggressive opponent to form positive

opponents and take more risk, and try to best reply to these.

Figure 1 below presents a summary of the tentative mechanism we have outlined above[16]. Anxiousness and aggressiveness are the independent variables we measured, and are externally correlated (the curved arrow indicates the correlation is a result of both variables being correlated with a third variables not drawn here, rather than causing each other). The model suggests that anxiousness leads higher risk aversion and to beliefs that the other is more likely to enter. Likewise, aggressiveness leads to lower risk aversion and to beliefs the other is less likely to enter. We intend to test this model in future experiments, where we will measure risk attitude in addition to personality traits (using, for example, Holt and Laury's 2002 risk aversion scale), and also elicit beliefs in an incentive compatible way prior to choosing an action in the game. In plain words, our goal is to check whether the difference in the behavior of anxious and aggressive players' is due to them holding different beliefs about the behavior of their opponents or to them having similar beliefs but different levels of risk or uncertainty aversion.

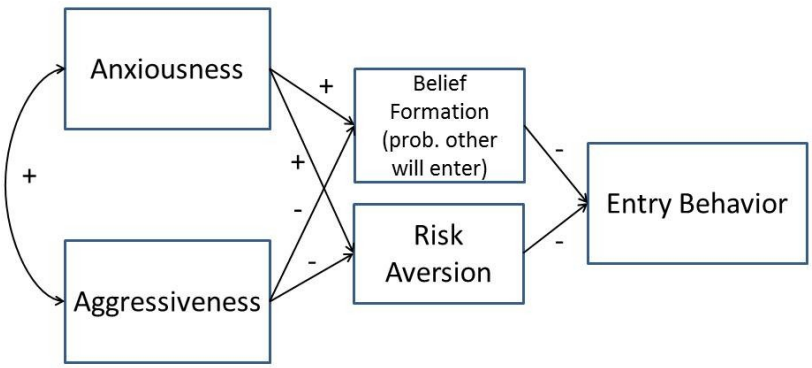

Figure 1: Tentative model describing how anxiousness and aggressiveness affect behavior.

This study suffers from two limitations. First, both anxiousness and aggressiveness were measured using self-report questionnaires. While this is standard in personality research, it raises some

16 The Figure was drawn following the conventions of structural equation modeling (SEM). We use boxes to display constructs (theoretical variables), curved arrows to present externally correlated variables, and straight arrows for casual relationships.

doubts regarding reliability and validity. We would like to point out that this argument actually works against the results that we are getting. If personality questionnaires are noisy and not accurate, and we still get a consistent effect on incentive compatible behavior, it is likely that the real effect is even larger than what we report. It is also worth noting that common-source bias, potentially stemming from the similarity in how the two personality traits are measured, can account for part of the autocorrelation between the traits, but not for their differential effects on entry behavior, that is measured using a very different technique. Finally, framing the game as an 'entry game' may have contributed to our results. It is certainly possible that if the game was not framed in approach-avoid terms ("enter" and "stay out"), but rather in neutral terms (option A and option B) we would have gotten weaker effects. We intend to test this effect of labeling in future experiments as well.

7. References

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Appendix 1: Interaction Anxiousness Scale (Leary, 1983)

Indicate how characteristic each of the following statements is of you according to the following scale:

1 = Not at all characteristic of me.
2 = Slightly characteristic of me.
3 = Moderately characteristic of me.
4 = Very characteristic of me.
5 = Extremely characteristic of me.

_____ 1. I often feel nervous even in casual get-togethers.

_____ 2. I usually feel comfortable when I'm in a group of people I don't know.

_____ 3. I am usually at ease when speaking to a member of the other sex.

_____ 4. I get nervous when I must talk to a teacher or a boss.

_____ 5. Parties often make me feel anxious and uncomfortable.

_____ 6. I am probably less shy in social interactions than most people.

_____ 7. I sometimes feel tense when talking to people of my own sex if I don't know them very well.

_____ 8. I would be nervous if I was being interviewed for a job.

_____ 9. I wish I had more confidence in social situations.

_____ 10. I seldom feel anxious in social situations.

_____ 11. In general, I am a shy person.

_____ 12. I often feel nervous when talking to an attractive member of the opposite sex.

_____ 13. I often feel nervous when calling someone I don't know very well on the telephone.

_____ 14. I get nervous when I speak to someone in a position of authority.

_____ 15. I usually feel relaxed around other people, even people who are quite different from me.

Appendix 2: Aggression Questionnaire

For the following 12 questions, please indicate how characteristic or uncharacteristic each of the following statements is about you. Next to each statement, please select the number corresponding to your response, according to the following scale:

1 extremely uncharacteristic of me
2 somewhat uncharacteristic of me
3 neither uncharacteristic nor characteristic of me
4 somewhat characteristic of me
5 extremely characteristic of me

17. I have threatened people I know

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

18. I sometimes feel like a powder keg ready to explode

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

19. Once in a while, I can't control the urge to strike another person

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

20. There are people that pushed me so far that we came to blows

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

21. I often find myself myself disagreeing with people

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

22. When people annoy me, I may tell them what I think of them

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

23. I am sometimes eaten up with jealousy

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

24. If I have to resort to violence to protect my rights, I will

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

25. Given enough provocation, I may hit another person

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

26. Other people always seem to get the breaks

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

27. I can't help getting in to arguments when other people disagree with me

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

28. I sometimes feel that people are laughing at me behind my back

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5