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Patience, Cognitive Skill, and Coordination in the Repeated Stag Hunt

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Coordination games have become a critical tool of analysis in fields such as development and institutional economics. Understanding behavior in coordination games is an important step toward understanding the differing success of teams, firms, and nations. This article investigates the relationship between personal attributes (cognitive ability, risk-aversion, patience) and behavior and outcomes in coordination games, an issue that, to the best of our knowledge, has never been studied before. For the repeated coordination game that we consider, we find the following: (1) cognitive ability has no statistically significant bearing on any aspect of behavior or outcomes; (2) pairs of players who are more patient are more likely to coordinate well and earn higher payoffs; and (3) risk-aversion has no statistically significant bearing on any aspect of behavior or outcomes. These results are robust to controlling for personality traits and demographic characteristics.

Keywords: coordination, IQ, personality, discount rate, patience, risk-aversion

Social interactions are routinely characterized by multiple equilibria: every game theory text makes this point. Often, these equilibria are Pareto-ranked, so the failure to coordinate efficiently is a genuine tragedy (*inter alia*, Schelling, 1960; Hardin, 1995; Weingast, 1997; Weber, 2006). The tragedy is especially salient in the development and institutions literatures: Bardhan (2005) notes that "*pervasive coordination failures"* may "afflict an economy at early stages of industrial transformation" (p. 2, italics in original), whereas Ray (1998) devoted an entire chapter of his influential development economics textbook to the issue of coordination failures. And of course, coordination failure models are a part of the Keynesian business cycle tradition (Cooper & John, 1988). In this article, we search for individual and group traits that predict coordination on better equilibria.

We focus on a particular coordination game, the repeated stag hunt. It is depicted in Figure 1. The stag hunt's key features are the presence of two pure-strategy equilibria that are Pareto-rankable: a dominating equilibrium (*stag*, *stag*) that is risky, and a dominated equilibrium (*rabbit*, *rabbit*) that is risk free.

Because many social environments—political, work, social—contain stag hunt, team-joining elements (Skyrms, 2003), the ability to play stag in a repeated game may be an important skill for productive social interaction. In public choice settings, the stag hunt might reflect the decision to go it alone (building yourself a swimming pool, or "Bowling Alone"; Putnam, 1995) or to cooperate in producing an excludable good (helping to build a community

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	Stag	Rabbit
Stag	75, 75	0, 50
Rabbit	50, 0	50, 50

Figure 1. Stag hunt. Row (column) denotes player 1's (2's) strategy choice. First (second) number denotes player 1's (2's) payoff.

pool or a bowling league); in firm settings, the stag hunt might reflect the decision to toil in a cubicle rather than volunteer to join a high-status team project.

Theory points toward three attributes that could predict coordination on the Pareto-ranked outcome: risk tolerance (a predictor of one-shot coordination, because hunting rabbit is the risk-dominant outcome), patience (as a result of the repetition and the self-control required to remain with the same choice; Daly, Delaney & Harmon, 2009); and cognitive skill (in part because cognitive skill usually predicts patience and risk tolerance; Frederick, 2005; Benjamin, Brown & Shapiro, in press; Burks, Carpenter, Goette & Rustichini, 2009; and also because understanding a game's rules typically helps in winning a game). Cognitive skill appears in particular to predict good performance in a Keynesian beauty contest (Gill & Prowse, 2012; Burnham, Cesarini, Johannesson, Lichtenstein & Wallace, 2009) and therefore may predict a more accurate theory of mind. Individuals and groups differ widely in these attributes, so if these attributes predict coordination failure they likely predict weaker institutions, less social capital, and perhaps even greater business cycle volatility. This article investigates how behavior and outcomes in coordination games are related to risk-aversion, patience, and cognitive ability.

Also known as the two-player minimum-effort game, the stag hunt has been studied extensively in the literature on coordination games, especially the experimental literature (Van Huyck, Battalio & Beil, 1990; see Devetag & Ortmann, 2007 for a review). Scholars have been particularly interested in analyzing behavior in *T*-period versions of the game, with an emphasis on understanding the factors that make sustained (efficient) play of (*stag*, *stag*) more likely. These factors include precedent (Van Huyck, Battalio & Beil, 1991; Camerer & Knez, 1994), information about play in previous periods (Bornstein, Gneezy & Nagel, 2002; Devetag, 2003), leadership (Weber at al., 2001; Brandts, Cooper & Fatas, 2007), horizon (Berninghaus & Erhart, 1998; Schmidt, Shupp, Walker & Ostrom, 2003), communication (Cooper, DeJong, Forsythe & Ross, 1992; Blume & Ortmann, 2007), and the exact nature of the payoffs (Rankin, Van Huyck & Battalio, 2000; Brandts & Cooper, 2006).

However, although economists have intensively studied whether differences in *institutions* influence coordination, they have not yet investigated (with the exception of Al-Ubaydli, 2011) whether differences in the players *themselves* influence coordination. Our article begins that process.

In our experiment, we record player choices in 10-period stag hunts, and we collect data on players' attributes: cognitive ability, patience, and risk-aversion. We then study the relationship between a player's (pair's) attributes and her (their) behavior in the stag hunt.[1] In their survey of the literature on cognitive ability and personality traits, Borghans, Duckworth, Heckman, and Weel (2008) demonstrate the importance of such attributes to key life outcomes (such as labor market earnings), and they call for more research on their effects.

Because variation in such attributes is naturally occurring rather than being varied exogenously by an experimenter, we try to control for as many potential sources of endogeneity as possible. We collect data on personality traits and demographics. Such controls are particularly important given the frequently reported positive relationships between cognitive ability

[1] To the best of our knowledge, no such study has been conducted. Al-Ubaydli (2011) looks at the relationship between behavior in a coordination game and risk-aversion, but without any additional controls. Burks et al. (2009) examines the impact of such factors on behavior in the one-shot, sequential prisoner's dilemma, and Jones (2008) and Al-Ubaydli, Jones and Weel (2010) mimic the present article but for the repeated prisoner's dilemma. There are good reasons to expect similarity in the mechanisms linking personal attributes to behavior across these different game types (see the discussion below), however the games still differ in important ways and this is reflected in the different results obtained.

and patience, and cognitive ability and risk tolerance (Frederick, 2005; Benjamin, Brown & Shapiro, in press; Burks et al., 2009).

Our main results are as follows: risk-aversion and cognitive ability have no bearing on any aspect of behavior or outcomes in the stag hunt at conventional significance levels, and individual patience predicts negligible effects on playing *stag*, but pairs of players who on average are more patient are both more likely to play (*stag*, *stag*) and earn higher payoffs. The average patience of a pair of players is a statistically and economically significant predictor of the tendency to coordinate on (*stag, stag*).

The absence of an effect of cognitive ability might seem unexpected, particularly because recent work (Jones, 2008; Al-Ubaydli, Jones & Weel, 2010) has found that cognitive skills predict success in repeated prisoners' dilemma experiments. However, Mueller (2004) notes that repeated coordination games like the stag hunt are far less cognitively demanding than repeated prisoner's dilemmas:

> Pareto-optimal sets of strategies can be expected to emerge when coordination games are repeated, under far less demanding behavioral assumptions than are needed to sustain Pareto-optimal outcomes in prisoner's dilemma supergames (Mueller, 2004; p. 15).

Mueller points to an evolutionary game theory literature on the limited cognitive demands of coordination games (*inter alia*, Wärneryd, 1990; Kandori, Mailath & Rob, 1993; and Young, 1993). Our experimental results thus confirm both Mueller's specific prediction and the deep relevance of this larger theoretical literature.

In the majority of empirical studies, all three of these traits—cognitive ability, patience, and risk tolerance—are modestly positively correlated. Thus, the fact that only one of these traits strongly predicts stag hunt coordination should be of interest to researchers modeling the underlying structure and effects of these traits. Our results suggest that patience is the driving cognitive force in Pareto-optimal coordination.

Our results can also be applied; for example those seeking to help a group suffering from coordination failure, such as the use of an inefficient technology standard. Our results suggest that forming a subgroup of patient players is likely to help that subgroup; this can then be combined with a strategy of gradual group expansion (Weber, 2006). Alternatively, following the marketing and social psychology literatures, one could use conscious and unconscious priming techniques that draw players' attentions to the benefits of patience.

Experimental Design

Data Collection and Order

In our experiment, for each participant, we collected data on the following:

- Behavior in the coordination game
- Personal attributes
- Cognitive ability
- Patience
- Risk-aversion
- Personality traits
- Demographic information

We had subjects play the game and then collect data on personal attributes and cognitive traits.[2] The precise order of tasks was as given in Figure 2.[3]

Procedure

All sessions were run at an Interdisciplinary Center for Economic Sciences computer laboratory at George Mason University (GMU). Participants were recruited from a campus database of students who had expressed an interest in economics experiments. Sessions lasted an average of approximately 100 minutes (inclusive of check-in and payment processing), and average earnings were approximately $30 per participant. Sessions had exactly 8, 10, or 12 participants.

[2] As has been demonstrated in the extensive psychology literature on framing and anchoring (Bacharach & Chartrand, 2000; Epley & Gilovich, 2004), any data based on human choices is sensitive to payoff-irrelevant features of the environment and experimental procedure. The main payoff-irrelevant feature of concern for our study is that there may be a spillover between the two data classes, for example, the fact that we are collecting data on attributes affects how people play in a coordination game, regardless of the attributes. To minimize such bias, we made the subjects play the game first.

[3] The method for measuring cognitive ability (a 45-min Raven's test; see below) was the most mentally exhausting for participants, and accounted for the lion's share of cognitive effort expended during a session. We therefore made it the last task.

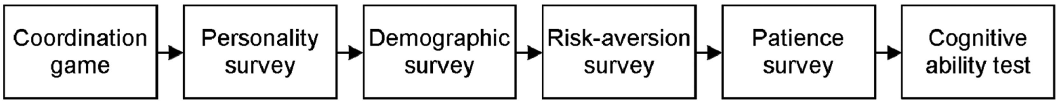

Figure 2. Order of tasks.

Some of the tasks were incentivized, whereas others were not (the detailed descriptions and explanations are below). Participants received a fixed fee for each unincentivized task. The drawback of incentivized tasks is that they potentially generate wealth effects. To minimize such wealth effects, it was common knowledge that participants would be paid for exactly one of the incentivized tasks, with a die roll at the end of the experiment determining which.

Because, by the standards of GMU experiments, the experiment was quite long, cognitively intensive, and involved large stakes, we wanted to convey as much payment credibility as possible. Consequently, for each of the unincentivized tasks, we paid the participants in cash immediately after they completed the task (we also paid the show-up fee in cash at the start of the experiment).

For the entirety of the experiment, participants sat at private, individual desks with other participants within eyeshot in the same room. There was no communication. Though most of the tasks were undertaken on the computer, all instructions were printed, handed out, and read aloud to all participants. See the Appendix for the full instructions.

Coordination game.[4] Participants were anonymously and randomly assigned a partner who would be their partner for 10 rounds. Each round, the two players would play the stag hunt in Figure 1 (with an exchange rate of 1 point = 1¢). Strategies were given a neutral frame (*green, blue* rather than *stag, rabbit*).

At the end of each round, participants were only informed of their earnings from that round rather than the actual outcome. Thus anyone playing *rabbit* could not infer whether their partner was playing *stag* or *rabbit*. (Anyone playing *stag* could infer their partner's choice.) This is the norm in the *n*-player versions of the minimum-effort game, though some studies examine behavior when the entire action vector is common knowledge after each round.

This could have the effect of making players *more* likely to play the risky stag strategy to acquire information about the other player's behavior. Thus, in a repeated game, playing stag is in an important dimension safer (because more informative) than playing rabbit. This phenomenon is likely of genuine real-world importance for stag-hunt-style interactions, and may explain why risk-aversion ultimately has no influence in the repeated game.

Personality survey. Participants were asked to complete a Big-5 personality survey, a standard measure of personality traits (Borghans et al., 2008). Participants responded to each of 50 statements about their personality using a 5-point Likert scale (1 = *very inaccurate*, 5 = *very accurate*). The 50 questions broke down into 10 questions corresponding to 5 personality traits: openness to new experiences, conscientiousness, agreeableness, extraversion, and neuroticism. Participants were paid a fixed fee of $5 after completing this survey and the demographic survey regardless of their responses.

Demographic survey. Participants were asked a few questions about their personal demographics (gender, age, class etc.) and their self-reported scores in standardized tests (SAT, GRE etc.).[5]

Risk-aversion survey. Participants completed a Hey-Orme risk preferences test (Hey & Orme, 1994).[6] Each period, the participant is faced with a choice between two lotteries, each over the same four outcomes ($0, $10, $20, $30). The participant chooses which she prefers (or expresses indifference). The participant does

[4] In addition to playing a coordination game, participants played a repeated prisoner dilemma as part of separate study (see Al-Ubaydli, Jones & Weel, 2010). We randomized which they played first by session, and we included session effects in all our econometric tests to control for this. As mentioned above, it was common knowledge that participants would be paid for exactly one of the incentivized tasks.

[5] Self-reported SAT (GRE) scores correlated 0.27 (0.20) with IQ.

[6] The instructions (see the appendix) are adapted from a set provided by Glenn Harrison.

this for 20 pairs (periods).[7] To generate incentives for truthful revelation, participants were informed that—if it were the unique incentivized task for which they were paid—one of the pairs would be selected at random at the end and each participant will play out the lottery for which she declared a preference.

We selected a Hey-Orme test rather than the more conventionally deployed Holt-Laury test (Holt & Laury, 2002) because it is a richer test that permits more accurate identification of economic risk-preference parameters. Using maximum likelihood estimation (see Harrison & Rutstrom, 2008; Andersen, Harrison, Lau & Rutstrom, 2008; see Wilcox, 2011 for a new microeconometric model of risk-attitudes), one can use the choice data to estimate the parameter K in the constant relative risk aversion (CRRA) von Neumann-Morgenstern utility function $u(m) = m^K$, where m denotes $ wealth. K is a measure of risk tolerance (the negative of risk-aversion: larger values indicate less risk-aversion).

Patience survey. Participants were presented with a multiple price list (Harrison, Lau & Williams, 2002; Andersen, Harrison, Lau & Rutstrom, 2006) with 20 rows. For each row, the participant is faced with a choice between $10.00 tomorrow and $$Y$ in one week. The amount $$Y$ started at $10.50 and increased in $0.50 increments to $20.00. To generate incentives for truthful revelation, participants were informed that—if it were the unique incentivized task for which they would be paid—one of the pairs would be selected at random at the end of the experiment and each participant paid according to their choice.

Tests of patience involving reasonable horizons require participants to leave the laboratory and receive payments at a later time. This generates credibility issues: to what extent are differences in observed preferences the result of differences in patience (the goal) versus differences in the perceived credibility of the experimenter with respect to payment delivery? (See Andersen et al., 2008; Andreoni & Sprenger, 2012; for an extensive discussion of these issues).

To minimize any variation in perceived credibility, we took several steps to demonstrate our credibility at the decision-making stage. First, both options in each choice entail an amount that can only be received after exiting the laboratory, that is, there is a front-end delay (see Harrison, Lau & Williams, 2002).

Second, they were handed a contract on university letterhead signed by us and them confirming the earliest time that they can retrieve the envelope at a specified location on campus (in one day or in seven days, depending on their stated preference).

Our measure of patience is therefore the number of rows where the participant preferred the amount to be received in one week (rather than the following day).

Cognitive ability. Borghans et al. (2008) define cognitive ability as the ability to understand complex ideas, adapt effectively to the environment, learn from experience, reason, and overcome obstacles through purposeful thought. For a complete discussion of intelligence and its measurement, see Neisser et al. (1996). There are many tests of cognitive ability. We use the Raven's standard progressive matrices test of intelligence, which is one of the standard tools used in the literature (Borghans et al., 2008). We use the Standard Progressive Matrices Plus (SPM+), which is between the Standard and Advanced Progressive Matrices in difficulty.

The test is composed of 60 problems. Each problem consists of a pattern with a missing segment, and 6 to 8 segments, only one of which correctly completes the pattern (see the appendix for examples). Participants were given 45 minutes to complete the test. The test was unincentivized. Borghans et al. (2008) remark that the effect of incentivizing tests of cognitive ability is for scores in the lower tail to improve. We decided against using incentives because we wanted to maintain comparability between our results and the results reported in the psychology literature (which typically do not use incentives).

Research Hypotheses

The above procedure yields data on a vector of attributes that represents our explanatory variables. We investigate the effect of these explanatory variables on the following dependent variables:

[7] Participants do not know how many lottery pairs they will have to ponder.

- An Individual's decision to play *stag* in a given period
- A Pair's success in achieving a play of *stag-stag* in a given period
- An Individual's total earnings for the 10-period coordination game
- A Pair's total earnings for the 10-period coordination game

The previous literature gives us little basis for predictions about the effect of personality or demographics on any of the above dependent variables. Here, we offer hypotheses for the effects of risk-aversion, cognitive skill, and patience.

In a one-shot sense, playing *rabbit* is risk-free while playing *stag* generates payoff risk (this underlies the concepts of risk- vs. payoff-dominance; see Harsanyi & Selten, 1988). Thus it seems sensible to expect that risk-aversion will be a substantial determinant of outcomes. In a (modified) 3-period version of the stag hunt, Al-Ubaydli (2011) found that risk-aversion was negatively related to picking stag, though that study did not control for any additional attributes.

Using aggregate data, Jones (2008) finds that people drawn from distributions with higher cognitive ability are more likely to play *cooperate* in a prisoner's dilemma. Using individual-level data, and controlling for risk-aversion and a host of additional attributes (though not patience), Burks et al. (2009) find a positive relationship between cognitive ability and the likelihood of playing *trust* and *reciprocate* in a one-shot, sequential prisoner's dilemma.

Jones' (2008) explanation for these findings is that higher cognitive ability allows people to see the future with greater resolution; he also notes that the greater patience of high-cognitive-ability individuals makes Axelrod's (1984) "shadow of the future" more salient. Both channels imply that high-ability players are therefore better able to appreciate the benefits of early cooperation, and consequently cooperate more. Additionally, he notes that they are more likely to understand the literal rules of the game. The link between understanding the repeated prisoner's dilemma and "winning" in the repeated prisoner's dilemma is emphasized by Axelrod (1984). Putterman, Tyran and Kamei (2010) find that higher IQ predicts higher contributions to a repeated public goods game, which is an *n*-person prisoner's dilemma. Because none of the three studies control for patience, and patience is usually positively related to cognitive ability (Burks et al., 2009), it is not clear whether cognitive ability or patience is driving the result.

Despite the key payoff differences between the stag hunt and the prisoner's dilemma, they do share a requirement of cooperation for avoidance of an inefficient outcome. Consequently, we would predict that cognitive ability, patience, or both are positively related to plays of *stag*, and consequently to the remaining dependent variables of interest.

Patience naturally matters because of the repetition; playing stag early on can be seen as an investment, one that may well be reasonable if players have low discount rates. Further, experimental work by Daly, Delaney and Harmon (2009, p. 667) finds "strong evidence that self-control has a strong independent effect on patience" and reports modest evidence that a measure of mindfulness, attention, and awareness is positively correlated with patience. Thus our survey measures of patience likely measure traits with relevance beyond the discounting of future income and utility flows.

In light of the documented relationships between cognitive ability, risk-aversion, and patience, a key feature of our study is the ability to control for potential confounds. This will help us gain a sharper understanding of what drives successful coordination.

Empirical Results

We ran 16 sessions during spring 2010. After eliminating observations where demographic data was missing or where subjects had clearly not attempted the Raven test in a serious manner, we are left with data from 167 subjects (yielding a total of 1670 behavioral observations).[8]

Descriptive Statistics

Table 1 details the sample means and standard deviations of the main variables. Note that

[8] The Raven's standard progressive matrices test handbook contains statistical tables designed to allow the experimenter to identify egregious cases of not seriously attempting the test. In our sample, only 3 subjects had their data dropped for this reason.

Table 1
Sample Statistics

Variable	Mean	*SD*
Raven score	42	(5.5)
Patience	16	(4.2)
Risk tolerance parameter	0.63	(0.23)
Openness (−2 to + 2 likert)	0.81	(0.54)
Conscientiousness (−2 to + 2 likert)	0.48	(0.65)
Extraversion (−2 to + 2 likert)	0.22	(0.73)
Agreeableness (−2 to + 2 likert)	1.0	(0.49)
Neuroticism (−2 to + 2 likert)	−0.10	(0.74)
Age (years)	24	(4.5)
Male (dummy)	0.68	(0.47)
Play *stag* (dummy)	0.64	(0.48)
Pair playing *stag*−*stag* (dummy)	0.55	(0.50)
Game earnings, individual ($)	5.9	(1.6)
Game earnings, pair ($)	12	(3.1)

Note. Data are from 167 observations.

the risk tolerance parameter is based on a MLE estimate of K in the von Neumann-Morgenstern utility function $u(m) = m^K$. The mean coefficient implies near-square-root utility. In Figures 3, 4, and 5, we can see histograms of Raven score, patience, and risk tolerance. All three depict rich variation. For instance, the Raven standard deviation of 5.5 is close to the standard deviation of 6.1 reported by Raven (2000) in a large representative sample (albeit one based on the slightly different Standard Progressive Matrices), and Thoma et al. (2005) reported that their own sample's standard deviation on the Raven of 6.36 were "consistent with published normative values." The same held true for our sample: the standard deviation was consistent with published normative values. Given our rich variation, any restriction of range corrections would have negligible effects on reported relationships.

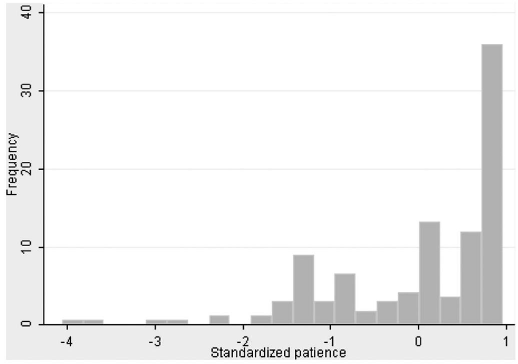

Figure 4. Histogram of standardized patience. M = 16, standard deviation = 4.2.

In Figure 4, we can see that around 35% of observations imply a maximum level of patience (these participants all stated a preference of $10.50 in one week to $10.00 tomorrow). This is a particularly large proportion compared with the literature (e.g., see Andersen et al., 2008). One possibility is that this was the result of our estimation procedure being one of numerous tasks in the experiment, or possibly of the relatively small stakes. (Typically, experiments that measure patience do so as the only task in the experiment *and* with larger stakes).

Consequently, we conducted a follow-up survey with larger stakes, a finer measure of patience and where the only task was measuring

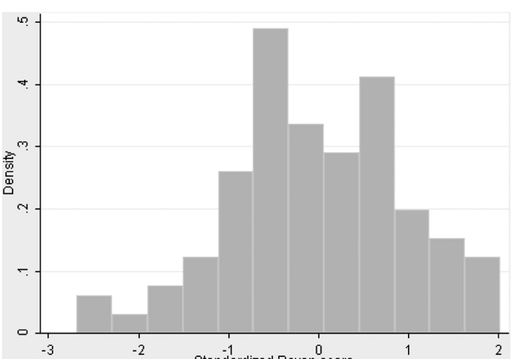

Figure 3. Histogram of standardized Raven score. M = 42, standard deviation = 5.5.

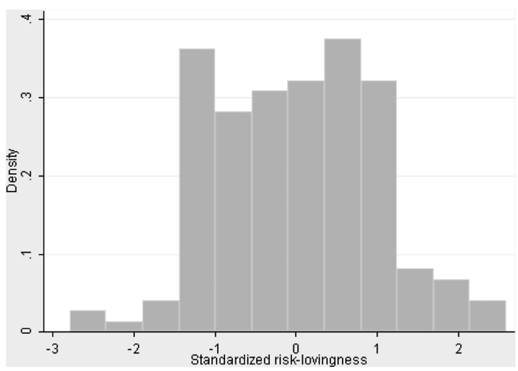

Figure 5. Histogram of standardized risk tolerance. M = 0.63, standard deviation = 0.23.

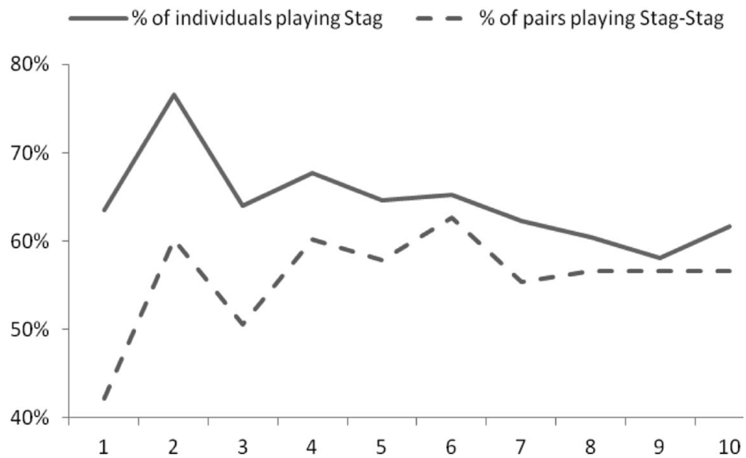

Figure 6. Time series of individual plays of *Stag* and pair plays of *Stag-Stag*.

the patience of the subjects. The results confirmed that our original measure of patience was not an artifact of our procedure: the correlation between the two measures was very high (0.69, p value <1%). The high level of short-run patience may have been driven by the exceptionally high payment credibility of GMU's Interdisciplinary Center for Economic Sciences—the laboratory where the experiments were conducted.[9]

In Figure 6, we can see the time path of plays of *stag* and of successful coordination by pairs on the *stag* equilibrium. In both series, in the second period, plays of *stag* and coordination on *stag* rise sharply.

We also examine the autoregressive features of the strategy time series. In aggregate, 81% of plays of *rabbit* are followed by plays of *rabbit*, with the corresponding figure for plays of *stag* being 90%. Similarly, 88% of pairs who fail to reach the *stag-stag* equilibrium in a given period continue to fail in the subsequent period, whereas 93% of those that succeed continue to succeed. Thus, there is a lot of persistence in behavior.

Table 2 depicts the sample correlations between the variables in the dataset. Consistent with the literature (Benjamin, Brown & Shapiro, in press; Borghans et al., 2008; Burks et al., 2009; Dohmen, Falk, Huffman & Sunde, 2010), we find a positive relationship between cognitive ability and risk tolerance, and between cognitive ability and patience (though the latter relationship does not attain statistical significance).[10]

Also consistent with the literature, we find that cognitive ability is uncorrelated with most personality traits, with a weak positive relationship between cognitive ability and openness. Our data exhibits a slight inconsistency with the literature in the negative relationship between cognitive ability and neuroticism (usually they are uncorrelated). Finally, in line with the literature on gender-differences (Croson & Gneezy, 2009), we find that males are indeed more risk tolerant than females. Generally speaking, Table 2 offers us reassurance about the soundness of our data collection and the representativeness of our sample. Because Beauchamp, Cesarini, and Johannesson (2011), using a test-retest design, find that measurement error is a serious issue when measuring psychometric traits, all of the correlations we report below may plausibly be interpreted as lower bounds of the true relationship.

[9] The number of students surveyed in this second patience task was large enough to establish the correlation across the two patience measures, but too small to add value in the regressions results, so only the in-experiment measure is used in the results below.

[10] Dohmen et al. (2010) summarize the extensive evidence from the psychology literature on the relationship between cognitive ability and patience as "mixed" (p2).

Table 2
Sample Correlations

	Proportion of times played *stag*	Individual earnings	Raven	Risk tolerance	Patience	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	Age
Individual earnings	0.78***	—	—	—	—	—	—	—	—	—	—
Raven	0.0072	−0.017	—	—	—	—	—	—	—	—	—
Risk tolerance	0.063	−0.047	0.21***	—	—	—	—	—	—	—	—
Patience	0.10	0.15*	0.072	−0.047	—	—	—	—	—	—	—
Openness	−0.011	0.017	0.15*	0.10	−0.10	—	—	—	—	—	—
Conscientiousness	−0.047	0.016	0.11	−0.028	0.12	0.053	—	—	—	—	—
Extraversion	−0.057	−0.037	0.022	−0.024	−0.12*	0.27***	0.16**	—	—	—	—
Agreeableness	0.077	0.00050	0.037	0.011	−0.060	0.21***	0.19**	0.36***	—	—	—
Neuroticism	0.11	0.18**	−0.21***	−0.14*	0.055	−0.25***	−0.21***	−0.36***	−0.10	—	—
Age	−0.0066	−0.046	0.070	−0.029	0.010	−0.051	−0.066	−0.10	−0.0066	0.089	—
Male	0.094	0.077	0.090	0.34***	0.017	−0.084	−0.11	−0.10	−0.12	−0.19**	−0.019

Note. Based on a sample of size 167. Asterisks denote statistical significance * = 10%, ** = 5%, *** = 1%.

Estimation Strategy

Let Y_{its} be the value taken by a dependent variable for subject (or pair) i in period t of session s. Let C_i denote i's cognitive ability, P_i denote i's patience and R_i denote i's degree of risk tolerance (the negative of risk-aversion). Let X_i be a vector of i's remaining attributes. Let T^j be a dummy variable that takes the value '1' in period j and '0' otherwise. Let S^k be a dummy variable that takes the value '1' in session $T\ k$ and '0'otherwise.

For each dependent variable that we investigate, we estimate the following five models:

1. $Y_{its} = \alpha + \beta_C C_i + \sum_{j=2}^{10} \theta_j T_t^j + \sum_{k=2}^{16} \theta_j S_s^k + \varepsilon_{its}$; cognitive ability only, period/session effects
2. $Y_{its} = \alpha + \beta_p P_i + \sum_{j=2}^{10} \theta_j T_t^j + \sum_{k=2}^{16} \theta_j S_s^k + \varepsilon_{its}$; patience only, period/session effects
3. $Y_{its} = \alpha + \beta_R R_i + \sum_{j=2}^{10} \theta_j T_t^j + \sum_{k=2}^{16} \theta_j S_s^k + \varepsilon_{its}$; risk tolerance only, period/session effects
4. $Y_{its} = \alpha + \beta_C C_i + \beta_P P_i + \beta_R R_i + \sum_{j=2}^{10} \theta_j T_t^j + \sum_{k=2}^{16} \theta_j S_S^k + \varepsilon_{its}$; cognitive ability, patience, risk tolerance, period/session effects
5. $Y_{its} = \alpha + \beta_C C_i + \beta_P P_i + \beta_R R_i + \beta_X X_i + \sum_{j=2}^{10} \theta_j T_t^j + \sum_{k=2}^{16} \theta_j S_S^k + \varepsilon_{its}$; cognitive ability, patience, risk tolerance, remaining attributes, period/session effects

All regressions cluster the standard errors by i (individual or pair). Sometimes, we estimate models where the dependent variable is for a single (time) cross-section, for example, earnings. In that case, we retain the same structure but we omit period effects and clustering of the standard errors (since there is at most one observation per individual/pair).

As explained above, we are interested in four dependent variables:

Play stag dummy. A dummy variable that takes the value '1'when player i plays *stag* in period t of session s, and '0'if she plays *rabbit*

Stag-stag dummy. A dummy variable that takes the value '1'when pair i play the *stag-stag* equilibrium in period t of session s, and '0'if they play any of the three remaining possibilities

Earnings (individual). A variable denoting the total dollar earnings of player *i* in session *s*

Earnings (pair). A variable denoting the total dollar earnings of pair *i* in session *s*

To facilitate the interpretation of the estimated coefficients on the explanatory variables, we use linear regressions (linear probability model) rather than probits; our results are robust to using probits (results available upon request).

Finally, in all regressions, unless stated otherwise, the explanatory variables are standardized by the sample statistics in Table 1, allowing us to interpret the estimated coefficients as the effect on the dependent variable of increasing the explanatory variable by one standard deviation.

Main Results

We begin by analyzing how frequently subjects play stag.

Result 1. Cognitive ability has a negligible, statistically insignificant positive effect on the probability of playing *stag*; patience and risk tolerance have a small, statistically insignificant positive effect on the probability of playing *stag*.

This result is based on the estimates reported in Table 3. As can be seen, Result 1 is robust to including the various controls. We also find that agreeableness and being male have marginally significant positive effects on the probability of playing *stag*. A one standard deviation rise in agreeableness predicts a 6% rise in the proba-

Table 3
The Effect of Attributes on the Probability of Playing Stag

Model	1	2	3	4	5
Dependent variable	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy
Unit	Individual	Individual	Individual	Individual	Individual
Cognitive ability	0.0057	—	—	−0.0041	−0.0011
	(0.030)	—	—	(0.031)	(0.031)
Patience	—	0.044	—	0.043	0.046
	—	(0.030)	—	(0.030)	(0.030)
Risk tolerance	—	—	0.026	0.025	0.0032
	—	—	(0.030)	(0.031)	(0.034)
Openness	—	—	—	—	0.00027
	—	—	—	—	(0.031)
Conscientiousness	—	—	—	—	0.0048
	—	—	—	—	(0.028)
Extraversion	—	—	—	—	−0.015
	—	—	—	—	(0.034)
Agreeableness	—	—	—	—	0.058*
	—	—	—	—	(0.033)
Neuroticism	—	—	—	—	0.045
	—	—	—	—	(0.031)
Male (dummy; not standardized)	—	—	—	—	0.14*
	—	—	—	—	(0.076)
Age (in years; not standardized)	—	—	—	—	−0.0014
	—	—	—	—	(0.007)
R-squared	0.11	0.12	0.12	0.12	0.15
Observations	1670	1670	1670	1670	1670
Period effects	Yes	Yes	Yes	Yes	Yes
Session effects	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes

Note. Estimates are based on a linear probability model. Unless otherwise stated, all explanatory variables are standardized based on the figures in Table 1. Standard errors are in parentheses. *Unit* refers to 'individual' vs. 'group' (i.e., whether the dependent variable is defined at the level of the individual vs. pair). Estimated coefficients on constant, period, and session effects omitted for parsimony. Asterisks denote statistical significance * = 10%, ** = 5%, *** = 1%.

bility of playing stag, while males are 14% more likely to do so.

Next, we turn our attention to how frequently pairs reach the *stag-stag* equilibrium.

Result 2. Cognitive ability has a small, statistically insignificant negative effect on the probability of the pair playing *stag*; increasing each player's patience by one standard deviation increases the probability of the pair playing *stag-stag* by 15% (p value <5%); greater risk tolerance has a small, statistically insignificant positive effect on the probability of the pair playing *stag-stag*.

This result is based on the estimates reported in Table 4. As a reminder that some of the statistically insignificant relationships are imprecisely estimated, note that the one standard error bounds for the risk tolerance coefficient in Table 4 range from 12% to −4.6%. As can be seen, Result 2 is robust to including the various controls. (In fact, the effect of patience strengthens when additional controls are introduced.) The effect of patience is quite large, almost equaling a third of a standard deviation of the probability of a pair playing *stag-stag*.

We also find that neuroticism (15%) has a marginally significant effect; even more remarkable is the very large effect of both players being male versus both players being female, the former increasing the probability of playing *stag-stag* by 40%.

To illustrate the link between patience and coordination, we show two histograms in Figure 7: the average patience of a pair when a pair is versus is not playing *stag-stag*. As can be seen, the distribution stochastically dominates for the observations where the pair is successfully coordinating upon *stag*.

Table 4
The Effect of Attributes on the Probability of Reaching Stag-Stag

Model	1	2	3	4	5
Dependent variable	*Stag-stag* dummy	*Stag-stag* dummy	*Stag-stag* dummy	*Stag-stag* dummy	Stag-*stag* dummy
Unit	Pair	Pair	Pair	Pair	Pair
Cognitive ability	−0.030	—	—	−0.071	−0.095
	(0.077)	—	—	(0.084)	(0.088)
Patience	—	0.13**	—	0.14**	0.15**
	—	(0.056)	—	(0.056)	(0.072)
Risk tolerance	—	—	0.027	0.037	−0.00076
	—	—	(0.080)	(0.083)	(0.083)
Openness	—	—	—	—	0.078
	—	—	—	—	(0.079)
Conscientiousness	—	—	—	—	−0.020
	—	—	—	—	(0.088)
Extraversion	—	—	—	—	0.019
	—	—	—	—	(0.095)
Agreeableness	—	—	—	—	0.11
	—	—	—	—	(0.072)
Neuroticism	—	—	—	—	0.15*
	—	—	—	—	(0.076)
Male (dummy; not standardized)	—	—	—	—	0.40***
	—	—	—	—	(0.15)
Age (in years; not standardized)	—	—	—	—	0.0011
	—	—	—	—	(0.021)
R-squared	0.15	0.17	0.15	0.18	0.26
Observations	830	830	830	830	830
Period effects	Yes	Yes	Yes	Yes	Yes
Session effects	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes

Note. All explanatory variables are based on the average of the values of the two members of the pair. See Table 3 for additional explanation.

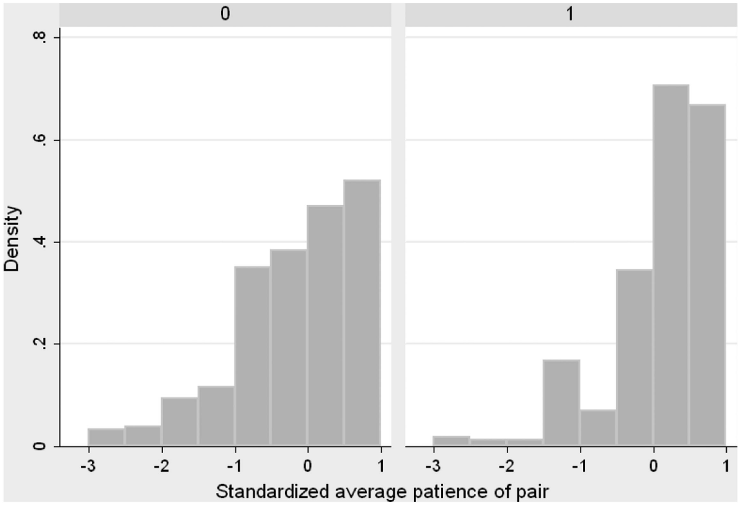

Figure 7. Histograms of standardized average patience of pair of players. The left histogram corresponds to observations where the pair were *not* playing *stag-stag*, that is, the stag-stag dummy = 0; the right histogram corresponds to observations where the pair were playing *stag-stag*, that is, the stag-stag dummy = 1. Both histograms are standardized by the same mean and standard deviation.

Next, we turn our attention to earnings.

Result 3. Cognitive ability has a negligible, statistically insignificant effect on an individual's earnings; patience has a small, statistically insignificant positive effect on an individual's earnings; greater risk tolerance has a small, statistically insignificant negative effect on an individual's earnings.

This result is based on the estimates reported in Table 5. As can be seen, Result 3 is robust to including the various controls. We also find that neuroticism ($0.39) and being male ($0.69) have significant positive effects on an individual's earnings.

Result 4. Cognitive ability and risk tolerance have a small, statistically insignificant negative effect on total earnings for a pair; increasing each player's patience by one standard deviation increases a pair's total earnings by $1.20 ($p$ value $<5\%$).

This result is based on the estimates reported in Table 6. As can be seen, Result 4 is robust to including the various controls. (In fact, the effect of patience strengthens when additional controls are introduced.) The effect of patience is quite large, slightly more than a third of a standard deviation. We also find that neuroticism ($1) has a marginally significant effect. Even more remarkable is the very large effect of both players being male versus both players being female, the former increasing total earnings for a pair by $3.50.[11]

Before proceeding to synthesize these results, it is worth noting that we investigated the relationship between cognitive ability/patience/risk tolerance and several other aspects of behavior in the repeated stag hunt. We looked at the plays of *stag* in the first round, plays of *stag* in the second round conditional on what occurred in the first round, and plays of *stag* conditional

[11] In this study, we do not attempt to explain the observed relationship between behavior/earnings and personality traits or gender. However, it is worth making the following observation concerning the seemingly strong effect of being male: in light of the well-documented finding that women are more risk-averse than men, it is reasonable to wonder whether our measure of risk-aversion is simply a noisy measure and that being male is picking up the poorly measured component. To investigate this possibility, we repeat our major regressions but dropping the risk tolerance regressor. We find that the coefficient on being male *decreases* slightly in magnitude (results available upon request). Combining this with the strong, positive relationship in our dataset between being male and our measure of risk tolerance, we conclude that the strong effect of being male is not the consequence of measurement error in risk tolerance.

Table 5
The Effect of Attributes on Individual Earnings

Model	1	2	3	4	5
Dependent variable	Earnings ($)	Earnings ($)	Earnings ($)	Earnings ($)	Earnings ($)
Unit	Individual	Individual	Individual	Individual	Individual
Cognitive ability	−0.0067	—	—	−0.0093	0.0089
	(0.12)	—	—	(0.13)	(0.13)
Patience	—	0.21	—	0.21	0.20
	—	(0.13)	—	(0.13)	(0.14)
Risk tolerance	—	—	—0.063	−0.069	−0.15
	—	—	(0.13)	(0.13)	(0.13)
Openness	—	—	—	—	0.12
	—	—	—	—	(0.13)
Conscientiousness	—	—	—	—	0.19
	—	—	—	—	(0.13)
Extraversion	—	—	—	—	0.036
	—	—	—	—	(0.14)
Agreeableness	—	—	—	—	0.071
	—	—	—	—	(0.13)
Neuroticism	—	—	—	—	0.39***
	—	—	—	—	(0.14)
Male (dummy; not standardized)	—	—	—	—	0.69**
	—	—	—	—	(0.30)
Age (in years; not standardized)	—	—	—	—	−0.032
	—	—	—	—	(0.029)
R-squared	0.19	0.21	0.19	0.21	0.27
Observations	167	167	167	167	167
Period effects	No	No	No	No	No
Session effects	Yes	Yes	Yes	Yes	Yes
Clustering	No	No	No	No	No

Note. See Table 3 for additional explanation.

on what occurred in the previous round in general (rather than any specific round). In all these cases, we failed to detect any systematic relationships.

Synthesizing the Main Results

Our principal goal is to distinguish the effect of three variables (cognitive ability, patience and risk tolerance) on behavior and outcomes in a coordination game, particularly in light of the fact that cognitive ability is positively related to patience and risk tolerance.

Based on our data, behavior and outcomes in a coordination game seem to be orthogonal to cognitive ability. The same can be said of risk tolerance. As an aside, being male increases the selection of the "risky" *stag* strategy and earnings; one might plausibly guess that this is because being male proxies for greater risk tolerance, yet this seems not to be the case (see footnote 11).

In contrast to cognitive ability and risk tolerance, patience has an impact. Players who are more patient play *stag* slightly more frequently than impatient players (see Table 3), and they earn slightly more (see Table 5); however neither effect is statistically significant. The real impact of patience occurs when two patient people are matched together, with the *stag-stag* equilibrium frequency and total group earnings both rising.

To confirm this, we repeat the regressions that correspond to Result 2 and Result 4 with one difference: rather than using the average patience of a pair, we use the minimum patience *or* the maximum patience. Using the maximum renders the effect of patience statistically insignificant, while using the minimum generally strengthens the statistical sig-

Table 6
The Effect of Attributes on Total Earnings for a Pair

Model	1	2	3	4	5
Dependent variable	Earnings ($)	Earnings ($)	Earnings ($)	Earnings ($)	Earnings ($)
Unit	Group	Group	Group	Group	Group
Cognitive ability	−0.13	—	—	−0.47	−0.63
	(0.57)	—	—	(0.63)	(0.67)
Patience	—	1.0**	—	1.1**	1.2**
	—	(0.41)	—	(0.42)	(0.53)
Risk tolerance	—	—	0.27	0.32	−0.098
	—	—	(0.57)	(0.60)	(0.62)
Openness	—	—	—	—	0.73
	—	—	—	—	(0.60)
Conscientiousness	—	—	—	—	−0.040
	—	—	—	—	(0.65)
Extraversion	—	—	—	—	0.12
	—	—	—	—	(0.74)
Agreeableness	—	—	—	—	0.66
	—	—	—	—	(0.57)
Neuroticism	—	—	—	—	1.0*
	—	—	—	—	(0.58)
Male (dummy; not standardized)	—	—	—	—	3.5***
	—	—	—	—	(1.1)
Age (in years; not standardized)	—	—	—	—	−0.037
	—	—	—	—	(0.17)
R-squared	0.19	0.24	0.20	0.25	0.37
Observations	83	83	83	83	83
Period effects	No	No	No	No	No
Session effects	Yes	Yes	Yes	Yes	Yes
Clustering	No	No	No	No	No

Note. All explanatory variables are based on the average of the values of the two members of the pair. See Table 3 for additional explanation.

nificance (results omitted for parsimony and available upon request). This suggests the possibility of a key complementarity between the patience of the two players: there is evidence of a "weak link" or O-ring element to successful coordination (Kremer, 1993).

Additional results: Dynamics

Pairs of patient players are substantially (15% per standard deviation) more likely to play *stag-stag* than impatient pairs, yet patient individuals are only slightly more likely (4% per standard deviation) than impatient players to play *stag*. How can these seemingly inconsistent observations be reconciled?

The key lies in a deeper examination of the dynamics. Let us define "patient" players as those with above-mean patience and "impatient" players as those with below-mean patience. Figure 8 shows the time series of plays of *stag* by patient versus impatient players, confirming that patient players are only slightly more likely to play *stag* than impatient players. The averages rates are 66% for patient players and 62% for impatient players.

Given that type-X players play *stag* Y% of the time on average, the breakdown will lie between two extremes:

1. Y% of type-X players always play *stag* and (100 – Y)% always play *rabbit* (maximum between-player variation, minimum within-player variation)
2. All type-X players play *stag* Y% of the time and *rabbit* (100 – Y)% of the time (minimum between-player variation, maximum within-player variation)

Intuitively, it is easier for a player to coordinate on *stag-stag* if her partner never varies from playing stag himself. If instead they are

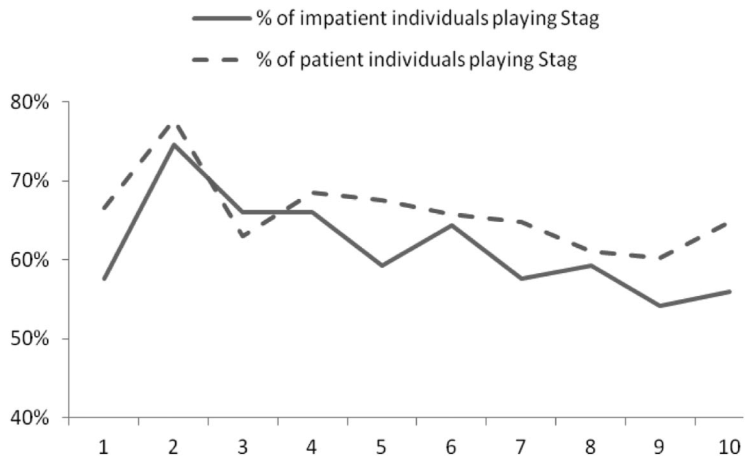

Figure 8. Time series of individual plays of *Stag*. "Impatient" refers to players who have below-mean patience and "Patient" refers to players who have above-mean patience.

switching randomly between *stag* and *rabbit* (the second extreme), it is much harder to ensure that both players simultaneously play *stag*. Further, when a player plays *rabbit* in the previous period, she is unaware of what her partner played. *Rabbit*, considered the safe strategy in a one-shot game, becomes a low-information strategy (and hence a risky strategy) in the repeated game.

This intuition is supported by the data. When both players play *stag*, a player plays *stag* in the following round 96% of the time; in contrast, when one plays *stag* and the other plays *rabbit*, the one playing *stag* persists with *stag* only 51% of the time.

With this in mind, it is possible that, in addition to playing *stag* slightly more frequently than impatient players, patient players play with greater persistence, that is, lower within-player variation and higher between-player variation (closer to extreme 1 above). This is precisely what we find in Results 5 and 6 below.

Result 5. Cognitive ability and risk tolerance have a statistically insignificant effect on the persistence of playing *stag* and *rabbit*; increasing a player's patience by one standard deviation increases his or her probability of continuing a play of *stag* by 6% and of continuing a play of *rabbit* by 5% (p value <5%).

This result is based on the estimates reported in Tables 7 and 8. Note that in both tables the omitted estimated coefficients on the constant, period, and session effects all imply that there is a baseline persistence in play (this is also reflected in the statistics reported at the end of the *Descriptive Statistics* section above). Consequently, the estimated coefficient on *patience* implies an accentuation of the persistence. We also find that being male statistically significantly increases the probability of continuing a play of *stag* by 16%.

Let σ_i be the standard deviation of player i's *play stag* dummy (across rounds). The average of σ_i for Group X (which we denote $\overline{\sigma}^X$) is a measure of the within-player variation in *stag* play. If Group X plays *stag* Y% of the time, then

$$\overline{\sigma}^X \in \left[0,\ \sqrt{\frac{Y}{100}\left(1-\frac{Y}{100}\right)}\right]$$

Where the lower bound corresponds to purely between-player variation (extreme case 1 above) and the upper bound corresponds to purely within-player variation (extreme case 2 above). In the following result, recall that we define "impatient players" as those with below-mean patience, and "patient players" as those with above-mean patience.

Result 6. Patient players exhibit substantially less within-player variation in their *stag* play ($\overline{\sigma}^{patient} = 0.16$) than impatient players ($\overline{\sigma}^{impatient} = 0.24$); ($p$ value <5% using a t test or a MW-test).

Table 7
The Effect of Attributes on the Probability of Playing Stag Given Having Played Stag in the Previous Period

Model	1	2	3	4	5
Dependent variable	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy
Unit	Individual	Individual	Individual	Individual	Individual
Cognitive ability	0.0065	—	—	−0.0012	0.0023
	(0.015)	—	—	(0.015)	(0.015)
Patience	—	0.060**	—	0.059**	0.059**
	—	(0.024)	—	(0.024)	(0.023)
Risk tolerance	—	—	0.021	0.019	−0.013
	—	—	(0.018)	(0.017)	(0.017)
Openness	—	—	—	—	0.031*
	—	—	—	—	(0.018)
Conscientiousness	—	—	—	—	0.011
	—	—	—	—	(0.018)
Extraversion	—	—	—	—	−0.0087
	—	—	—	—	(0.021)
Agreeableness	—	—	—	—	−0.0070
	—	—	—	—	(0.020)
Neuroticism	—	—	—	—	0.023
	—	—	—	—	(0.020)
Male (dummy; not standardized)	—	—	—	—	0.16***
	—	—	—	—	(0.046)
Age (in years; not standardized)	—	—	—	—	−0.0020
	—	—	—	—	(0.0035)
R-squared	0.12	0.14	0.12	0.15	0.19
Observations	973	973	973	973	973
Period effects	Yes	Yes	Yes	Yes	Yes
Session effects	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes

Note. See Table 3 for additional explanation.

Result 6 reinforces Result 5.[12] Patient pairs play *stag-stag* more often as a result of a combination of two factors:

1. Patient players play *stag* slightly more often
2. Patient players are more persistent in their choices, making it easier for both players to coordinate on *stag-stag*

Conclusion

We find that pairs of players who are on average more patient—who have a lower rate of time preference—are more likely to coordinate in a stag hunt, a classic game of team effort. This is an emergent phenomenon: a player's patience has only modest influence on her individual tendency to play stag. Average patience generates successful coordination in part because patient players are more persistent in their tendency to play stag, making it easier for the other player to coordinate.

Clark (2007) provides evidence that rates of time preference (proxied by risk-free interest rates) have differed across societies and across centuries. According to our results, that may help explain why different political, economic, and social institutions have been sustained across the millennia: with more patient members of society, better equilibria have a higher probability of being sustained. Cross-sectionally, economists have routinely found that time preference differs across groups: the future is discounted more heavily by

[12] Note that Result 6 is not driven by the effect of the 4% difference in average stag play on the upper bound of $\overline{\sigma}$, because the difference in the upper bounds is less than 0.02.

Table 8
The Effect of Attributes on the Probability of Playing Stag Given Having Played Rabbit in the Previous Period

Model	1	2	3	4	5
Dependent variable	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy	Play *stag* dummy
Unit	Individual	Individual	Individual	Individual	Individual
Cognitive ability	−0.027	—	—	−0.017	0.0095
	(0.024)	—	—	(0.025)	(0.028)
Patience	—	—0.040	—	−0.038	−0.052**
	—	(0.026)	—	(0.025)	(0.023)
Risk tolerance	—	—	−0.024	−0.016	0.0018
	—	—	(0.026)	(0.027)	(0.028)
Openness	—	—	—	—	−0.025
	—	—	—	—	(0.020)
Conscientiousness	—	—	—	—	−0.0027
	—	—	—	—	(0.027)
Extraversion	—	—	—	—	−0.022
	—	—	—	—	(0.024)
Agreeableness	—	—	—	—	0.036
	—	—	—	—	(0.025)
Neuroticism	—	—	—	—	0.027
	—	—	—	—	(0.030)
Male (dummy; not standardized)	—	—	—	—	−0.090
	—	—	—	—	(0.067)
Age (in years; not standardized)	—	—	—	—	0.00050
	—	—	—	—	(0.0077)
R-squared	0.18	0.18	0.17	0.19	0.22
Observations	530	530	530	530	530
Period effects	Yes	Yes	Yes	Yes	Yes
Session effects	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes

Note. See Table 3 for additional explanation.

low-income individuals (e.g., Lawrance, 1991) and by smokers (a literature beginning with Fuchs, 1982). Our results indicate that if groups differ in patience, there are likely to be substantial social consequences.

Our results also suggest that a potential solution to coordination problems is to group patient people together and thereafter expand group size (Weber, 2006). Alternatively, using lessons from the marketing and social psychology literature, one can emphasize patience to coordination-game players through conscious and unconscious priming (Bargh, 2006).

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(*Appendix follows*)

Appendix

Experimental Instructions

Welcome to our study in decision-making. Today's experiment will be done on the computer. You each have a printed copy of the instructions. I will read through those.

If you pay attention and make good decisions, you may earn a considerable amount of money. At the end of the experiment, you will be paid your earnings privately and in cash. I remind you that today's experiment will take approximately 90 minutes. Today you will do several different tasks.

Just for showing up, you have earned $5. All earnings for today's tasks will be in addition to the $5.

For the remainder of this experiment, please refrain from any communication with other participants. Please put away your cell phones.

The first two tasks are Task 1 and Task 2. Later on, you will do Task 4 and Task 5. In each of these tasks, the choices that you make will determine your earnings. However you will only be paid the earnings that correspond to one of the four tasks. At the end of the experiment, I will roll a die to determine which of the three tasks will be used to determine your earnings for Task 1, Task 2, Task 4 and Task 5. You will have a 10% change of being paid for Task 5 and an equal (30%) chance of being paid for each of the other three tasks.

Task 1

You will be put into pairs randomly. You will never know the identity of your partner. You will only interact with your partner. You will play the game with the same partner over 10 rounds.

- If you select *blue*, then you earn exactly $0.50 regardless of what your partner selects.
- If you select *green*, then:
- If your partner also selects *green*, then you earn $0.75.
- If your partner selects *blue*, then you earn $0.

Your partner faces exactly the same decision and earnings. You will play this for 10 rounds. At the end of each round, you will find out how much you earned for that round. You will then proceed to the next round.

Task 2[13]

You will again be put into pairs randomly. Your partner in *Task 2* is guaranteed to be different to your partner in *Task 1*. You will never know the identity of your partner. You will only interact with your partner. You will play the game with the same partner over 10 rounds.

[13] Task 2 is the prisoner's dilemma; see footnote 3.

(*Appendix continues*)

- If you select *square*, then:
  - If your partner also selects *square*, then you earn \$0.25.
  - If your partner selects *circle*, then you earn \$1.50.
- If you select *circle*, then:
  - If your partner selects *square*, then you earn \$0.
  - If your partner also selects *circle*, then you earn \$1.

Your partner faces exactly the same decision and earnings. You will play this for 10 rounds. At the end of each round, you will find out how much you earned for that round. You will then proceed to the next round.

Task 3

Task 3 is a survey that we would like you to complete. You will be paid \$5 for completing this short survey. We will pay you as soon as you complete the survey.

Please answer the questions carefully and truthfully. We guarantee that we will treat these surveys with the utmost confidentiality. I will now read the instructions in front of you.

Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence.

Indicate for each statement whether it is:

1. Very inaccurate
2. Moderately inaccurate
3. Neither accurate nor inaccurate
4. Moderately accurate
5. Very accurate

as a description of you.

1. Am the life of the party. 1 / 2 / 3 / 4 / 5
2. Feel little concern for others. 1 / 2 / 3 / 4 / 5
3. Am always prepared. 1 / 2 / 3 / 4 / 5
4. Get stressed out easily. 1 / 2 / 3 / 4 / 5
5. Have a rich vocabulary. 1 / 2 / 3 / 4 / 5
6. Don't talk a lot. 1 / 2 / 3 / 4 / 5
7. Am interested in people. 1 / 2 / 3 / 4 / 5
8. Leave my belongings around. 1 / 2 / 3 / 4 / 5
9. Am relaxed most of the time. 1 / 2 / 3 / 4 / 5
10. Have difficulty understanding abstract ideas. 1 / 2 / 3 / 4 / 5
11. Feel comfortable around people. 1 / 2 / 3 / 4 / 5
12. Insult people. 1 / 2 / 3 / 4 / 5
13. Pay attention to details. 1 / 2 / 3 / 4 / 5

(*Appendix continues*)

14. Worry about things. 1 / 2 / 3 / 4 / 5
15. Have a vivid imagination. 1 / 2 / 3 / 4 / 5
16. Keep in the background. 1 / 2 / 3 / 4 / 5
17. Sympathize with others' feelings. 1 / 2 / 3 / 4 / 5
18. Make a mess of things. 1 / 2 / 3 / 4 / 5
19. Seldom feel blue. 1 / 2 / 3 / 4 / 5
20. Am not interested in abstract ideas. 1 / 2 / 3 / 4 / 5
21. Start conversations. 1 / 2 / 3 / 4 / 5
22. Am not interested in other people's problems. 1 / 2 / 3 / 4 / 5
23. Get chores done right away. 1 / 2 / 3 / 4 / 5
24. Am easily disturbed. 1 / 2 / 3 / 4 / 5
25. Have excellent ideas. 1 / 2 / 3 / 4 / 5
26. Have little to say. 1 / 2 / 3 / 4 / 5
27. Have a soft heart. 1 / 2 / 3 / 4 / 5
28. Often forget to put things back in their proper place. 1 / 2 / 3 / 4 / 5
29. Get upset easily. 1 / 2 / 3 / 4 / 5
30. Do not have a good imagination. 1 / 2 / 3 / 4 / 5
31. Talk to a lot of different people at parties. 1 / 2 / 3 / 4 / 5
32. Am not really interested in others. 1 / 2 / 3 / 4 / 5
33. Like order. 1 / 2 / 3 / 4 / 5
34. Change my mood a lot. 1 / 2 / 3 / 4 / 5
35. Am quick to understand things. 1 / 2 / 3 / 4 / 5
36. Don't like to draw attention to myself. 1 / 2 / 3 / 4 / 5
37. Take time out for others. 1 / 2 / 3 / 4 / 5
38. Shirk my duties. 1 / 2 / 3 / 4 / 5
39. Have frequent mood swings. 1 / 2 / 3 / 4 / 5
40. Use difficult words. 1 / 2 / 3 / 4 / 5
41. Don't mind being the center of attention. 1 / 2 / 3 / 4 / 5
42. Feel others' emotions. 1 / 2 / 3 / 4 / 5
43. Follow a schedule. 1 / 2 / 3 / 4 / 5
44. Get irritated easily. 1 / 2 / 3 / 4 / 5
45. Spend time reflecting on things. 1 / 2 / 3 / 4 / 5
46. Am quiet around strangers. 1 / 2 / 3 / 4 / 5
47. Make people feel at ease. 1 / 2 / 3 / 4 / 5
48. Am exacting in my work. 1 / 2 / 3 / 4 / 5
49. Often feel blue. 1 / 2 / 3 / 4 / 5
50. Am full of ideas. 1 / 2 / 3 / 4 / 5

[Demographic survey]

1. What is your age in years?
2. What is your gender? Male / Female
3. Do you live on campus or off campus?
4. What is the highest level of education that you have completed? *Less than high school / High school diploma or GED / Bachelor's degree / Master's degree / Doctoral degree*
5. What class are you in? *Freshman / Sophomore / Junior / Senior / MA student / Pre-dissertation PhD student / Dissertation PhD student*

(*Appendix continues*)

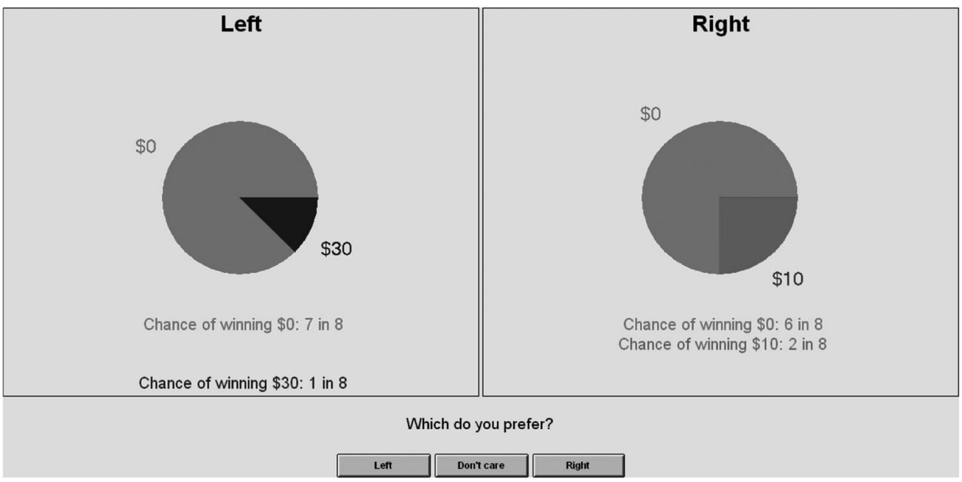
6. In what range is your GPA? 0 to 2.0 / 2.1 to 2.5 / 2.6 to 3.0 / 3.1 to 3.5 / 3.6 to 4.0
7. If you took it, what was your sat verbal score? (leave blank if you did not take it.)
8. If you took it, what was your sat quantitative score? (leave blank if you did not take it.)
9. If you took it, what was your GRE verbal score? (leave blank if you did not take it.)
10. If you took it, what was your GRE quantitative score? (leave blank if you did not take it.)
11. If you took it, what was your GRE analytical score? (leave blank if you did not take it.)

Task 4

In this task you will make decisions alone and your earnings will not depend upon the decisions of others. Recall that at the end of the experiment, we will roll a die to determine which out of Task 1, Task 2, Task 4, and Task 5 will be used to determine your earnings for the four tasks. You will have a 10% change of being paid for Task 5 and an equal (30%) chance of being paid for each of the other three tasks.

You will be given a series of choices between two games of chance. For each pair of games, you should indicate which of the two games you prefer to play. If you end up getting paid for Task 4, you will actually get the chance to play one of the games of chance you choose, so you should think carefully about which games of chance you prefer.

Here is a pair of games of chance like the ones you will see on your screen, although the display on your screen will be bigger and easier to read.



The outcome of the games of chance will be determined by a random number between 1 and 8. Each number between (and including) 1 and 8 is equally likely to occur. In fact, you will be able to roll the number yourself using a 8-sided die.

In the above example, the left game pays nothing ($0) if the random number is between 1 and 7, and pays $30 if the random number is 8. Notice that the size of the pie slices shows you the chances of each possible outcome.

In the above example, the game on the right pays nothing ($0) if the random number is between 1 and 6, and pays $10 if the random number is between 7 and 8. As with the game on the left, the pie slices represent the fraction of the possible numbers which yield each payoff.

Each pair of games is on a separate screen on the computer. On each screen, you should indicate which of the games you prefer to play by clicking on one of the three boxes beneath the games. You should click the ‘Left’ box if you prefer the game on the left, the ‘Right’ box if you prefer the game on the right, and the ‘Don’t care’ button if you do not prefer one or the other.

(*Appendix continues*)

You should approach each pair of games as if it is the only pair of games you are considering, because if you end up getting paid for this task, you are only going to play one of the many games. If you chose 'Don't care' in the games that we play out, we will pick one for you using a coin flip.

If you end up getting paid for *Task 4*, then at the end of the experiment, after you have worked through all of the pairs of games, we will roll a die to determine which pair of games have been chosen to play. If you picked 'Don't care' for that pair, we will flip a coin to decide which one you will play. Then we will let you roll the die to determine the outcome of the game you chose (or the game that was selected for you based on the coin flip).

For instance, suppose you picked the game on the left in the above example. If your die roll was 6, you would win nothing; if it was 8, you would get $30. If you picked the game on the right and rolled a 6, you would win nothing; if it was 8, you would get $10.

Therefore if end up getting paid for *task 4*, then your earnings are determined by three things:

1. Which pair of games of chance is chosen at random to be played out.
2. Which game you chose for the pair selected to be played.
3. The outcome of the game when you roll a die.

This is not a test of whether you can pick the best game in each pair, because none of the games are necessarily better than the others. Which games you prefer is a matter of personal taste. The people next to you may have different tastes, so their responses should not matter to you. Please work silently, and make your choices by thinking carefully about each game.

As a reminder, whether or not you get paid for task 4 does not affect your earnings from other tasks.

Task 5

In this task you will make decisions alone and your earnings will not depend upon the decisions of others. Recall that at the end of the experiment, we will roll a die to determine which out of Task 1, Task 2, Task 4, and Task 5 will be used to determine your earnings for the four tasks. You will have a 10% change of being paid for Task 5 and an equal (30%) chance of being paid for each of the other three tasks.

In the following sheet you are asked to choose between smaller payments tomorrow and larger payments in the future. Each choice looks like the one below:

Question	Which do you prefer
1	○$*X* tomorrow ○$*Y* a week from now

Instead of X and Y you will see actual dollar amounts. For each row, choose one payment: either the smaller, sooner payment or the larger, later payment. There are 20 decisions in total.

If you end up getting paid for Task 5, you will each roll a die to select one of the 20 rows at random. We will then pay you according to your choice for that row. Any one of the rows could be the row that counts! Treat each decision as if it could be the one that determines your payment.

We will place the money in an envelope in front of you. You will then seal the envelope and sign across the seal. We will then walk with you to Carow Hall, which is the building across the parking lot, and hand the envelope to Ms. Jane Perry, who is a staff member. You can pick up the payment either tomorrow or a week from now, depending on the choice you made. You can also pick up the envelope at any later time. You will be given a letter on university letterhead confirming this procedure. You each have an example in front of you.

(*Appendix continues*)

[There are 20 rows; X is always $10.00, Y starts at $10.50 and increases in $0.50 increments until $20.00]

[Following letter is personalized and is printed on GMU letterhead]

TO WHOM IT MAY CONCERN

8/25/2010

This letter confirms that NAME is to receive a sum of AMOUNT IN WORDS (AMOUNT NUMERICALLY) in cash on FUTURE DATE. Dr. Omar Al-Ubaydli will place this amount in a sealed envelope on 8/25/2010 and deliver it to Ms. Jane Perry (eperry2@gmu.edu, 703-993-2330), a staff member at Carow Hall. Both acts will be done in front of NAME.

Ms. Perry will retain the envelope until FUTURE DATE, upon which NAME will be able to retrieve it anytime between the hours 8am-11.30am and 1.30pm-4pm at his/her convenience (or at a subsequent date at his/her convenience) subject to presenting this letter and suitable identification. After retrieval, NAME will hand over this letter to Jane Perry, confirming the completion of the transaction.

Should any issue arise, please do not hesitate to contact Dr. Omar Al-Ubaydli:

Omar Al-Ubaydli
Assistant Professor of Economics
George Mason University
4400 University Dr
MSN 3G4
Fairfax VA, 22030
Tel: 703-993-4538
Email: oalubayd@gmu.edu

I have read and understand the above:

______________________________ Date: _____________

Omar Al-Ubaydli

______________________________ Date: _____________

NAME

Task 6

This is the final task in the experiment. You will be paid $10 for completing this test. We will pay you as soon as you complete the test. The test will take 45 minutes. Once the 45 minutes are finished, we will pay you for Task 6 in addition to any outstanding earnings from previous tasks. Please note that your earnings will not depend upon the number of correct answers you give. You will be paid $10 at the end of the 45 minutes.

As with all other aspects of this experiment, your choices are completely confidential.

(*Appendix continues*)

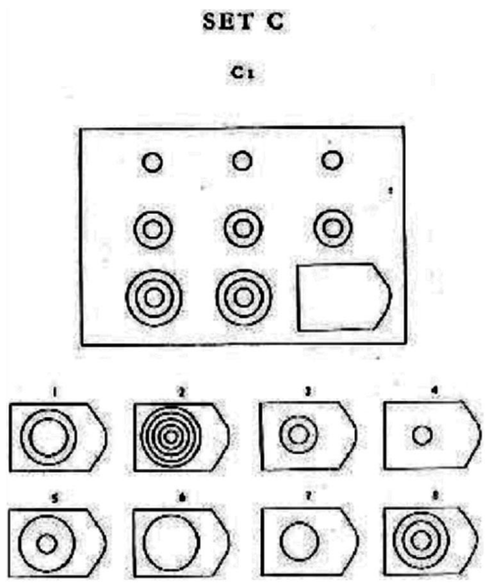
The next task consists of a sequence of puzzles. You will find on your desk a black booklet. Please do not write in the booklet. Please open the booklet to page A1.

On each page there is a pattern at the top with a missing segment, and a number of possible completions for the missing segment at the bottom. Only one of these correctly completes the pattern. It is up to you to select the right option that completes the pattern.

For page A1, the correct answer is 4. Please find the answer sheet on your desk and write number 4 in the first box in column A.

Now turn to page a2. the correct answer is 5. Please write number 5 in the second box in column A on the answer sheet.

Now you are on your own. have a look at the remaining pages and try to answer each problem as best you can.



[Above is a sample problem from the Raven's test]

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