The influence of labels in an experimental stag hunt game*

D. Dubois† S. Farolfi‡ M. Tidball§ P. Nguyen-Van¶

March 22, 2019

Abstract

We experimentally study to what extent a label attached on a strategy may affect players' choices in a 2×2 symmetric stag hunt game. The novelty of our study is twofold. First, we attach a label on only one strategy at a time in order to figure out whether it is possible to influence the frequency of choice of that strategy and its related equilibrium, despite the game's selection criteria (payoff-dominance and risk-dominance). Second, we test the impact of the valence of the label (positive vs negative).

Our experimental protocol is composed of five treatments that differ only with regards to the content of the label (valence) and the strategy it is attached on. The two main results of our study are (i) the label drastically changes the coordination issue, and (ii) a negative valence has a stronger effect than a positive one. Therefore, even in the presence of a strategic interaction and several selection criteria, it is possible to influence the issue reached by a pair of players with a simple element of contextualization.

Keywords: stag hunt game; label; experimental economics

*This research was conducted in the framework of the Coud'Pouce project and benefited from ONEMA's financial support. The authors acknowledge S. Thoyer and P. Biggins for their helpful comments. The authors would also like to thank participants in the research seminar "Ateliers d'économie de l'environnement et des ressources naturelles" de Montréal, participants in the Annual meeting of the French Experimental Economics Association (ASFEE) and participants in the "Ecole chercheur" of the French National Institute on Agronomic Research (INRA) entitled "Experimental Economics: state of the art and research dynamics at INRA". Finally the authors acknowledge the Laboratory for Experimental Economics - Montpellier (LEEM) for technical support and the organization of the experimental sessions.

†CEE-M, Univ. Montpellier, CNRS, INRA, Montpellier SupAgro, Montpellier, France.
E-mail: dimitri.dubois@umontpellier.fr

‡CIRAD, UMR G-EAU, Montpellier, France.
E-mail:stefano.farolfi@cirad.fr

§CEE-M, Univ. Montpellier, CNRS, INRA, Montpellier SupAgro, Montpellier, France.
E-mail: mabel.tidball@inra.fr

¶BETA, CNRS, INRA, Univ. Strasbourg, France & TIMAS, Thang Long University, Vietnam.
E-mail: nguyen-van@unistra.fr

1 Introduction

There is a growing literature in the field of behavioral economics on the possible alternatives or complements to traditional policy instruments and economic methods, like taxes or cost-benefits analyses, to reach solutions that are socially preferable. This is particularly true in environmental economics, where the challenge is to lead economic agents to adopt a pro-environmental behavior even when the individual interest is in conflict with the social well-being (Ashford 1981, Bocher 2012, Moseley & Stoker 2013). These alternatives are mainly based on behavioral interventions to favor intrinsic motivation and to avoid crowding out effects (Van Der Linden 2015). Thaler & Sunstein (2008) proposed the concept of "nudge" to refer to "any aspect in the framing of a decision problem that can affect people's decisions without changing economic incentives". Nudges can take different forms, like disclosure of information, warnings, default rules, framing, or drawing attention to social norms. A nudge is expected to have no effect on a rational individual since it does not alter the strategy space and associated payoffs. The objective of a nudge is to influence choices without using explicit incentives to do so. However, Thaler & Sunstein (2008) emphasize that the framing should alter people's behavior "in a predictable way", suggesting that the nudge should be based on sound scientific evidence that a change in the framing will have a specific effect (Croson & Treich 2014). In a recent report, entitled "A practitioner's guide to nudging", Ly et al. (2013) claim that the first step in the process of designing an effective nudging strategy is to audit the decision-making process of the end user. This audit "requires analysis of the context and the task, followed by identification of the key heuristics and influences that may affect the decision outcome".

Following Ly et al. (2013), in order to investigate context influence on the decision outcomes, our paper looks then to the effects of simplified contextual items (labels) on subjects' choice of strategies. More precisely, we study the impact of a label attached on a strategy in a 2×2 experimental stag hunt game. In this class of coordination games, two pure strategy Nash equilibria coexist. Furthermore, one is payoff-dominant and the other is risk-dominant. As a result, a conflict arises between two selection criteria. Harsanyi & Selten (1988) claim that payoff-dominance should be a focal point, while several years later, after several experimental observations and an evolutionary perspective proposed by Kandori et al. (1993), the same authors (Harsanyi & Selten 1995) select the risk-dominant equilibrium. Experimental findings do not really help in sorting out these predictions: Friedman (1996) and Berninghaus & Ehrhart (2001) mainly observed convergence towards the payoff dominant equilibrium while Cooper et al. (1990), Straub (1995) and more recently Bangun et al. (2006) found that subjects frequently coordinate based on Pareto-dominated equilibria. Several elements come into play, particularly the structure of the game such as the optimization premium (Battalio et al. 2001) or the risk characteristics of the available strategies (Schmidt et al. 2003, Dubois et al. 2012) and some factors help avoid a coordination failure in the game, like communication (Cooper et al. 1992) or assignments (Bangun et al. 2006). See Devetag & Ortmann (2007) for a survey. By creating focal points, labeling the options may also help players to coordinate, as originally claimed by Schelling (1960) and experimentally tested by Metha et al. (1994*a*,*b*). In a recent paper, Dugar & Shahriar (2012) attach strong labels to the payoff dominant strategy and manipulate the strength of the labels attached to the risk-dominant strategy in several experimental stag hunt games. The authors find that the relative salience of the label attached to the risk-dominant strategy affects the coordination rate on the payoff-dominant equilibrium.

Our research question is slightly different from Dugar & Shahriar (2012). Our point is to investigate whether it is possible to influence the issue in this class of coordination games by adding a simple frame that doesn't change the mathematical structure of the game. To this purpose we attach a label, which takes the form of a single sentence, on only one strategy at a time, and test experimentally to what extent the label affects the coordination issue. Moreover we experiment two valences, a positive one and a negative one. More precisely in our test treatments we add a sentence at the end of the instructions and on the decision screen, without any additional explanation. Depending on the treatment, this sentence either concerns the payoff-dominant strategy or the risk-dominant strategy and is either characterized by a positive valence or a negative one. The sentence is the following: "Option i preserves the environment" (positive valence) or "Option i degrades the environment" (negative valence), with i being either strategy X or strategy Y depending on the treatment. Our labels have an environmental connotations, for several reasons. First, we consider that everyone understands the sentence without the requirement of an additional explanation. Second, it is easy to create a distinction between a positive and a negative valence with the simple verb preserve/degrade. Finally, a third argument is related to pro-environmental behavior. As written by Turaga et al. (2010) "in this era of serious and potentially catastrophic global environmental change, inducing pro-environmental behaviors in individuals, is one of the important challenges in the path to sustainability". We therefore mix our desire to test whether it is possible to influence coordination issues with the necessity to determine the behavioral tools capables to lead individuals to act in a more environmental perspective.

The data collected in the lab confirm that a label attached on a strategy strongly influences the coordination issue in the studied stag hunt game. More precisely, compared to a baseline treatment without label, and keeping the game structure unchanged, the reached Nash equilibrium with a label is systematically the one favored by the label, whatever the nature of the equilibrium (payoff-dominant or risk-dominant) and the valence (positive or negative). Our second result is that a label with a negative valence has a stronger impact on choices than a label with a positive valence, and this is particularly true when it is attached to the less risky option.

The rest of this paper is organized as follows. Section 2 describes the experimental design and section 3 the conjectures. Section 4 presents the results and section 5 discusses them.

2 Experimental design

We consider a 2×2 symmetric stag hunt game. In its normal form, this game can be represented as in table 1. With the conditions that $a > c \geq d > b$ and $d - b > a - c$ this game admits two pure strategy Nash equilibria, XX and YY and one mixed strategy equilibrium in which strategy X is chosen with probability $p = \frac{d-b}{a-b+d-c}$. Furthermore, XX is payoff dominant and YY is risk dominant (Harsanyi & Selten 1988). A Nash equilibrium is payoff-dominant if it is Pareto-superior to all other Nash equilibria in the game, which is the case here with $a > d$. On the other hand, the YY Nash equilibrium is risk-dominant because adopting strategy Y is less risky than adopting strategy X. Indeed X has to be chosen by the opponent with a probability greater than 0.5 to obtain an expected payoff equal to that of Y.

Table 1: A symmetric 2×2 stag hunt game, with $a > c \geq d > b$ and $d - b > a - c$.

		Player B	
		X	Y
Player A	X	a, a	b, c
	Y	c, b	d, d

The parameters used for the experiment[1] are $a = 10$, $b = 5$, $c = 9.25$ and $d = 8$, as shown in table 2. With these parameters the mixed-strategy equilibrium is to play strategy X with probability p=0.8.

Table 2: The game used in the experiment

		Player B	
		X	Y
Player A	X	10, 10	5, 9.25
	Y	9.25, 5	8, 8

We run five treatments: two treatments where the label has a positive valence, either attached to strategy X (treatment XP) or to strategy Y (treatment YP), two treatments where the label has a negative valence attached either to X or Y (respectively treatments XN and YN) and a baseline treatment without label. What we call a label is a single short sentence added to the end of the instructions and displayed in the explanation area of the decision screen: "Option i preserves the environment" and "Option i degrades the environment" respectively for the positive and the negative valence, where i refers either to option X (treatments XP and XN) or Y (treatments YP and YN). It is therefore an extremely simplified contextualization of the game.

The experiment took place in the experimental laboratory of Montpellier in France (LEEM). A total of 178 subjects, students from various disciplines at Montpellier University[2], participated in the experiment. The experiment was composed of four parts. In part 1 pairs of subjects, randomly formed, played the stag hunt game given in table 2 in one-shot. In part 2, without any rematch of the groups, subjects played the same game as in part 1 but for 20 periods. We proceeded this way in order to collect observations both in a one-shot setting and in a repeated setting. One-shot is interesting because players interact without common history and without any perspective of future interaction. In a work that deals with saliency and focal points it is, to our opinion, important to also have observations in this condition. In part 3 subjects took part in a simple real-money portfolio game designed to capture their sensitivity to risky decisions (Gneezy & Potters 1997, Beaud & Willinger 2015). More precisely, they had an initial endowment of 10€ and had to decide how to allocate it between a safe asset (return rate of 1) and a risky one where the rate of return was $\tilde{k} = (0, 1/2; 3, 1/2)$, i.e. with a probability 1/2 they lost the amount invested and with a probability 1/2 they got back three times their investment. Finally, in part 4 subjects answered to the (revised) NEP scale questionnaire (Dunlap & Van Liere 1978, Dunlap et al. 2000). The NEP scale measures pro-environmental orientation and sensitivity to environmental concerns. It contains a set of 15 items. The eight odd-numbered items refer to pro-ecological behavior and the seven even-numbered ones to a disagreement with the pro-ecological world view. The items were classified according to the following five central ideas: (i) the reality of limits to growth (questions 1, 6, and 11), (ii) antianthropocentrism (questions 2, 7, and 12), (iii) the fragility of the balance of nature (questions 3, 8, and 13), (iv) rejection of exemptionalism (questions 4, 9, and 14), and (v) the possibility of an ecocrisis (questions 5, 10, and 15). The participants in the experiment answered all 15 questions, which we had carefully translated into French. We added this fourth part to our experiment because the labels used in the experiment are related to the environment. We thus would like to control whether subjects'

[1] These payoffs are those of game 2 of Dubois et al. (2012) divided by 4. We divided values by 4 to avoid the need for a conversion rate. The payoffs in the matrix are euros.

[2] The experimental sessions were organized with the ORSEE software (Greiner 2004).

sensitivity to environmental concerns could have played a role in their choice in the game.

Subjects were informed from the outset that the experiment was composed of four parts: three games and a questionnaire and that they would receive the instructions of each part[3] separately at the beginning of the corresponding part. Subjects were also told that payments were based on only one of the three games randomly selected at the end of the experiment.

3 Conjectures

Labels are irrelevant for a rational player that is only concerned by the mathematical structure of the game. However Schelling (1960) and Metha et al. (1994*a*,*b*) have experimentally shown that individuals take into account these framing elements and perform better than a computer that would make its choices on the solely basis of the payoff structure. In Metha et al. (1994*a*,*b*), most of the experimented games are pure coordination games where players, based on the payoff structure, are indifferent between the Nash equilibria. In theses games, what matters for individuals is to coordinate. Labels help players to select one issue based on considerations other than the mathematical structure of the game. Stag hunt games distinguish from other coordination games by the co-existence of two Nash equilibria and two selection criteria: payoff-dominance and risk-dominance. Therefore individuals make their choices also depending on their own preferences and beliefs about the counterpart's preferences. Few research papers focus on the effect of labels in stag hunt games. To our knowledge only the work of Dugar & Shahriar (2012) deals with this question. However the labels used by Dugar & Shahriar (2012) do not have a particular content, they are a date that is more or less far away from the current year, respectively "Year 2009", "Year 2008" and "Year 1999". Their objective is not to try to influence choices in the game but to observe to what extent the relative strength of the label attached to the risk-dominant strategy compared to the payoff-dominant affects the frequency of coordination on the payoff-dominant equilibrium. By attaching a label to only one option at time, our objective is quite different. We want to know to what extent players' choices can be influenced by the label and its content, even in a game with strategic interaction and in the presence of several selection criteria. Our first conjecture is that the presence of a label in the game acts as a focal point that helps players to coordinate. Our second conjecture is that players choose more frequently the action favored by the label content, whatever the target (X, the payoff-dominant strategy or Y, the risk-dominant one) and the valence of the content (positive or negative).

Conjecture 1 *The presence of a label decreases the coordination failure*

Conjecture 2 *Strategy choices of players are oriented by the label content*

Our third conjecture is related to the valence of the label content. Several experiments have shown that individuals are more sensitive to punishments than to rewards (Sefton et al. 2007, Bravo & Squazzoni 2013), and to losses than to gains with respect to climate and environmental issues (Newman et al. 2012). In terms of labels this can be interpreted in our context as a signal that a negative valence of the label content might have a stronger impact on decisions than a positive one. Our protocol allows a comparison, so we lay this out in conjecture 3.

Conjecture 3 *A negative valence of the label content has a stronger effect than a positive one*

[3]Instructions are available from the authors upon request.

Since the label content refers to the environment we asked subjects to answer the NEP scale questionnaire. This allows us to collect individual data about the subjects' sensitivity to environmental concerns and hence to see whether a relationship exists between these revealed preferences and the choices in the stag hunt game.

Conjecture 4 *Subjects with a high NEP score more frequently follow the indication given by the (environmental) label content*

Finally, the stag hunt game is characterized by the co-existence of a payoff-dominant and a risk-dominant strategy. One hypothesis, rarely tested in the lab, is that risk preferences are correlated with choices. To our knowledge only Buyukboyaci (2014) tested this correlation[4]. The authors found that the subject propensity to choose the risky action does not depend on his/her risk attitude but rather on his/her opponent's risk attitude. Part 3 of our experiment allows us to perform a further test.

Conjecture 5 *There is a positive correlation between the amount invested in the risky option of the porfolio choice and the strategy chosen in the stag hunt game*

4 Results

4.1 One-shot game

Table 3: Average frequencies in the one-shot game.

Treatment	# groups	Freq. XX	Freq. YY	Freq. XY
Baseline	18	0.500	0.167	0.333
XN	18	0.167	0.444	0.389
XP	17	0.471	0.059	0.470
YN	18	0.444	0.167	0.389
YP	18	0.111	0.500	0.389

Table 3 reports for each treatment the average frequency of the payoff-dominant equilibrium (XX), the risk-dominant equilibrium (YY) and the coordination failure (XY). First of all one can observe that the rates of coordination failure don't differ across treatments, which is confirmed by a Mann Whitney bilateral test based on averages by pairs performed on each combination of two-by-two treatments[5]. In the baseline treatment exactly 50% of the pairs coordinate on the payoff-dominant equilibrium, and 16.70% on the risk-dominant equilibrium. In treatments that favor the choice of option X, that is XP and YN, the observed frequencies are very close to those of the baseline, without any statistically significant difference[6]. There is furthermore no difference between the two treatments[7]. Conversely in the two treatments where the label favors the choice of option Y, namely XN and YP, the coordination rate on the

[4] Eckel & Wilson (2004) tested this correlation in a trust game, with the assumption that risk averse subjects exhibit less trust in the game.

[5] All Mann Whitney tests (thereafter MW) are based on averages by pair, the statistically independent data in our experiment.

[6] Compared to the frequencies in the baseline (respectively XX and YY): XP: MW p-value=0.879 and 0.338 and YN: p-value=0.756 and 0.980

[7] MW p-value=0.894 and 0.338 respectively for XX and YY equilibria

payoff-dominant equilibrium falls drastically to the benefit of the risk-dominant equilibrium[8]. There is however no significant difference between the treatments.

Table 4: One-shot game, logit model

Variable	Coefficient	Clustered-robust std.err.	Marginal effect	Std.err (delta method)
Treatment XN	-1.274**	0.552	-0.307**	0.124
Treatment XP	0.198	0.531	0.042	0.114
Treatment YN	-0.141	0.554	-0.032	0.125
Treatment YP	-1.529***	0.554	-0.364***	0.120
GP investment	-0.033	0.055	-0.007	0.012
NEP score	-0.004	0.023	-0.001	0.005
Intercept	1.050	1.328	–	–
Observations	178			
Log-likelihood	-112.596			
Pseudo-R^2	0.084			

Dependent variable: choice of X. Results obtained from logit regression.
The right panel represents the average marginal effects.
For treatment variables, marginal effect corresponds to discrete change from 0 to 1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

These descriptive statistics are confirmed by the estimation of a logit model reported in Table 4 where the dependent variable is the choice made by the subject, coded 1 for strategy X and 0 for Y.[9] Compared to the baseline, only treatments XN and YP have a significant (negative) marginal effect on the probability the player chooses X. We also included in the model both measures of individual attitudes towards risk and environment[10]. As revealed by the estimation, none seems to have an impact on the choice made by the subject. The explanatory power of the model is quite low, the pseudo-R^2 is about 8.4%.[11]

To summarize, in the stag hunt game played in one shot: (i) labels do not reduce the coordination failure (conjecture 1 is rejected), (ii) labels affect the coordination rate on the risk-dominant equilibrium but not on the payoff-dominant equilibrium (conjecture 2 is partially rejected), (iii) the valence of the label content does not matter (conjecture 3 is rejected), and (iv) risk and environmental attitudes, as measured in our experiment, do not explain the strategy choice made by subjects (conjectures 4 and 5 are rejected).

4.2 Repeated game

Table 5 reports the average frequencies of XX, YY and XY in the five treatments and figure 1 displays the evolution over time. The graph on the left side of the figure displays the evolution of the two treatments favoring the payoff-dominant equilibrium (XP and YN), the graph in

[8] XN: 16.70% of XX and 44.40% of YY p-value=0.038 and 0.013 compared to the frequencies in the Baseline, YP: 11.10% and 50.00% and p-value= 0.008 and 0.038 respectively

[9] Results obtained from the probit model are very similar (see Appendix for more details).

[10] The NEP scores observed in our experiment are in accordance with the literature, with an average of 55.4 compared to 54.8 and 54.1 observed in Kotchen & Reiling (2000). In the portfolio choice, subjects invested on average 4.24€ in the risky option, the median is 4.50€ and the third quartile corresponds to an investment of 6€, which means than most of the subjects are rather risk averse (or neutral), as usually observed in economic experiments (Holt & Laury 2002). We do not find any correlation between the NEP score and the amount invested in the risky option (Pearson correlation test, $\rho = -0.065$, p-value=0.386).

[11] We also performed a model with an interaction between these two variables and the treatment variable, but none of the coefficients were significant.

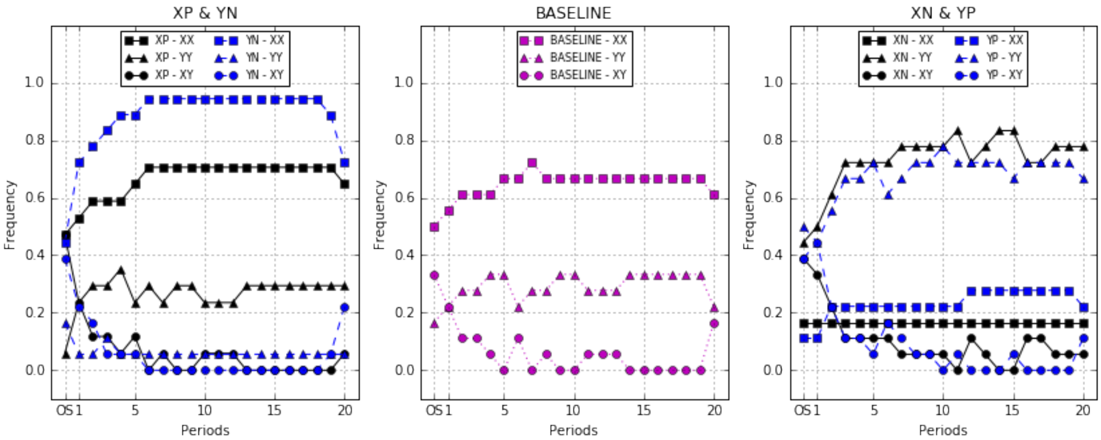

Figure 1: Evolution of the frequency of XX, YY and coordination failure (XY)

the middle displays the evolution of the baseline and the graph on the right side displays the evolution of the two treatments favoring the risk-dominant equilibrium (XN and YP).

Table 5: Average frequencies in the repeated game

Treatment	# groups	Freq. of XX	Freq. of YY	Freq. of XY
Baseline	18	0.653	0.297	0.050
XN	18	0.167	0.744	0.089
XP	17	0.674	0.279	0.047
YN	18	0.900	0.058	0.042
YP	18	0.239	0.683	0.078

As in the one-shot game, the presence of a label in the game does not reduce the rate of coordination failure, as none of the four treatments lead to a frequency of XY lower than in the baseline. If we first focus on treatments where the label content favors the choice of X (XP and YN, left side of the figure), we can observe that the negative valence of the label content attached to the less risky strategy leads to a very high frequency of XX, significantly higher than in the baseline (p-value=0.061) and in treatment XP (p-value=0.048)[12]. The positive information about X is on the other hand not sufficient to increase this frequency compared to the baseline (p-value=0.958). Since the rate of coordination failure is quite similar in all the treatments, this also implies that in treatment YN the frequency of YY is significantly lower than in the baseline and in XN (p-value= 0.048 and 0.043 respectively), without any difference between the latter (p-value=0.955). In treatments XN and YP (right side of the figure) the frequency of YY is significantly higher than in the baseline[13] and the frequency of XX significantly lower[14]. There is no difference between the two treatments (on YY p-value=0.425 and on XX p-value=0.617).

[12] More precisely, the frequency of XX in treatment YN is 95.29% if we exclude one group that never coordinates on XX (while the others coordinate on average with a frequency higher than 75%). With this group the p-values are respectively equal to 0.121 and 0.101.

[13] XN vs Baseline p-value=0.006 and YP vs baseline p-value=0.025.

[14] XP vs baseline p-value=0.004 and YP vs baseline p-value=0.004.

In order to study the choice of X accounting for the history of play, we use a learning model as in (Battalio et al. 2001) and (Dubois et al. 2012) where the player i's belief that his partner chooses X at time t is defined by

$$q_{it} = \frac{q_0 d^{t-1} + I_{i1} d^{t-2} + ... + I_{i,t-2} d + I_{i,t-1}}{d^{t-1} + d^{t-2} + ... + 1} \tag{1}$$

where q_0 is the initial probability, I_{it} indicates that player i's partner chooses X at time t, and d is the discount factor.[15] In this model, the probability that player i chooses strategy X at time t ($S_{it} = X$) corresponds to the following quantal response equilibrium (McKelvey & Palfrey 1995) (or logit regression model), augmented by some control variables:

$$Pr(S_{it} = X) = \frac{\exp(\alpha + \beta(q_{it} - q^*) + z_i'\gamma)}{1 + \exp(\alpha + \beta(q_{it} - q^*) + z_i'\gamma)} \tag{2}$$

where $q^* = 0.8$. Note that parameter α, which corresponds to the intercept of the model, captures the deviation with respect to the low payoffs while β represents the weight of player i's belief (on his opponent's action) in his own decision. The model has a set of control variables z_i, including treatment indicators (to capture treatment heterogeneity), individual attitudes towards risk and environment (investment amount in the risky option and NEP score). The logistic form in equation (2) can be alternatively replaced by a Gaussian distribution (leading to a probit regression model):

$$Pr(S_{it} = X) = \Phi(\alpha + \beta(q_{it} - q^*) + z_i'\gamma) \tag{3}$$

where $\Phi(.)$ is the cumulative normal distribution. We use maximum likelihood to estimate the parameters (α, β, d, q_0, and γ) of the models in (2) and (3).[16] As the model is nonlinear, we compute the marginal effects of explanatory variables on the probability of choosing strategy X for ease of interpretation.

The left panel of Table 6 reports estimation of our logit model for choice of strategy X. Estimation results for the probit model are very similar (see Appendix for more details). Before interpreting the results, we perform a likelihood ratio test to compare our model with the standard logit one. The LR statistic for the null hypothesis ($\text{H}_0 : \beta = d = q_0 = 0$) is 2419.21 and the corresponding p-value is close to 0, indicating a strong reject of the standard logit model in favor of our model with learning. The model provides a good explanation of individual choice as the pseudo-R^2 is pretty high (73.4%). Results show the existence of heterogeneity among treatments: treatments XN, YN, and YP are significantly different from the baseline. Indeed, the marginal effects as reported in the right panel indicate that, compared to the baseline, the probability of strategy X is higher in treatment YN (the marginal effect is positive and significant at the 10% level) while it is lower in treatments XN and YP (both marginal effects are negative and significant respectively at the 5% and 10% level). Parameters of the model (β, d, and q_0) are all strongly significant, indicating that player's belief and learning can play an important role in individual decision.

It is also interesting to investigate the coordination of pair of players in the game. This issue

[15] Player i can be player A or B in the game. Hence, if player i corresponds to player A, his partner is player B, and vice versa.

[16] Note that in the case of one-shot game, our regression in equations (2) and (3) will shrink respectively into the simple logit model and the simple probit model (see the previous section) where only α (or the intercept) and coefficients of control variables (γ) can be estimated.

Table 6: Estimation results of the logit model for individual choice of X, repeated game

Variables	Coefficient	Clustered-robust std.err.	Marginal effect	Std.err. (delta method)
Treatment XN	-1.197***	0.406	-0.073***	0.028
Treatment XP	0.047	0.411	0.003	0.024
Treatment YN	0.924**	0.462	0.058*	0.034
Treatment YP	-0.797**	0.388	-0.047*	0.025
Investment	0.069	0.054	0.003	0.003
NEP score	0.007	0.022	0.001	0.001
Intercept (or α)	1.713	1.239	–	–
β	6.765***	0.580		
d	0.651***	0.048		
q_0	0.510***	0.031		
Observations	3560			
Numbers of players	178			
Number of groups	89			
Number of periods	20			
Log-likelihood	-651.363			
Pseudo-R^2	0.734			
LR test ($\beta = d = q_0 = 0$)	2419.21***	p-value = 0		

Dependent variable: Choice of X. Results obtained from quantal response equilibrium model.
The right panel represents the average marginal effects.
The marginal effect for a treatment variable corresponds to discrete change from 0 to 1).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

can be addressed thanks to the following multinomial logit model (see, e.g., Greene (2012)):[17]

$$Pr(S_{jt} = s) = \frac{\exp(\alpha_s + \beta_s(q_{jt} - q^*) + z_j'\gamma_s)}{\sum_{s=1}^{3} \exp(\alpha_s + \beta_s(q_{jt} - q^*) + z_j\gamma_s)} \tag{4}$$

where S_{jt} indicates the choice of pair of subjects j (consisting of a player A and his partner, i.e. player B) at period t. We set $s = 1$ if both player A and player B of a pair choose X, $s = 2$ if one player chooses X while the other selects Y, and $s = 3$ if both of them choose Y. The model provides two sets of alternative-related coefficients, i.e. $\theta_s = (\alpha_s, \beta_s, \gamma_s)'$, $s = 1, 3$, using the normalization $\theta_2 = 0$. Remark that z_j denotes the set of variables measured at the pair level (here we use two variables: mean of individual NEP scores and mean of individual risky investments). We also note that q_{jt} is defined as in equation (1) above where index i is replaced by j and individual choice I_{it} by pair j's choice S_{jt}. Remark that, contrary to θ, parameters q_0 and d do not depend on s (i.e. they are invariant over alternatives). Estimation of the model is based on maximum likelihood.

Table 7 reports the estimates of the model. The explanatory power of the model is quite good as the pseudo-R^2 is relatively high (77.5%). We observe that coefficients associated to treatments XN and YP are significant for the case where both players A and B choose strategy X compared to the baseline (one player chooses X while the other chooses Y). The parameters of the learning model (α, β, and q_0) are statistically significant either in one or two alternatives, supporting the usefulness of the model. We observe that the discount factor d is not significant, suggesting that learning is only related to one period earlier. Moreover, the coefficient of mean NEP score is significant at the 5% level, meaning that environmental attitude may play a role in joint decision of players. To have a better idea about the coordination on individual choices, we examine the marginal effects of explanatory variables on the three probabilities (i.e. $Pr(S_{jt} = s)$

[17] A multivariate probit counterpart exists but it is much less tractable than the multinomial logit model.

where $s = 1, 2, 3$) in Table 8. It is confirmed that treatments are heterogenous as the marginal effects of treatments XN and YP in the case where both players choose X are significantly negative whereas the effects of treatment variables on other probabilities are not significant. Thus, a negative valence on X or a positive valence on Y will reduce the coordination of players on strategy X. The mean NEP score has a negative impact on $Pr(S_{jt} = 2)$ while its impacts on $Pr(S_{jt} = 1)$ and $Pr(S_{jt} = 3)$ are positive. This result indicates that an increase in the mean NEP score will improve the coordination of players either on strategy X or strategy Y.

Table 7: Estimation results of the multinomial logit model for coordination, repeated game

	Both A & B choose X		Both A & B choose Y	
Variables	Coefficient	Clustered-robust std.err.	Coefficient	Clustered-robust std.err.
Treatment XN	-1.452*	0.762	0.349	0.632
Treatment XP	-0.053	0.640	-0.119	0.591
Treatment YN	0.164	0.678	-0.987	0.773
Treatment YP	-1.076*	0.646	0.319	0.561
Mean investment	-0.009	0.112	0.031	0.117
Mean NEP score	0.096***	0.035	0.079**	0.031
Intercept (or α)	0.531	2.006	-8.096***	1.624
β	-4.951***	0.347	3.054***	0.344
d	0.079	0.095		
q_0	1.870***	0.058		
Observations	1780			
Number of groups	89			
Number of periods	20			
Log-likelihood	-349.529			
Pseudo-R^2	0.775			

Dependent variable: Choice of pair of players S_{jt}. $S_{jt} = 1$ if both A and B choose X, $S_{jt} = 2$ if one player chooses X while the other chooses Y (base outcome), $S_{jt} = 3$ if both A and B choose Y.
Results obtained from multinomial logit regression model.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

To summarize, in the repeated stag hunt game: (i) labels do not reduce the coordination failure (conjecture 1 is rejected), (ii) a negative valence of the label content strongly affects the coordination issue compared to the baseline, whatever the selection criterion behind that equilibrium while a positive valence has an effect only if it favors the less risky strategy, (partially) in line with conjectures 2 and 3, and (iii) environmental and risk attitudes do not explain the strategy choices made by subjects (conjectures 4 and 5 are rejected). However a higher mean NEP score at the pair level leads to a higher frequency of coordination, either on the payoff-dominant or the risk-dominant equilibrium depending on the treatment.

5 Discussion

Our objective was to investigate to what extent a minimal element of context may affect the choices made by subjects in an experimental coordination game characterized by two pure-strategy Nash equilibria – and a mixed-strategy equilibrium – with different selection criteria (payoff-dominance vs. risk-dominance). To that purpose, keeping constant the payoff structure of the game, we ran a baseline treatment and four test treatments. In the latter we attached a label to one of the two strategies. The label took the form of a simple sentence with an environmental content and either a positive or a negative valence.

We show that in the one-shot game the label does not help to improve the coordination

Table 8: Marginal effects, multinomial logit model for coordination, repeated game

	Pr(both A & B choose X)	Pr(one player chooses X, the other chooses Y)	Pr(both A & B choose Y)
Treatment XN	-0.041**	0.014	0.026
	(0.017)	(0.029)	(0.022)
Treatment XP	-0.001	0.004	-0.004
	(0.015)	(0.024)	(0.020)
Treatment YN	0.013	0.032	-0.044
	(0.015)	(0.037)	(0.033)
Treatment YP	-0.031**	0.008	0.023
	(0.014)	(0.023)	(0.019)
Mean GP investment	-0.001	-0.001	0.001
	(0.002)	(0.004)	(0.004)
Mean NEP score	0.002**	-0.004**	0.002*
	(0.001)	(0.001)	(0.001)

Clustered-robust standard errors (calculated by delta method) in parentheses.
The marginal effect for a treatment variable corresponds to discrete change from 0 to 1.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

on the payoff-dominant equilibrium but performs well for a coordination on the risk-dominant equilibrium. In a repeated environment the label improves the coordination on the Pareto-dominant equilibrium but only when the valence of its content is negative. A label with a positive valence attached to the risky but payful strategy has no influence in the experimental game either in a one-shot or in a repeated environment. Our findings furthermore reveal that the environmental concern, measured by the NEP score, and the risk attitude, measured by the decision in a portfolio choice, are not part of the individual decision process in the game. The environmental concern aggregated at the pair level, combined with the environmental labels, is however an important element accounting for the nature of the equilibrium reached by the pair. It would worth to study more specifically the link between the individual risk attitude and the choices made in the game. A possible alternative could be to measure ambiguity aversion instead of risk aversion. Ambiguity would refer to the belief dimension about the opponent's choice whereas risk aversion is only linked to the game's probabilities.

This research paper contributes obviously to the literature on stag hunt games, but also to the literature on nudges as evoked in the introduction. Even if we do not explicitly introduce a nudge in our experiment, we nevertheless test one of its main feature, the context (Ly et al. 2013). It would be interesting to replicate the experiment with a label content related to another field than the environment, in order to test whether our observations are mainly due to the possible existence of a pro-environmental behavior.

References

Ashford, N. A. (1981), 'Alternatives to cost-benefit analysis in regulatory decisions', *Annals of the New York Academy of Sciences* **363**(1), 129–137.

Bangun, L., Chaudhuri, A., Prak, P. & Zhou, C. (2006), 'Common and almost common knowledge of credible assignments in a coordination game', *Economics Bulletin* **3**, 1–10.

Battalio, R., Samuelson, L. & Van Huyck, J. (2001), 'Optimization incentives and coordination failure in laboratory stag hunt games', *Econometrica* **69**, 749–764.

Beaud, M. & Willinger, M. (2015), 'Are People Risk-Vulnerable', *Management Science* **61**(3), 624–636.

Berninghaus, S. K. & Ehrhart, K. (2001), 'Coordination and information: Recent experimental evidence', *Economics Letters* **73**, 345–351.

Bocher, M. (2012), 'A theoretical framework for explaining the choice of instruments in environmental policy', *Forest Policy and Economics* **16**, 14–22.

Bravo, G. & Squazzoni, F. (2013), 'Exit, punishment and rewards in commons dilemmas: An experimental study', *PLoS One* **8**(8).

Buyukboyaci, M. (2014), 'Risk attitudes and the stag-hunt game', *Economics Letters* **124**(3), 323–325.

Cooper, R., Dejong, D., Forsythe, D. & Ross, T. (1992), 'Communication in coordination games', *Quaterly Journal of Economics* **107**, 739–779.

Cooper, R. W., Dejong, V. D., Forsythe, R. & Ross, T. (1990), 'Selection criteria in coordination games: Experimental results', *American Economic Review* **80**, 218–233.

Croson, R. & Treich, N. (2014), 'Behavioral environmental economics: Promises and challenges', *Environmental and Resource Economics* **58**(3), 335–351.

Devetag, G. & Ortmann, A. (2007), 'When and why? A critical survey on coordination failure in the laboratory', *Experimental Economics* **10**(3), 331–344.

Dubois, D., Willinger, M. & Nguyen Van, P. (2012), 'Optimization Incentives and Relative Riskiness in Experimental Coordination Games', *International Journal of Game Theory* **41**, 369–380.

Dugar, S. & Shahriar, Q. (2012), 'Focal Points and Economic Efficiency: Role of Relative Label Salience', *Southern Economic Journal* **78**, 954–975.

Dunlap, R. E. & Van Liere, K. D. (1978), 'The 'new environnmental paradigm': a proposed measuring instrument and preliminary results', *Journal of Environmental Education* **9**, 10–19.

Dunlap, R., Van Liere, K., Mertig, A. & R.E., J. (2000), 'Measuring endorsement of the new ecological paradigm: A revised NEP scale', *Journal of Social Issues* **56**(3), 425–442.

Eckel, C. & Wilson, R. (2004), 'Is trust a risky decision?', *Journal of Economic Behavior & Organization* **55**(44), 447–456.

Friedman, D. (1996), 'Equilibrium in evolutionary games: Some experimental results', *The Economic Journal* **106**, 1–25.

Gneezy, U. & Potters, J. (1997), 'An experiment on risk taking and evaluation periods', *The Quarterly Journal of Economics* **112**(2), 631–645.

Greene, W. H. (2012), *Econometric Analysis*, Prentice Hall, Upper Saddle River, 7th Edition.

Greiner, B. (2004), The Online Recruitment System ORSEE 2.0 - A Guide for the Organization of Experiments in Economics, Working Paper Series in Economics, University of Cologne, Department of Economics.

Harsanyi, J. & Selten, R. (1988), *A General Theory of Equilibrium Selection for Games with Complete Information*, Cambridge, M.I.T. Press.

Harsanyi, J. & Selten, R. (1995), 'A new theory of equilibrium selection for games with complete information', *Games and Economic Behavior* pp. 91–122.

Holt, C. A. & Laury, S. K. (2002), 'Risk aversion and incentives effects', *American Economic Review* **92**(5), 1644–1655.

Kandori, M., Mailath, G. J. & Rob, R. (1993), 'Learning, mutation, and long run equilibria in games', *Econometrica* **61**(1), 29–56.

Kotchen, M. J. & Reiling, S. D. (2000), 'Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species', *Ecological Economics* **32**(1), 93–107.

Ly, K., Mazar, N., Zhao, M. & Soman, D. (2013), A practitioner's guide to nudging, Research Report Series - Behavioural Economics in Action, Rotman School of Management, University of Toronto.

McKelvey, R. & Palfrey, T. (1995), 'Quantal response equilibria for normal form games', *Games and Economic Behavior* **10**, 6–38.

Metha, J., Starmer, C. & Sugden, R. (1994*a*), 'Focal Points in Pure Coordination Games', *Theory and Decision* **36**, 163–185.

Metha, J., Starmer, C. & Sugden, R. (1994*b*), 'The nature of salience: An experimental investigation of pure coordination games', *American Economic Review* **84**, 658–673.

Moseley, A. & Stoker, G. (2013), 'Nudging citizens? prospects and pitfalls confronting a new heuristic', *Resources, Conservation and Recycling* **79**, 4–10.

Newman, C., Howlette, E., Burton, S., Kozup, J. & Tangari, A. (2012), 'The influence of consumer concern about global climate change on framing effects for environmental sustainability messages', *International Journal of Advertising* **31**(3), 511–527.

Schelling, T. (1960), *The Strategy of Conflict*, Cambridge, MA: Harvard University Press.

Schmidt, D., Shupp, R., Walker, J. & Ostrom, E. (2003), 'Playing safe in coordination games: the roles of risk-dominance, payoff dominance and history of play', *Games and Economic Behavior* pp. 281–299.

Sefton, M., Shupp, R. & Walker, J. (2007), 'The effect of rewards and sanctions in provision of public goods', *Economic Inquiry* **45**(4), 671–690.

Straub, P. (1995), 'Risk dominance and coordination failures in static games', *Quaterly Review of Economics and Finance* **35**, 339–363.

Thaler, R. & Sunstein, C. (2008), *Nudge: Improving Decisions About Health, Wealth and Happiness*, Yale University Press, Penguin.

Turaga, R. M. R., Howarth, R. B. & Borsuk, M. E. (2010), 'Pro-environmental behavior', *Annals of the New York Academy of Sciences* **1185**, 211–224.

Van Der Linden, S. (2015), 'Intrinsic motivation and pro-environmental behaviour', *Nature Climate Change* **5**, 612–613.

Appendix A: Estimations using the probit model

Table A: One-shot game, probit model

Variable	Coefficient	Clustered-robust std.err.	Marginal effect	Std.err (delta method)
Treatment XN	-0.791**	0.337	-0.307**	0.124
Treatment XP	0.126	0.321	0.044	0.114
Treatment YN	-0.084	0.338	-0.032	0.125
Treatment YP	-0.948***	0.336	-0.364***	0.119
GP investment	-0.021	0.034	-0.008	0.012
NEP score	-0.003	0.014	-0.001	0.005
Intercept	0.373	0.827	–	–
Observations	178			
Log-likelihood	-112.581			
Pseudo-R^2	0.085			

Dependent variable: choice of X. Results obtained from probit regression.
The right panel represents the average marginal effects.
For treatment variable, marginal effect corresponds to discrete change from 0 to 1).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B: Estimation results of the probit model for individual choice of X, repeated game

Variables	Coefficient	Clustered-robust std.err.	Marginal effect	Std.err. (delta method)
Treatment XN	-0.530***	0.200	-0.064**	0.027
Treatment XP	0.033	0.210	0.003	0.025
Treatment YN	0.429*	0.231	0.052*	0.031
Treatment YP	-0.405**	0.198	-0.048*	0.026
GP investment	0.069	0.029	0.003	0.003
NEP score	0.007	0.011	0.001	0.001
Intercept (or α)	1.112	0.603	–	–
β	3.712***	0.264		
d	0.638***	0.044		
q_0	0.509***	0.031		
Observations	3560			
Numbers of players	178			
Number of groups	89			
Number of periods	20			
Log-likelihood	-650.672			
Pseudo-R^2	0.734			
LR test for $\beta = d = q_0 = 0$	2420.76***	p-value = 0		

Dependent variable: Individual choice of X. Results obtained from Gaussian regression model.
The right panel represents the average marginal effects.
For treatment variable, marginal effect corresponds to discrete change from 0 to 1).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.