DEPARTMENT OF MANAGEMENT

COLORFUL ECONOMICS:

SEEING RED IN A PRISONER'S DILEMMA GAME

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RESEARCH PAPER 2009-017
ACED 2009-007
NOVEMBER 2009

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D/2009/1169/017
^{A}CED/2009/007

Colorful Economics:

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November 2009

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** This project was financially supported by an Odysseus grant from the Flemish Science Foundation (FWO).

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Abstract

The color red has been found to influence behavior and performance in a wide range of settings. We introduce the color red in a Prisoner's Dilemma by performing a series of one-shot and repeated Bertrand duopoly laboratory games. We hypothesize a positive relationship between the color red and the number of competitive choices. Furthermore, we expect to see a habituation effect, implying that the impact of red on competitive behavior is more pronounced at the beginning of the experiment, to then fade away over time. Results indicate that the effect of the color red on cooperative behavior is more complex than hypothesized. We find no main effect for the color red, but we do reveal a significant habituation effect of the color red in the one-shot games. Contrary to our expectation, however, an escalation effect emerges in the repeated game, which suggests that the competition-enhancing effect of red is reinforced by receiving feedback about the other party's choice.

JEL classification: C72, C73, C91

PsycINFO classification: 2260

Key words: color; cooperation; prisoners dilemma game

1. Introduction

Despite a vast amount of empirical research, our understanding of cooperative behavior is still far from complete. The rational player as proposed by traditional game theory does seem to be rare. Consequently, countless studies have attempted to reveal the conditions that spur cooperation. According to Boone, Declerck, & Suetens (2008), at least two different classes of determinants of cooperative behavior can be distinguished, namely social information (e.g., in the form of subtle social cues about the opponent) and ecological information (e.g., as to strategic opportunities through incentive structures). With regard to the former, Kiesler, Sproull, & Waters (1996), for instance, found that people act more cooperatively if they face other people of flesh and blood than if they deal with computers. In a similar vein, cooperation is promoted when playing against friends as opposed to strangers (Thompson, Kray, & Lind, 1998) or against someone labeled 'partner' as opposed to 'opponent' (Burnham, McCabe, & Smith, 2000). Likewise, communication between participants stimulates cooperative behavior (Sally, 1995), even if communication is limited to silent identification of the interacting parties (Bohnet & Frey, 1999). For example, Scharlemann, Eckel, Kacelnik, & Wilson (2001) find some support for the hypothesis that a smile can elicit cooperation in a one-shot game. Yet another example is provided by Andreoni & Petrie (2008), who find that players expect beautiful people to play more cooperatively than unattractive people. Surprisingly, even mundane physical objects can induce a more competitive mindset (Kay, Wheeler, Bargh, & Ross, 2004).

Notwithstanding these examples, Utz, Ouwerkerk, & Van Lange (2004, p. 317) note that "it is fair to say that the extant literature has focused primarily on relatively explicit influences on cooperation in social dilemmas, thereby overlooking the potential ability of relatively subtle influences to affect cooperative interaction in social dilemmas." The purpose of this paper is to add another subtle psychological cue to the study of cooperative behavior:

the influence of color, particularly red. Although colors have been studied in a wide variety of settings for decades by now (e.g., in marketing and pharmacy research), there has recently been a renewed interest in the impact of color in general and the color red in particular on behavior and performance in laboratory and real-world settings.

In recent studies, the color red has been found, for instance, to *inter alia* increase the attractiveness of women in men's perception (Elliot & Niesta, 2008), to create a positive winning bias in sports matches (Attrill, Gresty, Hill, & Barton, 2008), and to impair performance in achievement tasks (Elliot, Moller, Friedman, Maier, & Meinhardt, 2007). In the present study, we bring the impact of the color red into the realm of the study of competitive *vis-à-vis* cooperative behavior. We posit that the color red will have a negative effect on cooperative behavior and a positive influence on competitive behavior. More specifically, we develop two hypotheses with regard to the impact of red on competitive behavior. First, we argue that the use of a red background in the computer screen's instructions in a Prisoner's Dilemma (PD) game will result in significantly more competitive choices. Second, we claim that this effect will fade away over time. We test this pair of hypotheses in a series of standard Bertrand duopoly one-shot games (without feedback of the opponent's choice) and repeated games (with feedback).

The structure of the paper is as follows. Section 2 provides a very brief overview of earlier color studies in general, followed by the introduction of such studies dealing with the effect of the color red in particular. Moreover, we develop our two hypotheses in this section. Section 3 introduces the experimental design, and Section 4 provides a description of our variables and methods. Results are reported in Section 5. Finally, we conclude with a discussion in Section 6.

2. The effect of the color red on behavior

Apart from countless animal studies (i.e., Pryke & Griffith, 2006; Setchell & Wickings, 2005), color studies have proven to be popular in such diverse domains as psychology (Crowley, 1993; Küller, Mikellides, & Janssens, 2009; Stone, 2001), marketing (Singh, 2006; Aslam, 2006; Yildirim, Akalin-Baskaya, & Hidayetoglu, 2007), pharmacy (Sallis & Buckalew, 1984; Jacobs & Nordan, 1979), and sports research (Hill & Barton, 2005; Rowe, Harris, & Roberts, 2005; Attrill et al., 2008). However, to the best of our knowledge, no research has been done yet on the impact of color on competitive and cooperative behavior. Also, we are not aware of any color studies in economic psychology. It is here where we seek to offer a contribution.

Many of the earlier color studies focus on the effect of red. In psychology, much work has been done on the emotional impact of color. Warm colors such as red are generally associated with activity, while cooler colors tend to be calming (Stone, 2001; Küller et al., 2009). Furthermore, the color red has also been found to make women more attractive in the eyes of men (Elliot & Niesta, 2008), and to distract men in a color-word Stroop test (Ioan, Sandukache, Avramescu, Ilie, Neascu, Zagrean, & Moldovan, 2007). In the marketing domain, the color red has been used in fast-food restaurants to stimulate appetite, while casinos use red lighting to convey the message to their customers that they are not wasting time in these places of questionable reputation (Singh, 2006). The activating role of red has been confirmed in pharmacy research, where red placebos were classified as stimulants (Jacobs & Nordan, 1979), presumed to yield high potency (Sallis & Buckalew, 1984).

Recently, a keen interest in the use and impact of the color red emerged in sports studies. In their study of Olympic boxing, tae kwon do, Greco–Roman wrestling and freestyle wrestling, Hill & Barton (2005) found that in all four sports contestants wearing red (as opposed to blue) won significantly more fights, despite the fact that outfits were assigned randomly. Similarly, Attrill et al. (2008) looked at the performance of English football teams since 1947, reporting that teams wearing red shirts have been champions more often, have the best home record, and show significantly better long-term performance. This leads them to conclude that the red advantage “applies across a range of sports, circumstances, and competitor colors” (Attrill et al., 2008, p. 581). In fact, Ilie, Ioan, Zagrean, & Moldovan, (2008) revealed that the red advantage even applies to the virtual world as red teams outperformed their blue counterparts in a popular multi-player shooter computer game.

In the present study, we examine the influence of the color red on competitive and cooperative behavior. We posit that introducing red as the background screen color in a computer Bertrand duopoly PD will result in more competitive choices. Our PD setup creates a setting in which each participant plays against a counterpart in order to earn actual money at the end of the game, as is common practice in experimental economics. It is a social dilemma interaction in which participants are inclined to play competitively (which is not unlike a sports setting), according to standard economic theory, as a result of the implied Nash equilibrium of setting competitive prices. Below, we will introduce our experimental design in detail. For now, it suffices to recognize that, in our Bertrand duopoly game, setting high prices is akin to cooperation (tacit collusion), whilst opting for low prices implies competition (price war). We argue that two general underlying mechanisms can substantiate the competition-enhancing effect of the color red: biological heritage, on the one hand, and color association, on the other hand.

Firstly, the biological heritage argument emphasizes the importance of the color red as a “sexually selected, testosterone-dependent signal of male quality” (Attrill et al., 2008, p. 577). This biological effect has been found in a wide variety of animal species. For our species, the homo sapiens, a reddening of the skin is associated with anger, whereas increased pallor is linked with fear (Hill & Barton, 2005; Attrill et al., 2008). In a PD setting such as the

Bertrand duopoly game, a more aggressive mindset triggered by the color red will generate a more competitive stance. This, in turn, will spur participants to under-price their opponents in order to maximize expected profits, which implies taking more competitive choices. Studies on the biological heritage effect of red focused on men (Ioan et al., 2007; Hill & Barton, 2005; Attrill et al., 2008; Elliot & Niesta, 2008), arguing that the testosterone mechanism is particularly active in males.[1]

Secondly, the color association argument focuses on the specific meaning of and information conveyed by color (Elliot et al., 2007). As a person goes through life, s/he encounters pairings between specific colors and particular experiences, messages and concepts. Over time, this turns into strong color associations (Elliot et al., 2007). In our study's setting, two types of color associations are particularly relevant: aggression and caution. The aggression association connects the color red to dominance and aggression, due to psychological associations (Hill & Barton, 2005; Ioan et al., 2007). One clear example of an associative link between the color red and aggression is provided by the English language through expressions such as 'fiery tempered' (Little & Hill, 2007), 'seeing red' and 'red rag to a bull'. From this, we argue that participants associating the color red with aggressive behavior will act more competitively themselves, and consequently set more competitive (low) prices in our Bertrand duopoly setting.

The association of red with caution is similarly expected to result in more competitive behavior. Elliot et al. (2007) argue that in an achievement context the color red is associated with danger, particularly linked to the psychological fear for failure. This association is the result of, for instance, the pairing of red with mistakes in education (i.e., using a red pen to correct wrong answers), the avoidance-oriented meaning of a red traffic light, and the red of warning signs (Elliot et al., 2007). In a Bertrand duopoly PD context, the caution association

[1] As our sample is too gender-biased to render gender-color interaction analyses useful, we refrain from formulating a hypothesis about the gender effect. We briefly return to this issue in the next footnote, as well as in the discussion.

with the color red implies that participant may become more risk-averse. In that case, the tendency will be to play the competitive price in order to prevent ending as the sucker (Axelrod, 1980). Consequently, both the aggression and the caution association of the color red imply the prediction of more competitive behavior – or low prices, in our setting.

Although the biological heritage and color association arguments provide different explanations for the positive main effect of red on competition, the distinction between both mechanisms is not that clear-cut. Elliot & Maier (2007, p. 251) mention, for instance, that learned associations linking red to danger "may be bolstered by or even derived from an evolutionarily ingrained predisposition across species to interpret red as a signal of danger in competitive contexts." Indeed, many of the earlier studies dealing with the red effect have based their theoretical logic on both the biological heritage and color association arguments jointly (Elliot et al., 2007; Elliot & Niesta, 2008; Ioan et al., 2007). In our case, we follow this tradition, and expect the biological heritage and color association mechanisms to jointly trigger more competitive choices. This gives

Hypothesis 1 *(red effect): The color red is positively associated with the number of competitive choices in a Prisoner's Dilemma.*

Although the red effect is hypothesized to have a significant impact on the number of competitive choices, we do not expect this effect to continue unabated over time. From psychology, we know that the effect of stimuli may be reduced over time as a result of habituation, which is "a decline in the tendency to respond to stimuli that have become familiar due to repeated exposure" (Gleitman, 1995, p. 106). Regarding the color red, Wolfson & Case (2000) manipulated screen background colors in a number of computer games, and found that both performance and heart rate of players with a red background peaked midway the experiment, but then started to deteriorate. This fading effect of the color red is attributed to habituation.

In our setting, an additional argument implies that we would expect the red effect to fade away over time. Many studies have shown that subtle influences are likely, at some point, to be pushed aside by strategic considerations. Charness & Gneezy (2008), for instance, found that the slight difference in social distance caused by revealing a partner's surname in an ultimatum game is quickly crowded out by strategic considerations. We therefore expect the red effect on competitive behavior to fade away over time in our Bertrand duopoly experiment, too, due to the habituation effect. This is further reinforced in the repeated game, as then strategic considerations will dominate in response to feedback about the other's behavior. This provides

Hypothesis 2 *(habituation effect): The positive relationship between the color red and the number of competitive choices in a Prisoner's Dilemma will fade away over time.*

3. Experimental Design

The experiment was conducted in a laboratory setting at Utrecht University (the Netherlands) in the spring of 2009. Participants were recruited through an email announcement from a large pool of university students, across all disciplines and programs. The experiment took place in one large computer room, with a network of connected PCs in walled cubicles, which could seat up to twenty participants at a time. Four sessions were held, all on the same day. In order to minimize time of day differences, all participants were given a green background (control group) in sessions 1 and 3, and a red background (experimental group) in sessions 2 and 4. Our experimental setting is the basic two-player Bertrand PD, with product homogeneity and non-binding capacities (see, e.g., Boone, De Brabander, & van Witteloostuijn, 1999). Participants were asked to play the role of a firm's top manager, and to make a choice between playing a low (competitive) or a high (cooperative) price. The complete instructions are included in the Appendix. Payoffs are based on the participant's own choice and the choice of the other party, as indicated in Table 1.

[Insert Table 1 about here]

The experiment consisted of two series of games: one-shot and repeated games, both with Table 1's payoffs. In the one-shot version, participants were asked to choose between a low and a high price for six rounds, without any feedback about payoffs or the other party's choices, neither along the way nor after round 6. Participants are randomly matched with another player in each round. Directly after the one-shot games, participants played a repeated game with an uncertain horizon, with the same payoffs. Compared to the one-shot games, where competition is the dominant Nash strategy, we would expect to see more cooperation (i.e., high prices) in the repeated game, in line with the Folk Theorem. So, the repeated game is identical to the one-shot game setup, except from three changes. First, participants now play against the same (anonymous) person throughout the entire repeated game part of the experiment. Second, the duration of the game is unknown beforehand. We announced that the game would last for at least 10 rounds, with a maximum of 20 rounds. We explained that a random generator incorporated in the experimental computer program would decide if an additional round was played after round 10 (with a 50% probability). Third, after each round, feedback was given about the pricing choice of the other firm, and the payoffs that resulted from the combined choices.

The experiment was programmed with the well-known z-Tree software (Fischbacher, 2007). Key is the programming of different background screen colors. Two versions of the Bertrand duopoly PD were created: one with a red background (the experimental group: sessions 2 and 4) and one with a green background (the control group: sessions 1 and 3). The choice for the color green as a contrast to red is in line with common practice in many color studies. For example, green is used as the opposite color to red in opponent color models

(Plataniotis & Venetsanopoulos, 2000). We made use of the standard colors red and green available in z-Tree that have identical luminosity and saturation, and a hue of 0° (red) and 80° (green), respectively.

The experiment commenced by asking participants to take a seat in the waiting room located next to the experimental laboratory. As more than twenty participants were invited for each session (to account for possible no-shows), each participant was given a random seat number between 1 and 20. Any participants showing up after the experimental room had been filled (and who were still on time) were sent home with a € 5 show-up fee. No subject was allowed to participate in more than one session. Game instructions were distributed, and subsequently participants had the opportunity to ask questions to one of the experimenters, if needed. After having read and understood the instructions, participants were instructed to click on a continue button. The one-shot game part of the experiment began immediately after the last participant had clicked on the continue button. After the one-shot part (which lasted for about ten minutes, including reading the instructions), participants had to click on a continue button, again, to proceed to the repeated game part of the experiment. This part lasted for about five minutes. The number of rounds in the repeated game part of the experiment was unknown beforehand, as mentioned above: it turned out that 13, 10, 11 and 10 rounds were played, respectively. Only data from the first 10 rounds of the repeated version of the game are used in the analysis.

Finally, while the experimenters calculated the earnings of the participants and put these earnings into envelopes, participants had to fill out a questionnaire, which was meant to provide information about a series of control variables such as the participants' age, gender, and prior knowledge of the self-interest model of economics (see below). The questionnaire took about five minutes to complete. At the end of the session, participants were asked to remain seated until one of the experimenters had provided them with the envelope containing her or his earnings. Earnings from the experiment are based on total payoffs from both the one-shot and repeated games, divided by 1,800 to arrive at the earnings in Euros. Earnings for the experiment averaged at slightly under € 6. Each session lasted for about 30 minutes in total. This incentive scheme was explained in the instructions.

4. Variables and Methods

The **dependent variable** of our study is a choice dummy, *Decision*, with a value of 1 for a competitive price and a value of 0 for a cooperative price. We have two **independent variables**. The first (Hypothesis 1) is the color red, which is operationalized as a dummy variable, *Color*, with a value of 1 if the screen's background color is red and 0 if the color is green. The second is included in order to explain the dynamics of the impact of the color red over time (Hypothesis 2): we added the period number of the game as a continuous variable, *Period*, and interacted this dummy with the color red through a *Color*Period* product term. We added four **control variables**. *Gender* is included as a control dummy variable (with a value of 1 for males and 0 for females), as the literature generally indicates that females act more cooperatively than males in these types of games (see, for instance, Ortmann & Tichy, 1999). We also include two other well-established control variables: *Age* and *Familiarity*, the latter reflecting knowledge of the self-interest model of economics. *Age* is included as a continuous variable, because we expect cooperation to increase with age (i.e., Gächter, Herrmann, & Thöni, 2004). We control for prior knowledge of the self-interest model of economics, since this has been found to alter self-interested behavior (Frank, Gilovich, & Regan, 1993), by creating a dummy variable that measures whether or not participants are familiar with the concept of Prisoner's Dilemma games (yes = 1; no = 0). Finally, in the repeated games, we added the lagged *Other's Decision*, to control for the previous price choice made by the counterpart.

In order to analyze the effect of the color red over time, we ran a Generalized Estimating Equation model (GEE) logit panel analysis. The GEE generalizes quasi-likelihood estimation to a panel data context (i.e., Liang & Zeger, 1986). It is a very flexible approach for dealing with clustered data, offering the opportunity to account for different within-subject autocorrelation structures by specifying a working correlation matrix. After inspection, we found that the exchangeable autocorrelation matrix fits our data best. The models presented below were also estimated with so-called unstructured and independent autocorrelation matrices, by way of robustness analyses. These estimates are qualitatively similar (not reported here). As we cannot assume that the observations within the subjects are independent, we use robust standard errors. All models were estimated using the XTGEE routine in Stata 10.

5. Results

Descriptive statistics

Tables 2 and 3 provide descriptives and zero-order correlations of both the one-shot and repeated games (pooled samples; N = 78 participants * 6 one-shot rounds = 468 observations, and N = 78 participants * 10 repeated rounds = 780 observations, respectively).

[Insert Table 2 and 3 about here]

Our final sample involves 78 participants (40 assigned to the green and 38 to the red condition). Participant’s age averages at just over 21 years. The percentage of males is low (26.9%). Roughly 42% of the participants indicated that they were familiar with the concept of a Prisoner’s Dilemma game. To check if participants were aware of the background color used in the experiment, they were asked about the purpose of the experiment in the post-experiment questionnaire. None of the participants mentioned the word color in their answer.

One-shot games

Figure 1 provides an overview of the percentage of competitive choices in the six rounds of the one-shot game.

[Insert Figure 1 about here]

Overall, we find that the percentage of competitive choices is very high (ranging from 68.4% to 89.5% per round). Nevertheless, Figure 1 clearly indicates that players confronted with a red background play more competitively than 'green' players in rounds 1 and 2 of the one-shot game. This difference is significant, offering partial support for Hypothesis 1. Yet, from round 3 onwards, we can no longer observe a discernible difference between the red and green group.

The results of the GEE analysis for the one-shot games are provided in Table 4.

[Insert Table 4 about here]

Our baseline Model 1 has a poor fit, which could be explained by the lack of individual heterogeneity in our sample. Most importantly, we do not have a main effect for the *Color* red, and consequently do not find support for our Hypothesis 1 here. Adding our interaction variable between *Color* and *Period* in Model 2 improves the model fit significantly. In Model 2, we find a significantly negative relationship for the interaction between *Color* and *Period* ($p < 0.05$), as expected, indicating that the number of competitive choices of players in the red condition is reduced over time. These results are in line with our visual inspection of Figure 1, providing support for Hypothesis 2.[2]

Repeated games

Figure 2 provides an overview of the percentage of competitive choices in the repeated games.

[2] We have also tested for an interaction effect between *Color* and *Gender*, but this effect did not become significant, neither in the one-shot nor in the repeated game analysis. Probably, this is due to the lack of gender variation in our sample.

[Insert Figure 2 about here]

The percentage of competitive choices is high, again, as was the case in the one-shot games. The repeated games were played right after their one-shot counterparts. Consequently, the priming effect of the color red should have died out, given Hypothesis 2's habituation argument, which is why we do not find a red effect at the beginning of the repeated games. However, completely contrary to our expectation, the red effect 'flares' after round 3, boosting the percentage of competitive choices to 89.5% in round 10 for players in the red condition.

These results are confirmed by our GEE analysis, as shown in Table 5.

[Insert Table 5 about here]

In our baseline Model 3, the *Period* variable is significant ($p < 0.01$) with a positive coefficient, indicating that players play more competitively over time in the repeated games. Again, there is no main effect for *Color*, however, which means that we find no support for Hypothesis 1. The interaction variable between *Color* and *Period* is, as above, significant in Model 4 ($p < 0.05$), only this time the coefficient is positive as opposed to the negative coefficient in the one-shot games. Adding the lag of the *Other's Decision* in Models 5 and 6 does not significantly alter our results. The positive sign for the interaction variable coefficient is quite puzzling, as we did not expect to find an escalation effect of the color red. A possible explanation for this unexpected finding is provided by Andreoni & Petrie (2008). In this study, a public goods game is used in order to determine the returns to beauty and gender. When only the contribution of the group as a whole is revealed, they find evidence for a beauty premium (attractive people make more money). However, if individual contributions become observable, the beauty premium turns into a beauty penalty. Consequently, "people seem to expect beautiful people to be more cooperative than others, and when their behavior does not meet expectations, people are less cooperative with them" (Andreoni & Petrie, 2008,

p. 74). In our own setting, the same principle seems to hold. At the beginning of the repeated games, there is no significant red effect, as expected. However, when during the game players with a red background observe that the other party is not cooperating, their response is much stronger than we would expect based on solely rational reasons. We return to this issue in the discussion.

6. Discussion

A huge body of literature attempts to explain cooperative behavior in an experimental setting. Previous research has indicated that very subtle cues can significantly influence cooperative behavior, but to date no study has sought to investigate the effect of color on cooperative behavior – or competitive behavior, for that matter. In the current study, we contribute to this literature by performing an experimental study in which the effect of the color red on competitive and cooperative behavior is explicitly tested. The experiment consisted of standard one-shot and repeated Bertrand duopoly games, in which our experimental group received instructions against a red and our control group against a green background on the computer screen.

We do not find much support for our first hypothesis, which suggests a positive main effect of the color red on competitive behavior, neither in the one-shot nor in the repeated games. We do find partial support for our second hypothesis, which states that the effect of the color red will fade away over time. In the first two rounds of the one-shot games, players in the red condition indeed made significantly more competitive choices than their green counterparts, which offer partial support for Hypothesis 1, but after the second round the habituation effect came in, eliminating any significant difference between our experimental and control group. Surprisingly and interestingly, however, we find the opposite effect in the repeated games. That is, in the repeated games, the red effect gains intensity over time, which goes against both our second hypothesis and our results from the one-shot games.

Here, we offer a speculative interpretation to explain this unexpected finding. Apparently, the combination of seeing red and receiving feedback about the other party's choice causes an escalation effect, which boosts competitive behavior to a very high level. This escalation effect only occurs when there is observable and repeated interaction with another (anonymous) party. After all, the habituation effect that we witness in the one-shot games does not occur in the repeated game setting, as the red effect reemerges after the initial rounds of the repeated games, to remain active throughout the entire interaction period. Our interpretation is that the red effect reinforces the stimulus received from the other party's choices. Put differently, red may trigger more forceful tit-for-tat behavior in iterative settings, not unlike the beauty penalty described by Andreoni & Petrie (2008). Such an escalation effect interpretation makes sense in settings of other color studies as well. For example, soccer teams with red shirts would probably not be more successful than their non-red opponents if the red effect only lasted for the first few minutes of a match.

Our study has several limitations that might serve as the starting point for future research. We would like to briefly refer to two of these. Firstly, our sample consists of a relatively homogeneous subject pool in terms of demographic characteristics. It could be worthwhile to study the effect of color with a more diverse group of subjects. Particularly interesting might be the effect of gender. We identified two underlying mechanisms that could explain the red effect: biological heritage and color association. The biological heritage argument predicts a gender effect. However, we do not find such a gender effect in our analyses, which could imply that color associations are the main driving force behind the red effect in our specific context. This finding is difficult to generalize, however, as the majority of our randomly selected sample is female.

Secondly, our experimental design can be easily extended in two directions, at least. For one, we have only studied the effect of the color red, using green as the benchmark. Future research might focus on other colors, such as the achromatic colors white and gray. Furthermore, the dyads were provided with the same background color in each session (red versus red or green versus green). It might be worthwhile to match subjects with a green screen with opponents with a red screen, to explore whether or not the red-green background combination produces results that are different from the red-red and green-green findings obtained in the present study. Moreover, we have limited our design to the specific setting of the standard Bertrand duopoly Prisoner’s Dilemma. It would be interesting to determine if the red effect also applies to other economic settings, such as a dictator game or public goods game – and if so, if the effect is similar to the effect that we have found here.

Acknowledgements

We would like to thank Stephanie Rosenkranz and Vincent Buskens for using the ELSE laboratory, and for their valuable comments as to programming and design issues. Furthermore, we benefitted from the support of colleagues, particularly Saraï Sapulete, who helped us out with the pilot experiment.

Appendix: Experimental instructions

Experimental Laboratory for Sociology and Economics Universiteit Utrecht

- Instructions -

- Setting -

Welcome to the experiment! The following experiment consists of three phases. In phase 1 and phase 2, you take on the role of a firm and are asked to make a pricing decision, while phase 3 consists of a questionnaire. Note that both your actions during phases 1 and 2, as well as the information provided in the questionnaire in phase 3, will be treated confidentially.

During phases 1 and 2, there are only two choices available: a low price and a high price. Your payoff depends on both your own price and the price of the other firm. The possible payoffs are provided in the following table.

<u>Payoffs for the experiment: payoff for your choice is shown first</u>

	OTHER FIRM'S CHOICE Low price	 High price
YOUR CHOICE Low price	(570, 570)	(1200, 0)
High price	(0, 1200)	(900, 900)

As you can see from the table, there are four potential outcomes. If, for instance, your choice is to play a low price, and the other firm also chooses to play a low price, then both of you will make a profit of 570. If both of you decide to play a high price, then you will both make a profit of 900. Finally, if you play a low price and the other firm plays a high price, you will make a profit of 1200, while the other firm makes no profit at all, and vice versa.

A screenshot of phases 1 and 2 is shown below in a figure.

Screenshot of the input screen, phases 1 and 2

In the middle of the screen, you see the input box where you need to indicate your pricing decision. Making a decision is really easy; you either type in a 1 for a low price or a 2 for a high price, and then click on the OK button.

In the upper right corner, you see the time remaining for your choice. You have 30 seconds per round to make your choice and to click on the OK button.

- Phase 1 -

Phase 1 consists of six rounds in which you are asked to make a pricing decision. Note that in each round you play against a different firm. No feedback is provided about the choice of the other firm, nor about your payoff.

- Phase 2 -

In phase 2, you will again make a pricing decision, only this time you will play against the same firm in each round. Furthermore, after both you and the other firm have confirmed the pricing decision for that round, you will see your own choice, the other firm's choice and your payoff. Click on the OK button; then, the next round of the game will begin. The duration of this part of the experiment is unknown beforehand, although it will last for a minimum of 10 rounds and a maximum of 20 rounds. After the tenth round, for each round thereafter the program will randomly determine if another round will be played or not; the chance that another round will be played after round 10 is equal to 50% for each consecutive round (i.e., if there will be a round 11, there is again a 50% chance that there will be a round 12, et cetera).

- Phase 3 -

In the third and final phase, we ask you to fill out a small questionnaire. Both at the beginning and at the end of the questionnaire, your final earnings from the experiment are shown. The answers to the questionnaire do not influence your payoffs, but are nonetheless an important part of the experiment.

- Earnings -

All payoffs from phases 1 and 2 are added to calculate your total payoff. This total payoff is divided by 1800 in order to calculate the actual amount of euro's which you will receive at the end of the session. Earnings will be rounded up to the nearest 20-cent mark. After completing the questionnaire, please remain seated until we have given you your payment.

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Figure 1

Competitive behavior in the one-shot games

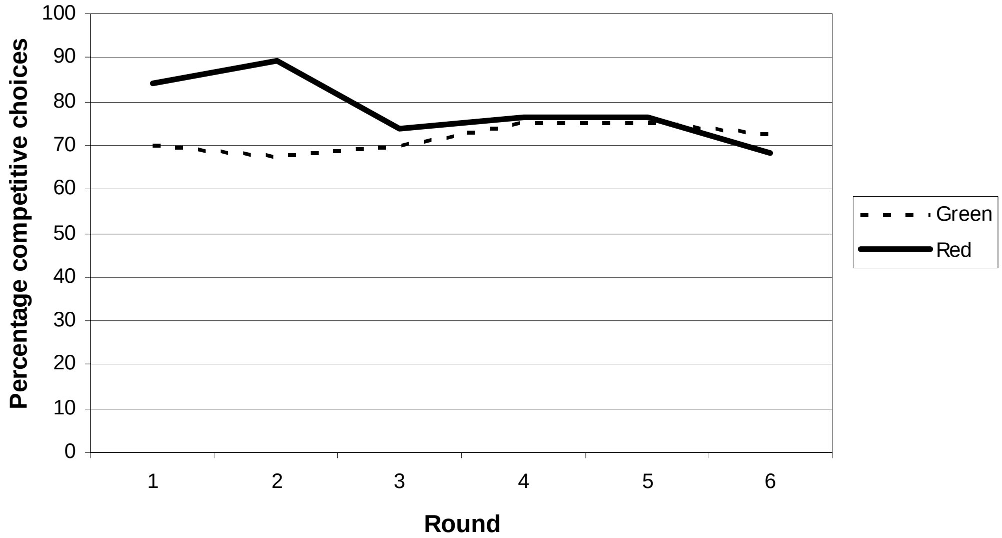

Figure 2

Competitive behavior in the repeated games

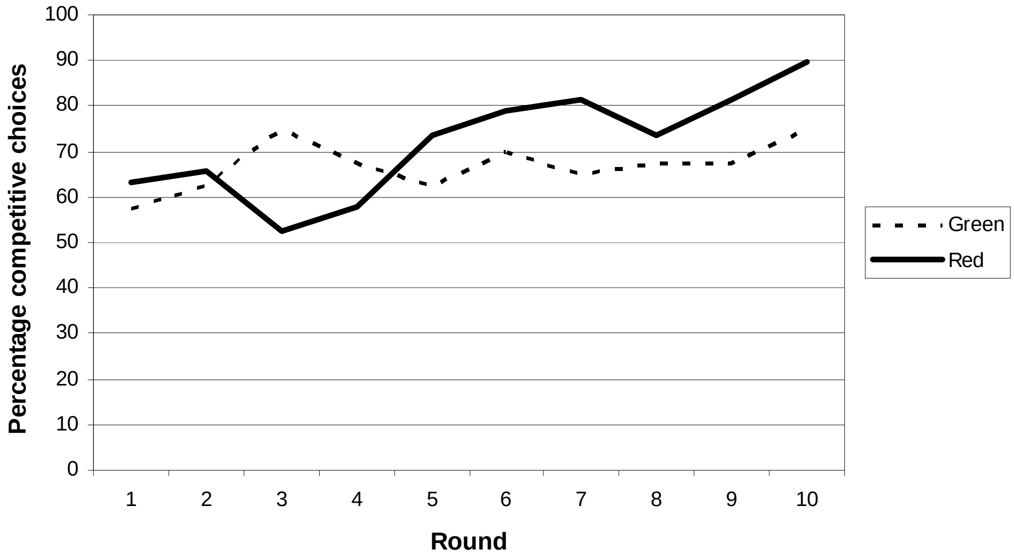

Table 1

Strategy-profit matrix Prisoner's Dilemma

		FIRM II	
		Low price (P_{II}^{L})	High price (P_{II}^{H})
FIRM I	Low price (P_{I}^{L})	(570, 570)	(1200, 0)
	High price (P_{I}^{H})	(0, 1200)	(900, 900)

Table 2

Descriptive statistics of one-shot games (pooled sample)

Measures	Mean	SD	1	2	3	4	5
1. Decision	0.75	0.43	1				
2. Color	0.49	0.50	0.07	1			
3. Age	21.28	3.44	-0.08	-0.07	1		
4. Gender	0.27	0.44	0.08	-0.07	0.17 *	1	
5. Familiarity	0.42	0.49	0.10 *	0.10 *	0.01	0.12 *	1

$N = 468$.
*$p < .05$ (two-tailed).

Table 3

Descriptive statistics of repeated games (pooled sample)

Measures	Mean	SD	1	2	3	4	5	6
1. Decision	0.69	0.46	1					
2. Color	0.49	0.50	0.05	1				
3. Age	21.28	3.44	0.09 *	-0.07 *	1			
4. Gender	0.27	0.44	0.03	-0.07 *	0.17 *	1		
5. Familiarity	0.42	0.49	-0.07	0.10 *	0.01	0.12 *	1	
6. Other's Decision (lagged)	0.68	0.47	0.42 *	0.04	0.06	0.01	-0.04	1

N = 780, except for other's decision (*N* = 702).
*p < .05 (two-tailed).

Table 4

One-shot game analysis

Measures	Model 1	Model 2
Color	0.30	**1.26 ****
	(0.31)	(0.53)
Period	-0.06	0.06
	(0.06)	(0.08)
Age	-0.06	-0.06
	(0.05)	(0.05)
Gender	0.56	0.58
	(0.36)	(0.36)
Familiarity	0.42	0.41
	(0.32)	(0.32)
*Color*Period*		**-0.26 ***
		(0.12)
Constant	(3.04) **	(2.61) *
	(1.23)	(1.27)
Wald chi2	6.69	12.04
Prob chi2	0.25	0.06

N = 468; robust standard errors are reported in parentheses.
*p < .05; and ** p < .01 (one-tailed).

Table 5

Repeated game analysis

	Model 3	Model 4	Model 5	Model 6
Color	0.25	-0.34	0.27	-0.61
	(0.29)	(0.41)	(0.26)	(0.49)
Period	**0.10 ****	**0.04 ****	**0.09 ****	**0.02 ****
	(0.03)	(0.05)	(0.04)	(0.05)
Age	0.05	0.06	**0.08 ***	**0.09 ***
	(0.06)	(0.06)	(0.05)	(0.05)
Gender	0.16	0.14	0.27	0.24
	(0.35)	(0.36)	(0.31)	(0.31)
Familiarity	-0.36	-0.38	-0.31	-0.34
	(0.30)	(0.30)	(0.27)	(0.27)
*Color*Period*		**0.12 ***		**0.16 ***
		(0.06)		(0.07)
Other's Decision (lagged)			**1.27 ****	**1.21 ****
			(0.23)	(0.23)
Constant	-1.02	-0.97	-2.29 *	-1.99 *
	(1.34)	(1.31)	(1.15)	(1.13)
Wald chi2	13.56	17.82	40.62	48.65
Prob > chi2	0.02	0.01	0	0

N = 780 in Models 3 and 4; *N* = 702 in Models 5 and 6 (due to the lagged other's decision variable); robust standard errors are reported in parentheses.
**p* < .05; and ** *p* < .01 (one-tailed).